Information Free Mechanisms for Regulating Bank Risk: Market Discipline and Its Effect on Systemic Risk

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Abstract

This paper studies a robust mechanism design problem for regulating banks risk taking. We assume that the regulator has no information regarding the riskiness of the banks assets and analyze the ability of market discipline, via mandatory subordinated debt issuance, to create incentives for banks to take less risk. We show that in a model where small banks issue subordinated debt to larger banks (a key assumption in mandatory subordinated debt proposals) and Nash bargain over the interest rate, that the smaller bank will choose a higher level of correlation between its assets and the large bank’s leading to an increase in systemic risk through a higher joint probability of failure. Furthermore, under some conditions, the mandatory subordinated debt proposal may in fact lead to an increase in the banks preferred risk of failure.

Since the introduction of federally insured deposits, there has been a large concern over how to properly regulate banks to keep them from engaging in excess risk taking at the tax payers expense. One of the key difficulties that regulators face is a lack of information regarding the underlying riskiness of a bank’s assets which is compounded by the fact that a banks portfolio can change dramatically over short periods of time. This lack of information led to many risk shifting activities by banks, largely intended to arbitrage risk based capital regulations, that played a large role in the cause and aftermath of the financial crisis (see e.g. Acharya and Suarez (2013)). In this paper we study a robust mechanism design problem whereby we assume that the regulator has no information regarding the riskiness of bank assets and analyze the ability of market discipline

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*This is a very preliminary draft. Please do not circulate with out the authors consent.
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to create incentives for banks to take less risk. Our main result is that a mandatory subordinated debt requirement can in fact lead to more risk taking and higher levels of systemic risk (i.e. correlated probability of bank failure) when small banks issue subordinated debt to large banks (a key component of current proposals).

For over 30 years now economists have been suggesting to complement bank capital regulation with a mandatory subordinated debt claim that would in effect impose market discipline on banks (see Evanoff and Wall (2000) for a survey of such proposals). Subordinated debt is uninsured and unsecured (i.e. involves no collateral) debt issued by a bank that receives the lowest priority to be repaid in the event that the bank is insolvent. The attractiveness of forcing banks to issue a mandatory amount of subordinated debt on a regular basis then comes from the fact that the required rate of interest on such debt is directly linked to the probability of the banks default. Therefore, if the bank is taking large risks, leading to a large probability of default, it will also face a high cost of refinancing its subordinated debt (for evidence of the relationship between risk and subordinated debt pricing see e.g. Federal Reserve Study Group on Subordinated Notes and Debentures (1999)). In this sense, a mandatory subordinated debt issue could help as a way to make banks internalize the risk that they impose on tax payers thereby aligning the incentives of the bank and the regulators. The relevance of the market discipline approach is large and gaining traction as evidence by the introduction of subordinated debt as tier 2 equity capital in the Basel Accords (i.e. it qualifies, to a limited extent, as regulatory capital).

In this paper we analyze a key issue in mandatory subordinated debt proposals; that smaller banks with a less established market for their subordinated debt will need to issue their debt to larger banks. For example, Calomiris (1999) proposes explicitly:

“Small domestic banks (those that may find it difficult to gain access to foreign banks as potential depositors or to international debt markets) must maintain a minimum fraction (say, 2%) of their risky (non-Treasury bill) assets in the form of uninsured time deposits held by large domestic banks or foreign banks."

In this paper we model such an interaction between a large and small bank in an over the counter style Nash bargaining environment (for the use of Nash bargaining in interbank lending models see e.g. Afonso and Lagos (1015)) whereby they negotiate over the interest rate charged based on the level of risk taken by the small issuing bank. Our key result, using a general model, is that the small issuing bank can correlate its portfolio with the large bank to benefit from a lower interest rate. This comes from the fact that the large bank, due to limited liability and its ability to obtain cheap funding via insured deposits, only cares about the risk of default of the small issuing bank when pricing its subordinated debt in the event that the small bank defaults but the large bank remains...
solvent. Therefore, when the joint probability of failure between the two banks increases, there is a larger surplus to be shared among them. We show that by imposing a minimum subordinated debt requirement the regulator incentivizes the smaller bank to increase the joint probability of failure of both banks, thereby increasing systemic risk (in the sense of correlated bank failures). Furthermore, the benefit of correlating the risk of failure may provide incentives for the small issuing bank to also increase its level of idiosyncratic risk (i.e. the its marginal probability of failure) completely undermining the intention of the mandatory subordinated debt issue in the first place.

1 Model

In this section we will outline the model used to obtain our results. Banks, indexed by \( i = 1, \ldots, n \), finance their time \( t \) investments of size \( A_i^t \) with equity capital \( K_i^t \), deposits \( D_i^t \), and subordinated debt \( S_i^t \). Bank \( i \)’s investment opportunity set is characterized by \( \mathcal{F} \) which consists of a set of set of cumulative distributions over asset returns \( q_i \in \mathbb{R} \). Namely, after choosing \( F \in \mathcal{F} \), the expected return from Bank \( i \)’s investments is

\[
R_F := \int_{-\infty}^{+\infty} q \, dF(q)
\]

we further categorize \( \mathcal{F} \) into families of distributions \( \mathcal{F}(\beta, K) := \{ F \in \mathcal{F} : F(-K) = \beta \} \) such that the probability of insolvency of Bank \( i \) with equity capital \( K_i^t \) who chooses a distribution of returns \( F_i \in \mathcal{F}(\beta, -K_i^t) \) is exactly \( \beta \). To limit the amount of risk exposure that banks optimally take (i.e. the solution to the banks optimization problem being an infinite variance portfolio), we will make the following assumption regarding the classes of return distributions:

**Assumption 1:** \( R_F \) is concave function of \( \beta \). Namely, the marginal gains from taking excess risks are decreasing.

We assume that at time \( t = 0 \), Bank \( i \) has some exogenous level of equity capital \( K_i^0 \). According to the capital regulation, banks with capital holdings \( K_i^1 \) (potentially different from \( K_i^0 \)) should restrict themselves to return distributions \( F_i \in \mathcal{F}(\alpha, K_i^1) \) where \( \alpha \) is an exogenous regulatory parameter determining the maximum probability of individual bank insolvency the regulator is willing allow.\(^1\) We assume that there is a cost to recapitalization. Namely, Bank \( i \) faces a convex

\(^1\)Of course, the purpose of the following analysis is understand under what conditions such a regulatory scheme is incentive compatible.
increasing cost (for justification, see e.g., Myers and Majluf (1984)) \( c(K^i_t|K^i_{t-1}) \) when recapitalizing from \( K^i_0 \) to \( K^i_1 > K^i_0 \). Finally, we assume that banks have limited liability and their deposits are fully insured by the deposit insurance fund (e.g., FDIC). The banks time \( t \) optimization problem then consists of

\[
\max_{F \in \mathcal{F}} \left( 1 - F(-K^i_t) \right) \left( \int_{-K^i_t}^{+\infty} q \, dF(q) - (r_0 D^i_t + r^i_S S^i_t) \right) - c(K^i_t|K^i_{t-1})
\]

subject to \( K^i_t + D^i_t + S^i_t = A^i_t \).

where \( r_0 \) is the risk free interest rate paid on insured deposits and \( r^i_S \) is the interest paid on subordinated debt. It is worth noting that limited liability shows up in two places in the maximization problem. First, instead of maximizing the total expected returns, bank \( i \) maximizes the total expected return, conditional on solvency. Second, banks only internalize the cost of deposits and subordinated debt conditional on solvency (as indicated by the multiplicative \( 1 - F(-K^i_t) \) term).

In what follows, the regulators concern is to design a mechanism that gives each bank the incentive to curb their risk of insolvency to be no more than \( \alpha \). In what follows, for any \( F \in \mathcal{F} \), if \( F(-K^i_t) > \alpha \) we will denote by \( \beta^i_t(K^i_t) \) the probability of bank \( i \)'s insolvency exceeding \( \alpha \) so that \( F(-K^i_t) = \alpha + \beta^i_t(K^i_t) \). We will further assume that banks always choose optimally \( F^* \in \mathcal{F}(\beta, K^i_t) := \{ F \in \mathcal{F} : F(-K^i_t) = \alpha + \beta \} \) for each \( \beta \in [0, \bar{\beta}] \) where \( \bar{\beta} \) is the maximum level of risk a bank wishes to take which exists due to the concavity of \( R_F \) and the multiplicative term \( (1 - F(-K^i)) \) in the bank’s objective function. In what follows we will denote by \( R_{F^*}(\beta(K^i_t)) \) as the expected return (exceeding \( -K^i_t \)) given the optimal choice of \( F^* \in \mathcal{F}(\beta, K^i_t) \). Given these assumptions, we can rewrite Bank \( i \)'s maximization problem as

\[
\max_{\beta(K^i_t),K^i_t} \left( 1 - \alpha - \beta(K^i_t) \right) [R_{F^*}(\beta(K^i_t)) - (r_0 D^i_t + r^i_S S^i_t)] - c(K^i_t|K^i_{t-1}) \tag{1}
\]

For the moment we will assume that the bank does not face any regulatory constraints and therefore funds all of its assets with deposits at the risk free rate \( r_0 \), which we normalize to be zero.

In what follows, the key problem we will be concerned with is a bank with initial equity capital \( K^i_0 \) whose optimal solution to (1) is \( \beta(K^i_0) > 0 \) and, conditional on choosing the optimal return distribution \( F^* \in \mathcal{F}(\beta^*(K^i_0)) \), their optimal capital choice is \( K^i_1 = K^i_0 \). Namely this is the case whenever

\[
R_{F^*}(\beta(K^i_0)) < \frac{-\partial R_F(\beta(K^i_0))}{\partial \beta(K^i_0)} (1 - \alpha - \beta(K^i_0))
\]

\(^2\)Throughout the remainder of the paper we will not be interested in the case where banks repurchase equity capital in order to lower their equity capital stock in order to avoid modeling the costs and benefits of such an action and therefore do not specify the shape of \( c(K^i_t|K^i_{t-1}) \) for \( K^i_t < K^i_0 \).
Namely, by increasing equity capital, the bank decreases the probability of insolvency and therefore obtains a marginal increase in returns of \( R_F(\beta(K_0)) \) but at the same time decreases the expected marginal return by \(-\frac{\partial R_F(\beta(K_0))}{\partial \beta(K_0)} (1 - \alpha - \beta(K_0))\). Therefore, whenever the returns from decreasing the probability of insolvency is less than the decrease in the returns from less risk taking, the bank prefers not to recapitalize. It is important to note here that the regulator can formulate the problem of reducing the banks insolvency risk to less than \( \alpha \) as either inducing banks to optimally set \( \beta^*(K_0) = 0 \), or inducing banks to refinance to \( K_1 \) such that \( \beta^*(K_1) = 0 \). In what follows we will focus on how subordinated debt issues can induce the former incentives, namely how mandating that banks issue subordinated debt can produce incentives for them to lower \( \beta^*(K_0) \).

In this subsection we observe the effect of the mechanism by which the regulator mandates that bank’s issue a minimum level of subordinated debt \( \bar{S} \). Assuming that this subordinated debt is not issued to another depository institution (we will tackle this issue in the next section), then the required rate of return \( r_{S}^i \) of a risk neutral investor on one dollar of bank \( i \)'s subordinated debt is given by the equation

\[
(1 - \alpha - \beta(K_1^i))(1 + r_{S}^i) - (\alpha + \beta(K_1^i)) = 1
\]

and therefore \( r_{S}^i = \frac{2(\alpha + \beta(K_1^i))}{1 - \alpha - \beta(K_1^i)} \). In this case, the mandatory subordinated debt issue gives bank \( i \) the following optimization problem

\[
\max_{\beta(K_1), K_1^i} (1 - \alpha - \beta(K_1^i)) \cdot R_F(\beta(K_1^i)) - 2(\alpha + \beta(K_1^i)) \cdot \bar{S} - c(K_1^i|K_1^{i-1})
\]

this leads us to our first proposition.

**Proposition 1.** Let the optimal solution for a bank facing a mandatory subordinated debt issue (restricted to non-banks) \( \bar{S} \) be \( (\beta^S, K^S) \) and \( \beta^*, K^* \) the the optimal solution without such an issue. Then,

1) Banks take less risk; \( \beta^S < \beta^* \).

2) If the costs of recapitalization do not increase too quickly, then they also hold a higher level of capital \( K^S > K^* \).

What this proposition states is that when forcing banks to issue a minimum level of subordinated debt to non-banking institutions, they are incentivized to strictly decrease their probability of insolvency, regardless of the cost of capital. Then, provided that the cost of recapitalization does not increase too drastically, it may also give them the incentive to increase their equity capital holdings.
1.1 Interbank Subordinated Debt Claims

In this section we assume that there is a large bank indexed by Bank 1 and a small bank, indexed by Bank 2, who negotiate over a subordinated debt issue from the small bank to the large bank. In what follows we take a cooperative approach to subordinated debt pricing. Namely, in order to understand the longer term dynamics that will inevitably develop between small banks issuing subordinated debt to larger banks, we assume that the large bank chooses its risk level, $\beta_1$, characterized by the solution to its maximization problem (including the gains from the negotiation with bank 2), then Bank 2 chooses a level of correlation between its asset returns and the asset returns of Bank 1 (one option being complete independence). Once these decisions are made we then assume that the two banks engage in an over the counter style generalized Nash bargaining. In this sense, the interest rate $r$ paid to Bank 1 for issuing a subordinated credit to Bank 2 is determined as the solution to the following maximization problem

$$\max_r (r - \bar{r})^\theta (\bar{r} - r)^{1-\theta}$$  \hspace{1cm} (2)

where $\theta \in (0,1)$ is the bargaining power of Bank 1, $r - \bar{r}$ is the net surplus that Bank 1 receives from lending to Bank 2 (see below) at the rate $r$ and $\bar{r}$ is the markets required rate of return on Bank $j$’s subordinated debt. The solution to 2 is then

$$r = \theta \bar{r} + (1 - \theta)\bar{r}.$$  

Although not necessary to the results, for the purpose of this extended abstract we will assume that the Bank 2 chooses a level of correlation $\rho$ such that the joint probability of failure between Bank 1 and Bank 2 is given by table 1: Namely, we assume that Bank 2 chooses the correlation of solvency with Bank 1 to be equal to 1 and then decides on how to correlated the joint probability of failure by choosing $\rho \in [0,1]$.

<table>
<thead>
<tr>
<th></th>
<th>Failure 2</th>
<th>Survival 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Failure 1</td>
<td>$\beta_1 \rho$</td>
<td>$\beta_1 (1 - \rho)$</td>
</tr>
<tr>
<td>Survival 1</td>
<td>0</td>
<td>$1 - \beta_1$</td>
</tr>
</tbody>
</table>

Table 1: The joint probability $P(E_1 \cap E_2)$ of events $E_1 \in \{\text{Failure 1, Survival 1}\}$ and $E_2 \in \{\text{Failure 2, Survival 2}\}$.

In the main paper we assume that Bank 2 chooses both the level of correlation of success and failure and obtain
is one whereby both firms invest heavily in the same industry but where Bank 1 makes riskier investments in that industry than Bank 2. In such a case, when Bank 1 survives it would be an indication of good news (i.e. the riskiest investments have paid off) which means it is very likely that Bank 2 also survives (our example is an extreme case where the probability of Bank 2’s success conditional on Bank 1’s success is equal to 1). Then, given that both banks are invested in the same industry, their failure is correlated with respect to the bad state of the world which is captured by the joint probability of failure $\beta_1 \rho$. Finally, the fact that Bank 1 makes more risky investments than Bank 2 leads to a positive probability of failure for Bank 1 conditional on the survival of Bank 2.

For the purpose of this simplified example, we will assume that Bank 1 commits to a level of risk $\beta_1$ and Bank 2 chooses the level of correlation $\rho$. Then, once both $\beta_1$ and $\rho$ are fixed, the solution to the Nash bargaining solution yields the following interest rate

$$r = \theta \bar{r} + (1 - \theta) \underline{r}.$$ 

Now, in this example, the surplus $r - \bar{r}$ to Bank 1 comes from the break even equation:

$$(1 - \beta_1)(1 + \bar{r}) = 1$$

Namely, given that the probability of success between banks is perfectly correlated, Bank 1 is paid $(1 + r)$ in the event that he succeeds and never loses money on the investment (if Bank 2 fails, then Bank 1 also must have failed, implying that he does not internalize these losses). Therefore the break even interest rate for Bank 1 is $\bar{r} = \frac{\beta_1}{1 - \beta_1}$. Further, we assume that the market rate that the small bank would face is determined by

$$(1 - \beta_1 \rho)(1 + \bar{r}) - \beta_1 \rho = 1$$

where $\beta_1 \rho$ is the probability of Bank 2’s failure in this example. This leads to $\bar{r} = \frac{2 \beta_1 \rho}{1 - \beta_1 \rho}$. Therefore, the interest rate charged is

$$r = \theta \frac{2 \beta_1}{1 - \beta_1 \rho} + (1 - \theta) \frac{\beta_1}{1 - \beta_1}$$

the surplus of Bank 1 is

$$r - \bar{r} = \theta \left( \frac{2 \beta_1}{1 - \beta_1 \rho} - \frac{\beta_1}{1 - \beta_1} \right)$$

similar results.

*In the main paper we consider the result of Bank 2’s choice of $\rho$ on Bank 1’s ex ante decision of $\beta_1$.

*In fact, the underlying assumption is that the market may be sparse for the subordinated debt of small banks implying that $\bar{r} \geq \frac{2 \beta_1 \rho}{1 - \beta_1 \rho}$ meaning that the following results may be more pronounced.
and the surplus of Bank 2 is

$$\bar{r} - r = (1 - \theta)(\frac{2\beta_1}{1 - \beta_1 \rho} - \frac{\beta_1}{1 - \beta_1})$$

It is easy to see that the surplus of both Banks is increasing in $\rho$. Therefore after formulating Bank 2’s maximization problem:

$$\max_{\rho} (1 - \beta_1 \rho)(R_F(\beta_1 \rho) + (1 - \theta)(\frac{2\beta_1}{1 - \beta_1 \rho} - \frac{\beta_1}{1 - \beta_1})S_2) - c(K_1|K_0)$$

where $S_2$ is the mandatory amount of subordinated debt that Bank 2 must issue, it is easy to show that the solution to the problem when $S_2 > 0$ results in a higher level of $\rho$ (and therefore higher probability of default $\beta_1 \rho$) than when $S_2 = 0$.

**Proposition 2.** When Bank 2 is mandated to issue subordinated debt $S_2$ to Bank 1, this results in a higher probability of joint default and higher individual probability of default of Bank 2.

### 2 Conclusion

We highlight a key issue in providing informationally robust incentives for banks to curb excess risk using market discipline. Namely, we show that when small banks issue subordinated debt to large banks, this creates an incentive for the small bank to correlate their assets with the large bank to benefit from a lower interest rate. In the main paper we extend these results beyond the simple example of section 1.1 to a general correlation structure (which includes the possibility for Bank 2 to choose completely independent asset returns) and show that while subordinated debt may have indeterminate effects on the joint correlation in success it unambiguously creates an incentive for the smaller bank to increase the joint probability of failure creating systemic risk concerns. Finally, we discuss how redistributive taxes (a tax on gains and a subsidy for losses not exceeding capital) can help to alleviate these incentives.

### References


