BANK DEREGULATION, CREDIT MARKETS AND THE CONTROL OF CAPITAL

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February 1986

This paper was prepared for the Carnegie-Rochester Conference on Public Policy to be held at the University of Rochester, April 11-12, 1986. The comments and assistance of the University of Pennsylvania Macro Lunch Group, Mitch Berlin, Michael Smirlock, and especially, Roger Farmer were greatly appreciated.

Abstract

A model with endogenously arising credit markets and banks is displayed. The model economy requires both types of institutions because they serve to control capital in different, yet complementary, ways. The value of credit market securities depends upon bank control of capital which markets cannot achieve. As regulations and technology change, the decision rules and contracts change, and the financial system creates new institutions, markets and assets. Since the model is at the level of underlying preferences and technology it can be used to consider the optimality of banking regulations when the underlying technology of controlling capital shifts. We show that, whatever the merits of the original arguments for bank regulation, with technological change bank regulation may become self-justifying. That is, we show that under plausible conditions the only reason bank regulation is needed is that it currently exists. Moreover, bank regulation can cause the very bank failures it purports to prevent. Bank regulators observing the world would erroneously argue for more bank regulations, including FDIC insurance, when this is, in fact, unnecessary.

I. INTRODUCTION

Public policymakers face the unenviable task of having to make decisions about banking deregulation with only the existing highly regulated world as a point of reference. Economists have been of little help since there are currently no models which have simultaneously existing banks and capital markets, and in which banks would not disappear if they were completely unregulated. This paper develops a model of the endogenous and simultaneous occurrence of banks and stock or credit markets. Since the model is at the level of preferences and technology, it can consider technological and regulatory changes.

Realistically, a model adequate to the task of assisting policymakers must not treat banks and capital markets separately. First, both exist as major players in the financial world. As of 1983, commercial banks and related intermediaries held business loans of $678 billion, while corporate equity equalled $2.15 trillion. Intermediaries also held over $1.5 trillion in mortgages and consumer loans (Kaufman [1986]). Also, much of the current regulatory controversy revolves around interactions between markets and intermediaries. Examining the split between commercial banking and underwriting, for example, makes no sense without both banks and asset markets. It takes a similarly rich model to consider allowing banks to invest in marketable securities or to consider the increased competition between banks and money market mutual funds or non-bank banks.

As a preface, consider why the theoretical problem is not trivial. Other markets do not need extensive regulation, so why isn't the invisible hand a sufficient regulator for the credit market? Fama [1980] points out that in a frictionless world, banks would look like any other mutual fund. In effect, an Arrow-Debreu world eliminates banks, banking panics, and even money. The

Modigliani-Miller theorem also holds, reducing the capital structure problems of firms to a triviality. Thus, market imperfections--transaction and agency costs, information asymmetries--create the need for financial institutions, but also force us to question the invisible hand.

Relying on imperfections, the literature has developed theories of financial institutions which serve to both aggregate and control capital. In that sense an underlying message of modern information-based banking theory (Diamond [1984], Diamond and Dybvig [1983], Haubrich and King [1983]), where banks arise due to information asymmetries, echoes the message of modern capital structure theory (Grossman and Hart [1982], Jensen and Meckling [1976]), where agency costs create the need for appropriate managerial incentives. But the literature has focused on corner solutions, while the full solution to agency problems involves both markets and institutions like banks. The inadequacy of corner solutions has recently been emphasized by Fama [1985] and Stiglitz [1985].

This essay develops a model in which both markets and banks exist because they provide complimentary aspects of control of capital. Markets provide indirect control. Because stockholder meetings and takeover bids imperfectly constrain management (See Stiglitz [1985]), much of the control exercised by equity holders takes the form of designing reward structures that induce acceptable behavior from the firm. This includes bonding or signalling via the debt-equity ratio (Grossman and Hart [1982], Leland and Pyle [1977]), or more generally, setting incentive compatible return structures (Ross [1973], Allen [1980]). Banks and intermediaries control more directly by limiting the action set of agents. Lenders sit on boards, approve projects and enforce costly covenants. We show how, technologically, these two forms of control are related and how the total financial structure of the economy results from a simultaneous decision problem involving direct and indirect control.

When the liabilities of banks, which are controlling capital in a direct way, circulate as inside money, there is the possibility of banking panics. Most bank regulation is motivated out of fear of banking panics. We consider bank regulations such as the Glass-Steagal Act, "capital adequacy" requirements, prohibitions against interstate branching, prohibitions against nonbank banks, and so on. We show that if technological change in the control of capital occurs, then the possibility of banking panics can disappear. In this case, bank regulation should also disappear. But we show that when regulation is in place, and a technological shift occurs, it can appear that regulation is still needed. Regulation, itself, can cause the need for regulation. That is, bank regulation can be self-justifying. Discussions of optimal regulations, like varying FDIC premia, presume that regulation is required. We show that this may be completely misguided.

II. AGENCY PROBLEMS AND THE ROLE OF MONITORING

In an economy characterized by a separation of ownership and control, investors will have to entrust resources to the control of managers who oversee investment projects. How do the investors know that the manager-agents are making efficient decisions, i.e., the decisions the investors would make if they were managing their own projects? A large literature exists which shows that if complete contracts are not possible, and if agent-managers cannot offer riskless debt, then the decisions made by the agent-managers are not efficient. Instead, the decisions are "second best."

Second best solutions result because of distortions which occur when the manager-agent is not the sole residual claimant (i.e., can't issue riskless debt). One situation in which this occurs is if the manager is risk-averse and cannot completely insure himself. In this case, studied by Holmstrom [1979], Holmstrom and Weiss [1985], and Shavell [1979], among others, it is not optimal for the manager to be the sole residual claimant. The second situation in which distortions occur is when it is not feasible for the manager to be the sole residual claimant because of limited liability. In this case, outside investors must hold some residual claim in some states of the world even if the manager is risk-neutral. This case has been studied by Sappington [1983], Farmer and Winter [1985], and Kahn and Scheinkman [1985].

In this section we will study the agency problem which exists in this second situation, that is, where there is a binding limited liability constraint. Our analysis will differ from the existing literature, however, in that we will allow for a solution which has not been previously considered. The basic problem the firm faces is structuring a contract with market principals in a way which is incentive compatible. In order to obtain financing the agent-manager must credibly constrain his own behavior in such a way that, once financing is obtained, his managerial decisions are in his own interest, and, at the same time, those the market-principals anticipated he would make. One way of obtaining this incentive compatible precommitment or bonding behavior is through design of the securities which the agent-manager offers the market, e.g., Grossman and Hart [1982]. We differ by allowing the agent-manager to directly purchase monitoring services which can serve the purpose of precommitment or bonding, in addition to selling securities.

In other words, in our set-up the agent-manager will be able to choose how to achieve incentive compatibility. Some bonding may occur directly through purchase of monitoring services. This will then change the design of marketable securities sold to raise the outside financing. Consequently, it can turn out that, for example, shareholders do not directly control the firm, but they need not control the firm because share value is conditional on the existence of direct monitoring purchased by the firm.

These issues are formalized as follows. Consider an entrepreneur-manager with no initial wealth, but with an opportunity to invest in a project at an indivisible cost, C. The project yields a gross return, X, that depends upon the manager's effort, e, and the realized state of the world, θ, where $\theta \in [\underline{\theta}, \bar{\theta}] \subset R$, with density $h(\theta)$. The production function is $X = \theta e$.[1]

Since the manager has no initial wealth (or initial wealth less than C), financing for the project must be raised by selling claims, S(X), on the observable output of the project, X. The residual X - S(X) accrues to the manager. The manager is assumed to be risk neutral with respect to realized wealth; his utility is given by $U = W - V(e)$, where W is realized wealth and $V(\cdot)$ is the disutility of effort. The security market participants are also risk neutral, so the security S(X) is valued at its expected value, $E[S(X)]$.

The security market cannot observe e or θ so contracts cannot be written on these variables. The manager, however, chooses e after observing the realization of $\tilde{\theta}$. The security market has rational expectations on the manager's choice of $e(\theta)$, however. Consequently, the manager must offer the market securities such that the effort level promised by the manager is, in fact, in the manager's self-interest <u>ex post</u>.

In designing an incentive compatible contract the manager may also choose to be monitored. That is, the manager can contract for monitoring services which guarantee that the manager expends some minimum amount of effort <u>independent of the state θ</u>. The choice variable L determines the level of monitoring according to a monitoring technology given by Q(L), where $Q(0) = 0$.[2] Monitoring is costly; K(L) is the cost, where $K(0) = 0$, and $K_L > 0$.

Monitoring may be performed by some third agent. The next section of the paper discusses monitoring the monitor.

The optimal contract implicitly solves the following problem:

$$\max_{S(\theta),e(\theta),L} \int_\theta \left[\theta e(\theta) - S(\theta) - V\left(e(\theta)\right)\right]h(\theta)d\theta \tag{I}$$

subject to:

(i) $$\int_\theta S(\theta)h(\theta)d\theta - K(L) \geq C$$ (Financing Constraint)

(ii) $$(\forall\theta)\ \theta \in \underset{m}{\operatorname{argmax}}\left[\theta e(m) - S(m) - V\left(e(m)\right)\right] \quad \text{subject to: } e(m) \geq Q(L)$$ (Incentive Compatibility Constraint)

(iii) $$e(\theta) \geq Q(L)$$ (Monitoring Constraint)

(iv) $$S(\theta) \leq \theta e(\theta)\ .$$ (Limited Liability Constraint)

The optimal contract, $\{S(X), L\}$, is a security, $S(X)$, and a level of monitoring, L. The manager chooses the contract, $S(X)$, and a level of L to maximize utility subject to four constraints. First, the expected value of the securities offered the market must be enough to finance the project and cover the monitoring costs. Second, the optimal contract must imply that the agent-manager's best strategy is to tell the truth. The third constraint requires effort in all states to be at least the minimum required by the monitor. Finally, limited liability means that the payment to the market in any state cannot exceed the available output.

The solution to problem (I) can be best understood if we first solve for the first best contract and then compare. The first best solution is obtained by solving problem (I) unconstrained. The usual Kuhn-Tucker condition characterizes the first best contract as follows:

Proposition 1: The first best contract occurs when effort, $e(\theta)$, is chosen to satisfy:

$$V_e = \theta .$$

This first best solution equates the marginal disutility of effort with the marginal benefit of more effort, in each state.

To characterize the second best solution to problem (I), recall that the hazard rate of a distribution is defined as $r(\theta) \equiv h(\theta)/\big(1 - H)\theta)\big)$, where $h(\theta)$ is the density and $H(\theta)$ is the cumulative distribution. Assume $r'(\theta) > 0$.[3] Also, define $\Psi \equiv (\lambda - 1)/\lambda$ where λ is the shadow price of the financing constraint. With this notation we can now state:

Proposition 2: The second best contract which solves (I) is a choice of effort, $\hat{e}(\theta)$, which solves:

$$V_{\hat{e}} = \left[\theta - \Psi\left(\frac{1}{r(\theta)} - \gamma\right)\right]$$

where γ is the shadow price of the monitoring constraint imposed on the incentive compatibility condition, constraint (ii).

Proof: See Appendix A.

The benefits of direct monitoring are best understood by first looking at the corner solution the literature has typically considered. It is clear that the solution is second best because:

Corollary 2A: If no monitoring is chosen, i.e., $\gamma = 0$, then effort supplied is less than under the complete contract in every state except the highest. (See Farmer and Winter [1985] for a proof.)

In the second best solution with no monitoring, the agent-manager behaves as if the state of the world is $\theta - \Psi \frac{1}{r(\theta)}$ instead of θ. Since $\Psi > 0$ (see

Appendix A) effort supplied is always less except when $\theta = \bar{\theta}$ because in that case $1/r(\bar{\theta}) = 0$.

The inferiority of the effort supplied compared to the first best solution results from having to obtain outside financing and being unable to offer the market riskless debt. The first best solution has the agent make a fixed (not state-contingent) payment to the principal. Because of limited liability the agent-manager cannot guarantee the first best solution in the lowest states. In bad states, production is simply too low to meet the optimal fixed payment, even if the agent turns over everything to the principal. The agent, therefore, promises a higher than first best return to the market in higher states. But, since the agent is no longer the sole residual claimant he must share the marginal return to any extra effort with the outsiders. In low states most (perhaps all) of the output resulting from extra effort accrues to the market-outsiders so there is no incentive for the agent to make the extra effort. This is true in every state but the highest.

Monitoring, however, creates the following possibility. Suppose a minimum amount of effort is required of the agent regardless of the state. There are two costs to such monitoring. First, $K(L)$ must be paid when $L > 0$. Second, the agent will be forced to work harder in some low states than he would under first-best, a costly inefficiency. But, the benefit is that in higher states, conditional on the monitoring, the agent need not promise, <u>ex ante</u>, as much of the residual to the market. Hence, the agent will have more incentive to work harder in those states. Comparing these marginal costs and benefits determines the choice of monitoring level. In Appendix A these marginal costs and benefits are compared. Using the notation of the appendix we have:

Proposition 3: A positive level of monitoring is chosen if:

$$\int_{\theta} P_2(\theta)\bar{e}_{\theta}\gamma_L h(\theta)d\theta > \lambda K_L + \int_{\theta} q_1(\theta)h(\theta)d\theta \ .$$

Proof: The condition is a transversality condition, satisfied with equality for $L > 0$, implied by the solution to (I) using Hestenes' Theorem. See Appendix A.

The right-hand side of the condition consists of the two marginal costs discussed above, while the left-hand side is the marginal benefit. More informative, however, is to examine the impact on the solution when positive monitoring is chosen. In terms of the solution given in Proposition 2 positive monitoring means that $\gamma > 0$. γ is the shadow price of forcing the agent-manager to work when he wouldn't otherwise. Concretely, the agent now chooses effort as if the state were $\theta - \Psi\left(\frac{1}{r(\theta)} - \gamma\right)$ instead of $\theta - \Psi \frac{1}{r(\theta)}$. Proposition 3 determines if it is optimal for the agent to act this way.

Figure 1 graphically displays the relevant comparison. The locus of points from the origin to point E is the first best solution. Without monitoring the second best solution is the locus $\overline{SE}$. The remaining, kinked, schedule is the second best solution with monitoring. Compared to the first best solution the efficiency loss in the second best world with no monitoring is the area C + B. The area C + B results because the agent's incentives to work are reduced when the outsider market principals share the residual, as previously discussed. With monitoring the efficiency loss is the area A + B. Area A results because monitoring forces the agent to work harder than he would in first best (for $\underline{\theta} \leq \theta \leq \theta^*$). Essentially, Proposition 3 says that positive monitoring is chosen if C + B > A + B. In that case, the solution with monitoring is a better second best solution.

It is worth stressing some of the implications of an interior solution in which the agent-manager chooses some positive monitoring. First, there is an important sense in which the securities marketed to finance the project depend on the existence of monitoring. The value of the securities sold depends on the monitoring. But, secondly, the control of the firm happens in a different way. Without monitoring, control, in the sense of an equilibrium effort function, occurs through design of the marketed securities. But with monitoring an important control is exercised by the monitor. The monitor must also be an outsider, but have powers which the "market" does not possess. We turn now to examination of the monitor.

III. INTERMEDIARIES AND FINANCIAL MARKETS

Modern financial systems contain both banks and stock markets; intermediaries and financial markets. This "interior solution" on a social level follows naturally from the interior solution found on the individual level. The costs of forcing the agent's work effort create the need for a delegated monitor bank as in Diamond [1984]. On the other hand, the incentive compatible pay-off structure allows the firm to sell shares directly with the public (Grossman and Hart [1982]). This section concentrates on the real side of the economy; the sequel further enriches the model by adding inside money as medium of exchange.

Determining this model economy's financial structure proceeds along the now standard path of producing an optimal mechanism by solving a programming problem, and then exhibiting institutions that support the solution (Harris and Townsend [1978]). Once we specify a few more necessary assumptions on the economy it will become apparent that this matches the individual problem already solved.

First, we present the specifics of the multi-agent model. The many agent-entrepreneurs, as before, each own a project of uncertain return but lack the wealth, C, to finance it. Thus, funding must come from the large number of investors (principals). Each investor starts with an endowment of $\frac{C}{n}$, so that it takes n investors to fund a project, where n is large relative to C and L. Thus, credit markets aggregate capital. The distribution of project productivity shocks, $H(\theta)$, is independent across entrepreneurs. This avoids, for the time being, analysis of macroeconomic shocks to the entire system. Finally, to verify that effort exceeds a minimum, $e(\theta) \geq Q(L)$, each investor must pay K(L) because one cannot observe the extent of others' monitoring.

The social planner's problem is to maximize people's expected utility subject to the appropriate constraint. It seems natural to cast the problem in terms of section 2, with the utility of principals tied down by their outside investment opportunity. This presents no restriction on the problem because the planner can vary that utility and trace out the Pareto frontier for the economy. Likewise, reversing roles and maximizing investors' utility given agents' utility results in no material change.

Thus, the social planner solves

$$\max_{S(\theta),e(\theta),L} \int \left[\theta e(\theta) - S(\theta) - V\left(e(\theta)\right)\right]h(\theta)d\theta \qquad \text{(II)}$$

s.t.

(i) $$\int S(\theta)h(\theta)d\theta - K(L) \geq C$$

(ii) $$\theta \in \underset{m}{\operatorname{argmax}}\left[\theta e(m) - S(m) - V\left(e(m)\right)\right] \quad \text{s.t. } e(m) \geq Q(L)$$

(iii) $$e(\theta) \geq Q(L)$$

(iv) $$S(\theta) \leq \theta e(\theta) .$$

That is, the optimal mechanism supports the optimal contract derived earlier.

In a decentralized credit market, where investors contract directly with the firm, monitoring costs will be very high. This implies either a free-rider problem or excessive monitoring costs. Without intermediation, society monitors too little, or pays too much. The next proposition formalizes this point.

Proposition 4: Direct contracts (a decentralized market) between investors and entrepreneurs cannot achieve the first-best solution to (II).

Proof: Suppose we provide the optimal monitoring level L^*, and the corresponding optimal payment schedule, $S^*(\theta)$. Then, since the financing constraint (i) binds in equilibrium,

$$\int_{\theta} S^*(\theta)h(\theta)d\theta - K(L^*) = C .$$

More than one person cannot monitor, since for $k > 1$,

$$\int S^*(\theta)h(\theta)d\theta - kK(L^*) < C .$$

One person with wealth $\frac{C}{n}$, cannot fully fund the project, however. Furthermore, the single monitor's action is not observable to others. Suppose one investor provides the optimal level of monitoring. Then the revised financing constraint on the agent's problem becomes

(ia) $$\int_{\theta} S(\theta)h(\theta)d\theta - K(L) \geq \left(1 - \frac{1}{n}\right)C + K(L^*) .$$

In solving this, if $L > 0$ which means other investors also monitor, in which case $L^* + L > L^*$ and an inefficiently high amount of monitoring occurs. If

$L = 0$, since those investors don't monitor, an inefficient payment schedule (and corresponding effort schedule) results. Lastly, if no one monitors, $L = 0 < L^*$.

Q.E.D.

The proof of proposition 4 suggests a role for a bank: some intermediary that pools investors' wealth and monitors projects for them. It avoids duplication of costs and internalizes the free rider problem. At the same time, the existence of a bank will make credible securities paying $S^*(\theta)$, allowing a credit market to exist.[4] Note that a purely information gathering firm, such as a rating agency, cannot solve the problem, since it too must be monitored. An intermediary, on which people have claims, must arise.

The next proposition shows that we can support the solution to (II) by a Diamond-style delegated monitor bank in concert with a credit market. This central result follows Diamond [1984] quite closely. The economic intuition also follows this delegated monitoring story. Banks hold claims against the firm in sufficient quantity to monitor the firm and pass along an adequate return to investors while maintaining non-negative profits. Depositors demand a return from the banks that the bank can obtain only by monitoring firms. Depositors face a problem monitoring the bank, but as the bank diversifies across firms the random, independent draws on projects cancel each other out, and the inference problem becomes trivial. With many projects, depositors know that chance would not produce a very low return; only a non-monitoring bank would. Depositors might directly force diversification if they observe size. Alternatively, they contract to give the bank nothing unless output is a particular value. This provides incentive to diversify, and if the level is chosen correctly, to monitor. The cost of monitoring the bank goes to zero. One way to view this is that the uncertainty about the state diversifies away. Alternatively, the probability that the bankruptcy constraint binds falls to zero, so that the cause of distortion disappears. Finally, notice that the bank provides only part of the firm's capital. Contingent on the existence of a functioning incentive compatible bank, investors may buy shares of $S(\theta)$ in an equity or credit market.

This background leads to

Proposition 5: As the number of firms financed by the bank approaches infinity, the allocation approaches the solution to (II).

Proof: Consider the following deposit contract. Since output x is observable, depositors' claims take the form of a constant ν times a Dirac δ-function centered on $E(x)$, where $\nu E(x) = C$. That is, all output reverts to the depositors unless the level providing their reserve return is reached. (This can be made a limiting argument by adding bounds $\pm\epsilon_N$ depending on the number of firms funded by the bank.) This induces the bank to (i) write a contract with each firm so that $E[S(\theta)] = C$, and (ii) to diversify across firms, since by the Strong Law of Large Numbers, $\sum_N \frac{x_N}{N} \to E(x)$ with probability 1 as $N \to \infty$. This may not induce a bank to monitor optimally, since it already receives a return of C. Firms prefer optimal L, however, so they compensate the bank for K(L). (This follows from I.)

Q.E.D.

One important corollary to the proposition is that the bank need only hold enough debt for optimal monitoring purposes. That level is determined by the monitoring technology, Q(L), at cost K(L). Given that amount, the firm is free to raise capital in the equity markets by selling shares in $S(\theta)$. The existence of an incentive compatible bank signals other investors that the asset is acceptable. Here, the bank debt is just the bank's share of the asset paying $S(\theta)$. We derive a more realistic debt contract in Appendix B, which also shows how the compound asset paying $S(\theta)$ is supported by a combination of debt, equity and options.

This split in financing between bank debt and market equity has its roots in the different forms of control available to investors. The first route of direct control imposes constraints on the agents' actions. Controllers sit on boards of directors, scrutinize projects, and enforce covenants. These covenants often restrict investment, asset disposition, mergers, plant and inventory maintenance, dividend policy, bond seniority and redemption, reporting, and so on. The lender has well-defined rights of intervention (Stiglitz [1985], Smith and Warner [1979]). Underlying this are the right to get one's money back and the option to restrict further lending. Equity investment (shares in $S(\theta)$ here) controls by designing reward structures that induce desired behavior. Equity owners have no rights of intervention although they may vote at shareholder meetings. As residual claimants, they cannot insist on getting money back from the managers, though they can sell their stock. These investors exert indirect control via a system of rewards and punishments, inducing proper behavior, rather than directly limiting the agents' action.

IV. BANK REGULATION

The model developed above has several natural applications to financial deregulation, which we pursue in this and the following section. Since the model stresses the role of informational problems in the financial system, and has endogenously arising markets and intermediaries, it can probe the most frequently used arguments for and against regulation. This section first presents a straightforward analysis of the split between commercial lending and underwriting enforced by the Glass-Steagal Act. It then considers complications arising from introducing inside money and banking panics, which also sets the stage for the analysis of other regulations in section V.

The equilibrium of Propositions 2 and 5 above determines the optimal quantities of bank debt and marketable securities given the available monitoring technology. This division closely corresponds to the separation required by the Glass-Steagal Act. The Act requires that the two types of securities, bank loans and marketable securities, and thus the two associated forms of controlling capital, correspond to two distinct industries, commercial and investment banking.[5] Consequently, analyzing this bank regulation represents a natural first application of the model developed above.

The Glass-Steagal Act, though, was originally motivated by the perceived cause of the banking panics during the 1930's, so our initial discussion abstracts from what many would consider the law's central point. By slightly complicating the model, however, we can extend the analysis to include banking panics. Both modern (Diamond and Dybvig [1983], Gorton [1985C]) and classical (Sprague [1910], Friedman and Schwartz [1963]) theories agree that banking panics result from certain types of information asymmetries and uncertainties. These could disappear or be dramatically altered with technological or regulatory changes. After introducing inside money and panics into the model, we analyze the effects of changes in the monitoring technology, the technology of producing inside money, and restrictions on bank assets and liabilities.

The results of this exercise prove quite surprising, though consistent with a good deal of evidence. We suggest that the only reason for bank regulation is that such regulation currently exists. Were bank regulation removed, the reason for that regulation might also disappear. Moreover, we suggest that such legislation causes the very bank failures it purports to prevent.

A) The Glass-Steagal Act

The National Banking Act of 1933, popularly known as the Glass-Steagal Act, was passed in 1933 in the aftermath of thousands of bank failures.[6] A major provision of the Act made it a felony for an organization that receives deposits to engage at the same time "in the business of issuing, underwriting, selling or distributing of stocks, bonds, debentures or other securities."[7] The stated logic behind this separation of investment and commercial banking activities was a perceived "conflict of interest" between the production of the two types of securities, or between the two forms of control of capital. This conflict of interest was viewed as having caused, in significant part, the bank failures and panics of the 1930's.

For the moment let us hold the issue of banking panics in abeyance. What would be the affect of this Act if it were a binding constraint on the economy? If the Act is binding, then it must act as a constraint which limits the form that securities in the economy may take. Moreover, for the moment we will also suppose that a binding Glass-Steagal constraint limits the form that the control of capital takes.

In other words, the constraint can bind in one of two ways. First, the Act can impose too much monitoring on the economy by preventing commercial banks from holding capital market stocks and bonds, and, consequently, being forced to make too many loans. (Assuming, momentarily, that too many loans corresponds to an excessive amount of monitoring.) Secondly, the Act could bind by limiting the monitoring required so that it is too low. This would occur because investment banks, underwriting the marketable securities, cannot act as banks and make loans corresponding to the role of delegated monitor.

When the Glass-Steagal Act imposes a binding constraint on the economy, then, it must be the case that the relative sizes of the two industries are sub-optimal so that the constraint prevents one or the other industry from assuming the other's function. This notion of the regulation's effect on comparative market size is clearly echoed in the debate between major banks and the securities industry over the repeal of Glass-Steagal (see SIA [1985]). The commercial banks' effort to end separation suggests, as most people suspect, that their market is the one constrained. With this interpretation,

Definition 1: A binding Glass-Steagal Act is a constraint, $L > \hat{L}$ which prevents the equilibrium of Proposition 2 from being realized.

Then, in the absence of other considerations, we have:

Proposition 6: A binding Glass-Steagal Act is inefficient.

Proof: See Appendix A.

The intuition behind Proposition 6 is clear. If there is no reason for Glass-Steagal, and it imposes a binding constraint, then an inefficiency is introduced into the savings-investment process. In particular, a distortion is imposed on the control of capital which prevents achieving the optimal allocation, characterized by Proposition 2. From Proposition 2, optimal effort satisfies $V_e = [\theta - \Psi(\frac{1}{r(\theta)} - \gamma)]$. The Glass-Steagal Act constrains γ away from its optimal value γ^*. When γ is too small, we move even further away from the optimal effort specification of $V_e = \theta$. Setting L, and thus θ, too high, however, imposes excessive costs on people.

Many activities of commercial banks indicate that the Glass-Steagal Act currently constrains these institutions. It seems unlikely that banks would vigorously push for the repeal of the Act if it did not affect them. Nor would they engage in the myriad of activities that test the grey area of the Act: private placement of commercial paper, lines of credit in support of new issues, brokerage activities in the guise of dividend reinvestment and employee investment plans, and rapidly growing trust services to corporations. In addition, comparison across countries indicates that banks usually play a larger role in the securities business than they currently do in the U.S.A.[8] In Germany, which follows the "universal banking" pattern, the large banks have long underwritten securities, as well as vote proxies and hold large equity stakes in non-financial corporations. In England, the major London banks profitably entered the underwriting and investment management fields when allowed to do so. Japan's experience is similar to that of the U.S., with the Long Term Credit Banks resisting the entry of commercial banks into areas proscribed by Article 65, the occupation version of Glass-Steagal.

This straightforward analysis may beg the question on Glass-Steagal, because the ostensible reason for the legislation was to prevent banking panics, which we have so far ignored. Thus, to consider possible benefits from Glass-Steagal we look at banking panics.[9]

B) Inside Money and Banking Panics

To consider broader issues of regulatory reform we now transform the model to allow for inside money and banking panics. We thus consider a monetary economy along the lines of Gorton [1985B]. The economy requires a given amount of inside money which serves transactions purposes (perhaps because of a cash in advance constraint). The economy finds it most efficient to produce this medium of exchange as inside money. Thus constrained circulating bank debt, D, must be at least the required amount $\bar{D}$. $\bar{D}$ is determined by an inside money production technology which includes a contracting technology making the bank's liabilities acceptable as a transaction medium, as well as such things as check clearing technologies. We assume that this technology also captures the reason that the activities of monitoring and inside money production are combined.[10]

If, in addition to circulating debt claims of the delegated monitor, we recognize that the delegated monitor of Proposition 5 actually refers to the banking system, then there is the possibility of panics. Assume that the banking system always satisfies Proposition 5, but that individual banks may not be perfectly diversified. If individual banks are not perfectly diversified, then individual banks face idiosyncratic risk. Since individual banks are not perfectly diversified, they cannot, individually, be monitored according to Proposition 5. We assume that since the delegated monitors (the banks) cannot be monitored by depositors banks must hold some equity.[11] (Notationally, bank equity is E.) Even with equity, though, depositors cannot distinguish between banks which are not diversified and banks which are not, in fact, monitoring firms. A "troubled" bank could be in trouble for either reason, but to depositors all banks look alike. A banking panic, then, is a form of monitoring the banking industry. (See Gorton [1985B, C].)

When there are many banks, none completely diversified, the combination of circulating private debt and delegated monitoring can create the possibility of banking panics because of market incompleteness. In particular there may be no markets for any bank assets or bank liabilities. There are no secondary markets for the banks' assets because of the monitoring function those assets are associated with. Nor are there secondary markets for bank liabilities, e.g., checks clear within the banking system rather than through markets. Incomplete markets mean that agents lack the information which would be revealed by the prices in those markets. Such information asymmetries are the basis for the theoretical explanations of banking panics provided by Diamond and Dybvig [1983] and Gorton [1985B].[12] Essentially what happens is that depositors don't know the state of their own bank and, without bank-specific information, can panic under a variety of scenarios. If a market opened which could price bank-specific risk, then the possibility of panic would be eliminated.

In summary:

Definition 2: A banking system in which: (1) there exists more than one bank; (2) each bank cannot achieve the diversification required by Proposition 5; and (3), there are no secondary markets for L, E, D; is called a Non-Diamond Banking System.

Definition 3: A banking panic is an event in which depositors seek to convert all their deposits into currency at every bank of the banking system.

Then, almost by definition:

Proposition 7: A banking panic can only occur if the banking system is Non-Diamond.

Proof: If there is full diversification, a là Proposition 5, then depositors are fully insured even if they hold claims on only a single bank. If depositors are always fully insured, then they never have any reason to panic. If there is not complete diversification, but there is at least one secondary market for a bank liability, for each bank, then those markets efficiently price idiosyncratic bank risk. But then depositors know bank states, and since underlying firm shocks are i.i.d., there is never a desire by depositors to run on every bank. Hence, no panic.

Q.E.D.

Proposition 7, in effect, eliminates "sun spot" equilibria.[13] In section V we consider what specific aspects of technology and regulation create a Non-Diamond System.

Before considering the effects regulation and technical change have on banking panics, it may be useful to summarize the key features of the model developed in this section. On the real side, a monitoring technology relates bank loans to firms' effort while other imperfections prevent an individual bank from diversifying away all the idiosyncratic risk of those loans. On the monetary side, transactions technology determines the level of inside money, while contracting technology associates this money with a specified level of monitored bank loans. The Glass-Steagal Act, the FDIC, FedWire or the smart card can alter the balance between these forces.

V. TECHNOLOGICAL AND REGULATORY CHANGES

If recurrent banking panics, and, subsequently, the existence of deposit insurance, were the original reasons for bank regulation, then, whatever we think of those original reasons, they cannot be the reference point for current decisions about regulatory issues. Underlying technologies can change in such a way as to eliminate the possibility of banking panics, and, hence, the need for bank regulation. In addition, changes in bank regulations can remove the need for regulation. Yet these possibilities would not necessarily be observable upon examination of the existing world of regulated banks. Theoretically, the above model raises these issues and some casual evidence suggests they are real possibilities.

A variety of technological and regulatory changes can be considered in the context of the above model. Our goal is to consider changes which roughly correspond to observed changes in technology and regulation, and to consider what implications these changes have for the possibility of banking panics.

If a proposed change removes the possibility of banking panics, by allowing for the opening of an information-revealing market, for example, then our presumption is that such a change is desirable.

We consider three changes. The three changes are: first, a change in the monitoring technology; second, a change in the size of the representative bank; and, thirdly, a change in the technology of inside money production. In considering each change, we hold the other two factors constant. The economy is currently constrained by bank regulation from making these three changes and, below, we present some evidence that these constraints are binding.

A) Technological Change in Monitoring and "Securitization"

Technological change in the monitoring capabilities of the banking system can result in the opening of a new market which by revealing information about individual bank portfolios, eliminates the possibility of banking panics and, hence, the raison d'etre of bank regulation. To see this consider a simple comparative static exercise for a representative bank in a Non-Diamond banking system. The representative bank initially holds nonmarketable securities (loans), corresponding to its role as delegated monitor, as assets, and holds demand deposits and equity as liabilities. The balance sheet of the representative bank is:

Assets	Liabilities
Nonmarketable Loans (L)	Demand Deposits (D) Equity (E)

Consider an improvement in the banking system's monitoring technology. At each level of loans, the banking system can monitor more effectively (or, equivalently, a given level of monitoring costs less to achieve), i.e., for given L, Q(L) is higher (or K(L) shifts in). This technological change would, in an unregulated economy, cause a shift in the proportion of private savings held by the banking system as nonmarketable claims. Suppose the economy is unregulated, but a minimum level of deposits is required as inside money. What will the representative bank look like now?

Proposition 8: If $Q_2(L)$ is the new monitoring technology, such that $Q_2(L) > Q_1(L)$, $\forall L$, where $Q_1(L)$ is the old technology (i.e., a technological improvement in monitoring), and $D \geq \bar{D}$ is binding (i.e., a minimum amount of inside money is technologically required), then, in the new equilibrium, bank equity is lower.

Proof: By hypothesis, equilibrium L is reduced. But, by assumption, D cannot be reduced. Then, by the balance sheet constraint, $L = D + E$, E is reduced.

Q.E.D.

In other words, to the regulator there would appear to be a "capital adequacy" problem when, in fact, there is no such problem.

But, in a Non-Diamond banking system depositors may require a minimum equity level as part of the contract to monitor the Non-Diamond banks. (Or, regulators may impose a binding equity constraint.) In that case,

Proposition 9: If $Q_2(L)$ is the new monitoring technology, such that $Q_2(L) > Q_1(L)$, $\forall L$, $D \geq \bar{D}$ is binding, and $E \geq \bar{E}$ is binding, then, in the new equilibrium no banking panics can occur.

Proof: By hypothesis equilibrium L is lower. But, by assumption, liabilities, $D + E$, cannot be reduced. Hence, $L < D + E$, and the shortfall can only be made up with S, i.e., $L + S = D + E$. But S is traded securities, so now the banking system is no longer Non-Diamond.

Q.E.D.

According to Proposition 9, banks, if allowed to, would hold some marketable securities as assets, corresponding to the new equilibrium division of securities in the economy. The unregulated, representative, bank balance sheet would be:

Assets	Liabilities
Nonmarketable Loans Marketable Assets	Demand Deposits Equity

For the same market value of liabilities, the bank now holds some traded assets.

The marketable securities could take the form of existing, traded, stocks and bonds or the marketable assets could also be loans themselves. Marketing loans, or claims on loans, would be a natural development for the commercial banking industry since it would not, thereby, concede competitive ground to the investment banking industry. Notably, if banks market claims on their loans, these claims would be junior to demand deposits, and consequently, the price of such a claim would reveal bank-specific information about the entire bank portfolio. The panic-causing information asymmetry is eliminated by the creation of a secondary market in bank loans.

However, a corollary to Proposition 9 is:

<u>Corollary 9A</u>: If $Q_2(L)$ is the new monitoring technology, such that $Q_2(L) > Q_1(L)$, $\forall L$, $D \geq \bar{D}$ is binding, $E \geq \bar{E}$ is binding, and Glass-Steagal is binding, then the Glass-Steagal Act causes the possibility of panics.

<u>Proof</u>: If Glass-Steagal were not binding, then, since we would not require $L > \hat{L}$, Propositon 9 would hold.

Q.E.D.

In other words, regulation becomes self-justifying because it creates the possibility of panics which it is supposed to prevent (and, thereby, creates the need for deposit insurance). But this is not the only implication.

Proposition 10: If $Q_2(L) > Q_1(L)$, $\forall L$, $D \geq \bar{D}$ is binding, $E \geq \bar{E}$ is binding, and Glass-Steagal is binding, then banks will fail over more states of the world than if Glass-Steagal were not binding.

Proof: See Appendix B.

The intuition behind Proposition 10 is as follows. At the same time as banks are forced to hold loans as assets, the banking system can reduce the level of monitoring to the new equilibrium level. The banking system monitors the same amount, but holds loans which can now fail over a larger range of states. Ironically, by prohibiting banks from holding securities other than loans, regulation makes the banking system riskier, though the economy as a whole is not riskier. Banks would prefer to trade some loans for traded stocks, but regulation prevents it.[14]

Some recent developments in banking suggest that this technological change has taken place and that the Glass-Steagal Act is a binding constraint. A new development in banking is the creation of secondary loan participations or "loan stripping." The practice of selling previously nonmarketed assets is called "securitization." Loan stripping works as follows. The bank sells shares in a loan it has made to third parties. These loan participations are typically for shorter maturities than the underlying loan and put the buyer of the participation at risk for the life of the participation. In other words, if the firm to which the underlying loan was made defaults during the life of the participation, then the "participant" loses. Though the bank also loses since the participation is of a shorter life than the underlying loan.[15]

The secondary loan participation market has grown enormously in the past few years. In 1983 $3 billion of loans were sold this way, out of $413 billion of loans outstanding; in 1984, $10.5 billion were sold, out of $453 billion of total loans outstanding; and in 1985, $18 billion worth of loans were sold out of $474 billion of total loans outstanding (Zweig [1986]). Every expectation is that this market will continue to grow by leaps and bounds.

This recent development in banking is consistent with the above explanation of a technological shift in the forms of control of capital. Suppose our representative bank sells some secondary loan participations, reducing the level of monitoring to correspond to the new social optimum. The new balance sheet is:

Assets	Liabilities
Loans { Loans Held	Demand Deposits
Loans { Loans Sold	Participations
New Securities	Equity

The bank sells some of its loans as participations, removing them temporarily from the balance sheet. The proceeds of this operation are used to purchase new securities, which must be new loans. The Glass-Steagal Act prohibits these new securities from being marketable capital market securities. Consequently, the process of making a loan and then selling it as a participation must be repeated.

The secondary loan participation market is information revealing about bank-specific risk. Since demand deposits are the senior claimant, participants are only paid if the bank is solvent (and then, only if the underlying borrower is solvent). Consequently, the price of a participation would reflect the risk of the particular bank defaulting.[16] This is exactly the information which would eliminate banking panics because with this information depositors can distinguish between banks. Technological change has created this new market which eliminates the information asymmetry, but regulators are quite likely to directly limit or prohibit this market's development.

B) Interstate Banking and the Size of the Banking Firm

The second change to be considered is regulatory, rather than technological. In this section we consider a change in the size of the representative bank, holding the monitoring technology, and the inside money production technology, constant. We suppose that if the prohibition against interstate banking were eliminated, then the average size of the American bank would increase. An increase in the size of the representative bank would tend to mitigate against the occurrence of banking panics because larger banks could insure themselves in a way not currently feasible, making the information asymmetry irrelevant to depositors.

Proposition 5 shows that the size of the banking firm is important for diversifying risk, which is the condition necessary for the economy to be able to efficiently monitor the monitor. Larger banks can diversify away nonsystematic risk, and consequently, can be monitored according to Proposition 5. This observation about the size of banks corresponds with the oft-made point that in most other countries where bank size is not constrained, the average bank size is larger than in the U.S. A commonly cited example is Canada where the last banking panic happened in 1837, despite the fact that deposit insurance was enacted in the 1960's. In particular, in Canada there was no banking panic in the 1930's.

In the United States opportunities for small banks to diversify loan portfolios occur through small banks' participating in loan syndicates. In a typical loan participation there is a lead bank, which is most likely the originator of the loan. Otherwise an agent bank is elected by the syndicate members. While all the syndicate participants negotiate the loan, the lead or agent bank is responsible for producing the monitoring, i.e., enforcing loan covenants against the borrower.

Definition 4: A loan participation contract is an arrangement between a lead bank (the agent-manager) and a group of participants (the principals) described by problem (I) above. I.e., the lead bank's efforts, $e(\theta)$, are not observable by the participants, nor is the state of the underlying loan, θ. Participants only observe realized output of the participation project, $x = \theta e(\theta)$.

With this definition, we have:

Proposition 11: Loan participation contracts cannot implement the Diamond equilibrium of Proposition 5.

Proof: We need to show that a representative bank cannot completely diversify by participating in every loan other than the ones it has originated. Suppose there are ℓ projects other than the ones the representative bank has originated loans to. I.e., the representative bank must be a party to ℓ participation contracts. In each participation contract, the lead bank faces a binding financing constraint. Since all banks, of which there are, say, $n + 1$, want to participate in each loan, each participation contract will require m participants, in addition to the lead bank. From here the proof proceeds exactly like the proof to Proposition 4.

Q.E.D.

According to Proposition 11, the solution to the planning problem (II) above cannot be achieved because monitoring of monitors by other monitors is required. The existence of many small banks introduces an extra layer of agency costs which creates the possibility of banking panics because each small bank cannot completely diversify. Depositors know that while the banking system is well-diversified, their bank is not--and, hence, must be directly monitored either by government regulators or the depositors, themselves, in a banking panic.

An international comparison suggests that the United States has a large number of small banks because of prohibitions against interstate banking which, until recently, were clearly binding constraints. This prohibition limits banks to accepting deposits only in their own states. Thus,

Definition 5: A binding interstate banking prohibition is a constraint that $D \leq \hat{D}$, where $\hat{D}$ is the maximum amount of deposits in a state.

Then, we have:

Proposition 12: If the interstate banking prohibition is binding, then the banking system is Non-Diamond.

Proof: In order to achieve the interior optimum of Proposition 2, each project requires a minimum amount of monitoring corresponding to L per project, for given $Q(\cdot)$. But, the number of projects the bank can monitor is given by $\hat{D}/L$ which is less than ∞. Consequently, the representative bank must attempt diversification through loan participation contracts. But, by Proposition 11, loan participation contracts cannot implement the Diamond equilibrium.

Q.E.D.

Once again, then, regulation can be self-justifying.

Recent developments in legalizing regional compacts (in which groups of states mutually agree to allow interstate banking), and developments with nonbank banks (discussed next) strongly suggest that the regulatory constraints on bank size are binding.[17]

C) Nonbank Banks and Technological Change in the Production of Inside Money

The final comparative static exercise to consider is a shift in the amount of debt needed to back up inside money, $\bar{D}$. Suppose there is a technological improvement in the production of inside money such that the constraint on the size of bank debt is not binding. Moreover, a stronger interpretation of such a technological change would be one which allows the production of inside money to be separated from the monitoring function which the assets backing demand deposits are associated with. If it is feasible to separate demand deposits from nontraded loans, then the panic-causing information asymmetry could be eliminated.

Demand deposits have an important characteristic associated with their use as a circulating medium of exchange. Checks are most efficiently cleared through a clearing system which is internal to the banking system. Unlike the older form of circulating bank debt, bank notes, demand deposits have no secondary market. The exchange rate between bank debt, in the form of a check, and currency is fixed at one as a feature of the monetary product, inside money. The technological change to be considered is one which allows this circulating bank debt, which cannot have a secondary market, to be separated from assets which also cannot be traded in secondary markets. Our conclusion is:

Proposition 13: If a technological change allows delegated monitoring and inside money production to be feasibly separated, then neither delegated monitoring firms nor inside money producing firms are Non-Diamond.

Proof: Since the two activities are separated delegated monitoring firms will have secondary markets for their debt. And inside money producing firms will have traded assets.

Q.E.D.

Casual evidence suggests that this scenario is already being realized in the form of nonbank banks. The 1970 Amendment to the Bank Holding Company Act of 1956 defined a commercial bank to be an institution that "(1) accepts deposits that the depositor has a legal right to withdraw on demand, and (2) engages in the business of making commercial loans." A corporation is not a bank, legally, if only one of these two activities is undertaken. A "nonbank bank" is a firm which undertakes only one of the two activities.

Most nonbank banks have chosen to forego commercial lending though this is not always the case. Firms which have attempted to open or have opened such nonbank banks include J. C. Penny, Parker Pen, Sears, Gulf and Western, E. F. Hutton, Prudential-Bache, Shearson/American Express, and Household International. Bank Holding Companies have also opened nonbank banks as a device for circumventing interstate banking prohibitions. The current regulatory status of such nonbank banks is unclear. It is clear that if the constraint preventing the separation of the activities of delegated monitoring and inside money is binding, then the banking system is Non-Diamond.

VI. CONCLUSION

Regulatory reform calls for cooperation between economists and policy makers. Too often, however, this partnership has failed to fulfill its promise, frequently because communication, both within and between groups, has been difficult. Careful analyses (for example Meltzer [1967] based on standard economic principles often seem unrealistic or unhelpful to regulators or even other economists (Tobin [1967]). Much conventional work deserves this practical skepticism, because standard analysis often neglects the market imperfections which determine financial structure, and also ignores the interaction between markets and intermediaries. We hope our basic model can serve as a focus for these issues, and help both sides to meet the criterion set forth by Meltzer [1967] that "Attempts to regulate banking should take into account the unique features of the industry."

From the economic standpoint, the model presented here has many uses beyond those employed in this paper. Adding monitoring to the principal-agent problem should have other applications, for example, labor contracting. Likewise, the system of banks and asset markets which we derive may answer other positive and normative questions. We extended the basic model by adding inside money and discussing regulation--other extensions are possible. Since the economy is modelled at the level of tastes and technology, it can claim to avoid the problems of the Lucas critique (see Haubrich [1985]) when analyzing institutions.

In speaking to the social planner or policy maker, we wish to stress both the interaction between markets and the self justifying nature of regulation. Financial markets directly affect the form and stability of intermediaries. Stock, bond, futures and secondary markets allow banks to diversify risk. Markets for bank stocks and securities convey important information to the public. Conversely, the existence of intermediaries supports the credit markets. Policy problems are also difficult to resolve because the current world presents a biased picture: regulation is already in place. The world has changed in fifty years, and the justifications invoked for regulations may be outdated. Policy makers should realize that existing regulation strongly influences the nature of current crises and inefficiencies, even if they will not fully accept our argument that the existing regulation artificially weakens the financial system, and leads to the very failures, panics and inefficiencies it is in place to prevent.

APPENDIX A

In this appendix we solve problem (I) along lines similar to Kahn and Scheinkman [1985], Farmer [1985], and Farmer and Winter [1985]. In solving problem (I) we assume that $S(\theta)$ and $e(\theta)$ are absolutely continuous. The basic strategy of solution is to transform problem (I) into another problem, problem (AII) below, assuming $e_\theta \geq 0$. We then verify that $e_\theta \geq 0$ for the solution. In order to transform problem (I), we need the following lemmas:

Lemma 1: If $\underline{\theta}e(\underline{\theta}) \geq S(\underline{\theta})$, then $\theta e(\theta) \geq S(\theta)$. (If the limited liability constraint is satisfied at the lowest state, then it is satisfied at all higher states.)

Proof: Using the fundamental theorem of the calculus,

$$\theta e(\theta) - S(\theta) = \underline{\theta}e(\underline{\theta}) - S(\underline{\theta}) + \int_{x=\underline{\theta}}^{\theta} [\theta e_\theta + e - S_\theta]dx .$$

From the agent's maximization problem, constraint (ii) of Problem (I), $\theta e_\theta - S_\theta - V_e e_\theta - \gamma e_\theta = 0$. Thus, $\theta P_\theta - S_\theta = V_e P_\theta + \gamma P_\theta$. Substituting, get:

$$\underline{\theta}e(\underline{\theta}) - S(\underline{\theta}) + \int_{x=\underline{\theta}}^{\theta} [V_e e_\theta - \gamma e_\theta + e]dx = \theta e(\theta) - S(\theta) .$$

When monitoring does not bind, $\gamma = 0$. Then since $V_e > 0$, $e(\theta) \geq 0$ and $e_\theta > 0$, the integral is always positive, so $\underline{\theta}e(\underline{\theta}) - S(\underline{\theta}) \geq 0$ implies $\theta e(\theta) - S(\theta) \geq 0$. For θ where the constraint binds, i.e., $\gamma \neq 0$, the constraint forces a constant level of effort, namely, $Q(L)$, so $e_\theta = 0$, yielding a positive integral of $\int edx$.

Q.E.D.

Lemma 2: If $e(\underline{\theta}) \geq Q(L)$, then $e(\theta) \geq Q(L)$.

Proof: Immediate, since $e_\theta \geq 0$.

Using the lemmas, problem (I) can be written as:

$$\underset{S(\theta),e(\theta)}{\text{MAX:}} \int_\theta \left[\theta e(\theta) - S(\theta) - V(e(\theta))\right]h(\theta)d\theta \qquad \text{(AII)}$$

subject to:

(i) $$\int_\theta S(\theta)h(\theta)d\theta - K(L) \geq C$$

(ii) $$e(\underline{\theta}) \geq Q(L)$$

(iii) $$\underline{\theta}e(\underline{\theta}) \geq S(\underline{\theta})$$

(iv) $$e_\theta = \bar{e}_\theta$$

(v) $$S_\theta = \theta\bar{e}_\theta - V_e\bar{e}_\theta + \gamma\bar{e}_\theta \ .$$

In this problem, $S(\theta)$ and $e(\theta)$ are state variables. Constraints (iv) and (v) are the associated differential equations. The two differential equations are related, however, by (v). Consequently, there is only one control variable, $\bar{e}_\theta$. But, the level of monitoring, L, must also be chosen. L, however, is not a function of θ, and is, therefore, a control parameter.

Formulated this way, (II) is the optimal control problem of Bolza-Hestenes. Using Hestenes Theorem (see Takayama [1974]) we solve the problem as follows.

The Hamiltonian is:

$$H = \left[\theta e(\theta) - S(\theta) - V(e(\theta))\right]h(\theta) + P_1\bar{e}_\theta + P_2S_\theta + \lambda\left[S(\theta)h(\theta) - C\right] \ .$$

P_1 and P_2 are costate variables.

The Lagrangian is:

$$\pounds = H + q_1\left[e(\underline{\theta}) - Q(L)\right] + q_2\left[\underline{\theta}e(\underline{\theta}) - S(\underline{\theta})\right] .$$

The control parameters are:

$$b = \left[\underline{e}, \bar{e}, \underline{S}, \bar{S}, L\right] ,$$

where:

$$e(\underline{\theta}) = \underline{e};\ e(\bar{\theta}) = \bar{e};\ \text{and},\ S(\underline{\theta}) = \underline{S};\ S(\bar{\theta}) = \bar{S} .$$

Optimal choice of $\bar{e}_\theta$ implies:

$$P_1 + P_2(\theta - V_e + \gamma) = 0 . \tag{A1}$$

The Euler-Lagrange equations are:

$$\frac{dP_1}{d\theta} = -h(\theta - V_e) + P_2V_{ee}\bar{e}_\theta \tag{A2}$$

$$\frac{dP_2}{d\theta} = h(1 - \lambda) . \tag{A3}$$

Totally differentiate (A1) and substitute (A2) and (A3) into the total differential to get:

$$\theta = \frac{h\gamma(\lambda - 1) - P_2}{h\lambda} - V_e . \tag{A4}$$

The transversality conditions are (see Takayama [1974], p. 660):

$$-P_1(\underline{\theta}) = \int_\theta q_1(1 - Q_L)h(\theta)d\theta + \int_\theta q_2\underline{\theta}h(\theta)d\theta \tag{A5}$$

$$P_1(\bar{\theta}) = 0 \tag{A6}$$

$$P_2(\underline{\theta}) = \int_\theta q_2h(\theta)d\theta \tag{A7}$$

$$P_2(\bar{\theta}) = 0 \tag{A8}$$

$$\lambda K_L = \int_\theta [P_2 \bar{e}_\theta \gamma_L - q_1] h(\theta) d\theta \ . \tag{A9}$$

Integrate Euler-Lagrange equation (A3) to get:

$$P_2(\theta) = P_2(\underline{\theta}) + (1 - \lambda) H(\theta) \tag{A10}$$

which, evaluated at $\bar{\theta}$, using the transversality conditions, yields:

$$0 = \int_\theta q_2 h(\theta) d\theta + (1 - \lambda) \ .$$

Therefore, we have:

$$(\lambda - 1) = \int_\theta q_2 h(\theta) d\theta \equiv Q > 0 \ . \tag{A11}$$

Define $\Psi \equiv (\lambda - 1)/\lambda$. (A11) implies $\Psi \in [0, 1]$. Now (A11) can be written as:

$$\frac{P_2(\theta)}{\lambda h(\theta)} = \frac{\Psi}{r(\theta)} \ . \tag{A12}$$

Substitute (A12) into (A4) to get:

$$\left[\theta - \Psi\left(\frac{1}{r(\theta)} - \gamma\right)\right] = V_e \ . \tag{A13}$$

(A13) implicitly defines the optimal effort function $\hat{e}(\theta)$, and is the condition of Proposition 2 in the text. Transversality condition (A9) is given as Proposition 3.

Problem (AII) was solved using the lemmas. The lemmas were derived assuming $e_\theta \geq 0$. We now need to verify that the solution to (AII), in fact, has $e_\theta \geq 0$. Incentive compatibility requires that:

$$\underset{m}{\text{Max}} \ \theta e(m) - S(m) - V[e(m)]$$

subject to:

$$e(m) \geq Q(L) \tag{A14}$$

occurs at $m = \theta$ for all θ, where m is the message which the manager conveys to the market. The first order condition for (A14) requires:

$$\theta e_\theta - S_\theta - V_e e_\theta + \gamma e_\theta = 0 \ . \tag{A15}$$

By totally differentiating (A15) and comparing the result with the second order conditions for (A14) it follows that $e_\theta \geq 0$ if the contract is incentive compatible. To see that this holds for our solution, recall the Kuhn-Tucker condition on the monitoring constraint, $\gamma[e(\theta) - Q(L)] = 0$. If $e(\theta) > Q(L)$, then $\gamma = 0$ and $e_\theta > 0$ follows from $r'(\theta) > 0$. If $\gamma \neq 0$, then $e(\theta) = Q(L)$ and $e_\theta = 0$.

Proof of Proposition 6

To prove Proposition 6 we solve (AII), above, subject to the additional constraint that $L > \hat{L}$, i.e., a binding Glass-Steagal constraint. So, the Lagrangian row is:

$$\pounds = H + q_1[e(\underline{\theta}) - Q(L)] + q_2[\underline{\theta}e(\underline{\theta}) - S(\underline{\theta})] + q_3[L - \hat{L}]$$

where H, the Hamiltonian, is the same as above. Now apply Hestenes Theorem as above. The only difference is in the transversality condition (A9) which is now:

$$\lambda K_L = \int_\theta [P_2 \bar{e}_\theta \gamma_L - q_1 - q_3] h(\theta) d\theta \ .$$

In order for the above solution, (A13), to be achieved, we must have $q_3(\theta) = 0$. And, by Hestenes Theorem, $q_3(\theta)[L - \hat{L}] = 0$, at an optimum. But, by assumption the Glass-Steagal constraint is binding, i.e., $L > \hat{L}$.

Therefore, $q_3(\theta) > 0$, $\forall\theta$, and the solution to Proposition 2 cannot be achieved.

Q.E.D.

APPENDIX B

In this appendix we set up the social planning problem of section III above where bank debt and credit market securities are not claimants of the same status. The equilibrium in the main text can be supported by recognizable securities, in particular, bank debt, equity, and options. But, in this appendix we explicitly consider the implications of bankruptcy, so we impose a hierarchy of claimants and argue that the bank will be the senior claimant.

As the senior claimant on the firms, bank debt has the following pay-off structure:

$$L(\theta) = \begin{cases} L & \text{if } \theta^* \le \theta \le \bar{\theta} \\ \dfrac{\theta e(\theta)}{L} & \text{if } \underline{\theta} \le \theta < \theta^* \end{cases}$$

where L is the amount the firm promises to repay (i.e., principal and interest). The firm can honor this debt commitment as long as the realized value of the output is at least equal to L. That is, for states higher than θ^* the firm pays off its bank debt at par, where θ^* is the lowest state such that $L = \theta^* e(\theta^*)$. For realized states less than θ^*, the value of the output cannot repay the bank debt at par, and, consequently, the bank suffers a capital loss.

The credit market securities, $S(\theta)$, only earn a positive return if the bank debt can be repaid, since these securities are junior claimants. Hence, the pay-off structure of these securities is:

$$S(\theta) = \begin{cases} S(\theta) & \text{if } \theta^* < \theta \le \bar{\theta} \\ 0 & \text{if } \underline{\theta} \le \theta \le \theta^* \text{ .} \end{cases}$$

The project can now be financed explicitly by some combination of bank debt, i.e., nonmarketable securities, and marketable stocks or bonds. The above pay-off structure introduces the new element of bankruptcy, which was not present in the model of the main text. The firm management receives the difference between realized output and payments to the outside claimants. However, bankruptcy for the firm is defined to be the inability to repay the bank debt at par, i.e., realizations of the state less than θ^*. The agent-manager only receives payment (consumption) if he does not default on the bank debt.

The introduction of bankruptcy changes the incentives the agent-manager faces compared to the problem discussed in the main text. In the main text the effort decision of the agent is distorted in all states because the outside claimants received a disproportionately large share of marginal effort in low states (due to the binding limited liability constraint). Now, with bankruptcy, the bank takes everything if output is less than what the bank is owed. The distortion, then, is much greater, and one might expect that more monitoring would be chosen. The definition of bankruptcy, however, depends on the face value of the bank debt (L) and on the effort function ($e(\theta)$). So the agent-manager can affect when bankruptcy occurs.

This endogeneity of the definition of bankruptcy does not make economic sense. Since bankruptcy imposes costs on the managers, the definition of when bankruptcy occurs should be viewed as a monitoring technique. Since the bank, as the monitor, is likely to have better information than markets, the bank debt should determine when bankruptcy occurs. Therefore, bank debt must be the senior claimant in order to optimally use bankruptcy as a monitoring technique. But this then requires us to link the monitoring technology and bankruptcy.

The link between the imposition of bankruptcy on the agent-manager and the monitoring process can be achieved as follows. Let the disutility of bankruptcy to the agent-manager be a constant, $\overline{V}$, across all bankruptcy states. This can occur if, in bankruptcy states, bank monitoring directly creates disutility in this way. For example, the bank requires more reports, calls the management on the carpet, and so on. Assume that $\overline{V}$ is large enough so that choice of the monitoring level determines effort in all bankruptcy states. Then:

$$L(\theta) = \begin{cases} L & \text{if } \theta^* \le \theta \le \overline{\theta} \\ \dfrac{\theta Q(L_m)}{L} & \text{if } \underline{\theta} \le \theta < \theta^* \end{cases}$$

Bankruptcy is now directly defined by the bank since $\theta^* = \frac{L}{Q(L_m)}$, and the endogeneity is circumvented. L_m is the level of monitoring and L is principal and interest on the bank debt. In the above formulation these are both choice variables.

The social planner now solves:

$$\underset{S(\theta),e(\theta)}{\text{MAX}}: \int_{\theta^*}^{\overline{\theta}} \left[\theta e(\theta) - S(\theta) - L - V(e(\theta))\right]h(\theta)d\theta - \overline{V}\left[1 - \int_{\theta^*}^{\overline{\theta}} h(\theta)d\theta\right] \quad \text{(BI)}$$

subject to:

$$\text{(i)} \quad \int_{\theta^*}^{\overline{\theta}} \left[S(\theta) + L\right]h(\theta)d\theta + \left(\frac{L}{Q(L_m)}\right)\left[E(\theta) - \int_{\theta^*}^{\overline{\theta}} \theta h(\theta)d\theta\right] - K(L_m) \ge C$$

$$\text{(ii)} \quad (\forall\theta) \quad \theta \in \underset{m}{\text{argmax}}\left[\theta e(m) - S(m) - V(e(m))\right] \quad \text{subject to: } e(m) \ge Q(L_m)$$

$$\text{(iii)} \quad e(\theta) \ge Q(L_m)$$

(iv) $$S(\theta) + L(\theta) \leq \theta e(\theta) .$$

In this form problem (BI) can be solved in the same way as the problem of Appendix A. Once transformed using analogous lemmas, the problem satisfies the conditions of Hestenes theorem. The only important difference here is that the lower end point θ^* is variable since it is a function of the control parameters L and L_m.

Proof of Proposition 10:

To prove Proposition 10 we need to solve problem (BI) above and compare that solution to the solution we get when the Glass-Steagal Act is binding. In order to solve (BI) we need lemmas analogous to those in Appendix A, except that here θ^* is the lowest state. Then, let q_3 be the multiplier on the Glass-Steagal constraint, $L > \hat{L}$. Applying Hestenes Theorem, (BI) can be solved as in Appendix A. To prove Proposition (10) consider the transversality conditions for choice of L and L_m, respectively:

$$\lambda\left(\frac{E(\theta)}{Q(L_m)} + \hat{\mathcal{E}}(\theta^*)\left(\frac{1}{Q(L_m)}\right) = \int_{\theta^*}^{\bar{\theta}} \left[\lambda\left(1/Q(L_m) - 1\right) - q_2 - q_3\right]h(\theta)d\theta \qquad \text{(B1)}$$

$$\lambda\left(K_{L_m} - \frac{LE(\theta)Q_{L_m}}{Q(L_m)^2}\right) + \hat{\mathcal{E}}(\theta^*)\left(\frac{LQ_{L_m}}{Q(L_m)^2}\right) = \int_{\theta^*}^{\bar{\theta}} \left[-q_1 Q_{L_m} + q_2 + \frac{\lambda L Q_{L_m}}{Q(L_m)^2}\right]h(\theta)d\theta \qquad \text{(B2)}$$

Notation is analogous to that of Appendix A. $\hat{\mathcal{E}}(\theta^*)$ is the Lagrangian, optimized, and evaluated at θ^*. Now, if Glass-Steagal is not binding, then $q_3 = 0$, and (B1) and (B2) characterize the optimal choices of L and L_m respectively. Then, these choices determine θ^* which is the lowest state which can be realized without bankruptcy being declared. Call this θ^*_{uc} for "unconstrained." If Glass-Steagal is binding, then $q_3 > 0$ (by Hestenes

Theorem). But then, substituting (B1) into (B2), the choice of L_m cannot be the unconstrained choice. The constrained level of monitoring, L_{mc}, is too low because monitoring is costly. Consequently,

$$\theta^*_{uc} = \frac{L}{Q(L_m)} < \theta^*_c = \frac{\hat{L}}{Q(L_{mc})}$$

So, the banking system fails over more states of the world because of the binding Glass-Steagal Act.

Q.E.D.

FOOTNOTES

[1]As long as the production function $X = F(e, \theta)$ yields stochastic constant returns to scale there is no loss of generality in adopting the formulation that $F(e, \theta) = \theta e$. As explained in Farmer and Winter [1985] normalization and relabelling of states of the world can always accomplish this.

[2]This specification of monitoring provides both tractability and realism. Literally a loan covenant, it forbids certain low effort levels, leaving effort at the discretion of management as long as the restriction is met. Similarly, accounting firms verify that practices meet some minimum standard. This sort of monitoring can also apply to other types of moral hazard; for example, the risks of a project chosen by the firm.

[3]The assumption that the hazard rate is increasing is not particularly restrictive. It is satisfied for a large class of density functions including the Exponential, the Gamma and Weibull with degrees of freedom parameter larger than 1, the Normal Distribution, La Place, and the uniform.

[4]Strictly speaking the equilibrium $\{S^*(\theta), L^*\}$ does not link the form of the securities or the amount of securities the bank has to the level of monitoring. In other words, one way of interpreting the equilibrium would be that for a given realization of θ, say $\hat{\theta}$, the bank gets a constant fraction of $S^*(\hat{\theta})$ and the credit markets get the rest. It is possible to show, however, that the equilibrium can be supported by a more complicated, yet readily recognizable, set of securities, namely, bank debt, equity, and options. Rather than display this support, we pursue a related problem in Appendix B. In Appendix B we explicitly introduce bankruptcy as part of the monitoring technology. This requires a hierarchy of claimants.

[5]Since investment banks sometimes enforce bond covenants this is not strictly true.

[6]Background information on the Glass-Steagal Act can be found in Saunders [1985], Sametz, et.al. [1979], and Kareken [1986].

[7]It also established the FDIC, restricted branch banking, and regulated interest rates and credit.

[8]For further information on the European and Asian approaches to separation, see Daskin and Marquardt [1983], and Langohr and Santomero [1985].

[9]Much evidence suggests that the banking panics and bank failures of the 1930's were themselves the result of regulation, rather than a result of the lack of regulation. The twenties and thirties, for example, were the only times in U.S. history to that point that deposits were not privately insured. See Gorton [1985D, E]. But whatever the facts were when Glass-Steagal was passed, our argument is that the situation could be different today.

[10]Under current banking regulations, of course, the activities of monitoring and producing inside money are required to be combined. Prior to this restriction, however, these activities were also combined. Two theoretical rationales, not mutually exclusive, have been put forth to explain this combination in unregulated environments. One argues that important informational interactions or scope economies exist when the two activities are internalized within a single firm. The other argues that the production of inside money requires a contract such that the private money producer put up a bond to assure contractual performance in not overissuing his money. The size of this performance bond is determined by technological assumptions about the economy's ability to monitor the private money producer (see Gorton [1985A]). The upshot is that an efficient arrangement requires the bond to be held by the intermediary-money producer (rather than by final investors), and consequently, the most efficient form of the bond is as claims held by the delegated monitor. These securities then become nonmarketed, and possibly, nonmarketable, because they are held as the performance bond. The intermediary already has nonmarketed loans, though, so it becomes the lowest cost money producer.

[11]The idea that equity serves the role of a bond, guaranteeing the performance of the intermediary, under asymmetric information, is discussed by Campbell and Kracaw [1980]. The existence of the problem, to which an equity bond is partially a solution, is not the information asymmetry per se, but the fact that the contract between depositors and the monitors cannot be reduced to first best as in Proposition 5. Gorton [1985C] shows that even with equity depositors will monitor by panic. In Gorton [1985B] depositors confound systematic and bank-specific risk. In Campbell and Kracaw the bond is sufficient to guarantee performance.

[12]In the Diamond and Dybvig model the assumed information asymmetry explains the existence of the banking system, and if the asymmetry disappeared so too would banks. In Gorton's model, the asymmetry is created by agents because it is socially optimal, but technological change could eliminate it without eliminating the need for banks. This latter possibility is the one we pursue.

[13]More precisely, only certain types of "sun spot" equilibria are eliminated. For example, the Diamond and Dybvig [1983] model of panics has "sun spot" panics. But these panics would disappear if the asymmetric information disappeared, so our definition allows this type of sun spot. "Sun spot" equilibria emanating from nonunique solutions to rational expectations models, however, we do not consider panics in any meaningful sense.

[14]Notice that Proposition 9 assumes that banks will not hold government securities, which they are not prohibited from holding by law. For Proposition 9 this makes no difference since government securities have active secondary markets. In considering a binding Glass-Steagal Act, however, as in Proposition 10, the existence of government securities may affect the result, but cannot eliminate it completely.

[15]See Norton [1984], Berg [1986], and Zweig [1986].

[16]In fact, there has not been a legal case to actually test this proposition, and it is likely to be debatable whether participations are

really secured loans, and hence, junior claimants to deposits, or purchase-sale agreements. This same issue has confused the status of repurchase agreements. In either case, however, the participation must price bank-specific risk. If the participation is junior to demand deposits, then bank default risk must be priced. If the participation is a purchase-sale agreement, the bank's monitoring capabilities of underlying loan must be priced.

[17]There is an additional point concerning bank size. If banks were larger, an information-revealing market in bank stock could potentially open and eliminate the information asymmetry. In the United States, of the 14,000 banks in existence, roughly 13,500 do not have stock which is actively traded. (This, in addition to no traded assets or any traded nonequity liabilities.) Larger banks and large bank hold companies have traded stock. In order for the stock of a firm to be traded, the firm must achieve a minimum size. It is not only that thin trading does not lead to informative prices, but also that trading at all may require a minimum size firm in order to make arbitrage possibilities profitable when information is costly. (Grossman and Stiglitz [1980] point out that if there are costs to obtaining information then such costs reduce market efficiency.)

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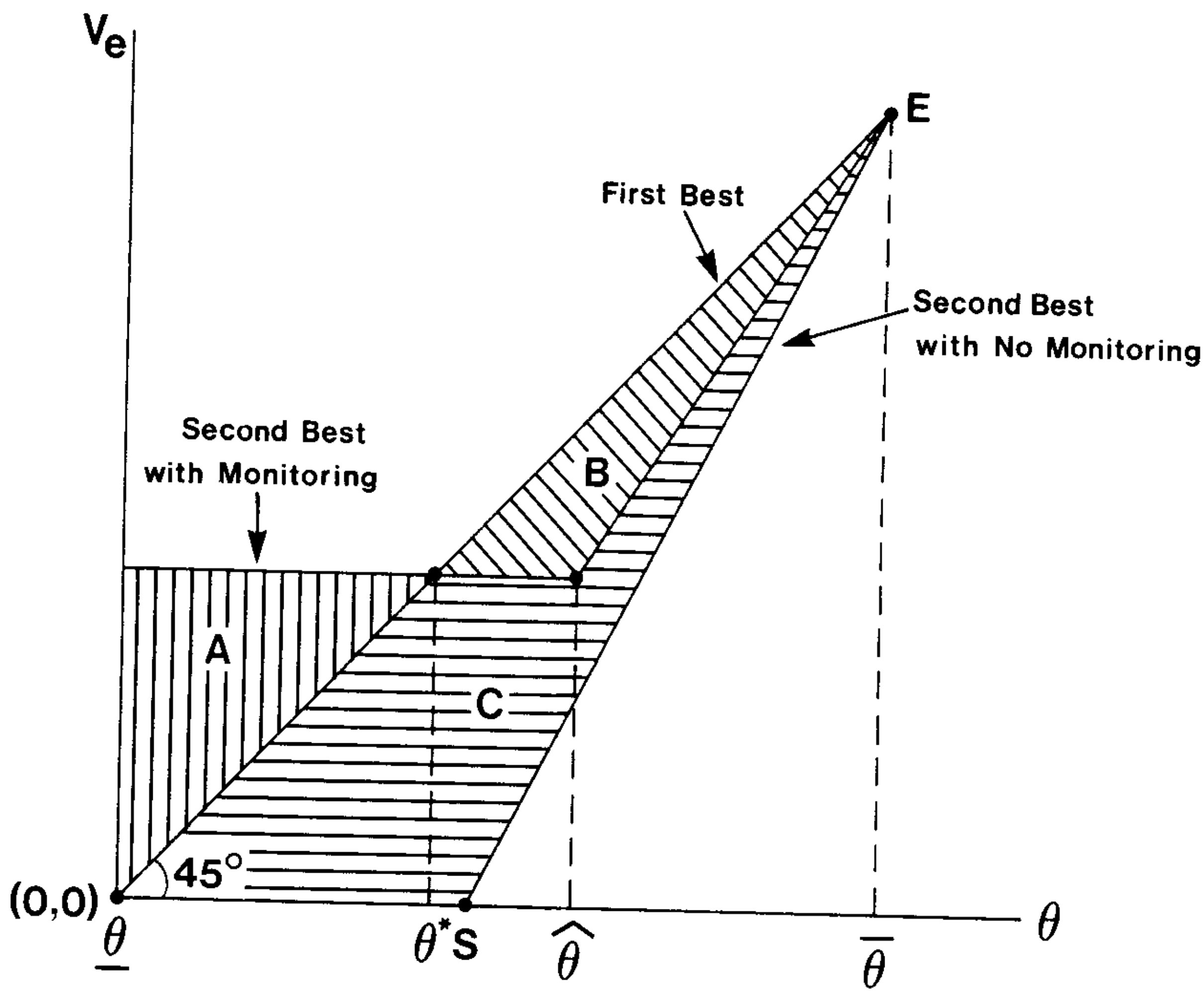
FIGURE I

THE OPTIMAL CONTRACT WITH MONITORING



where: $\theta^* \ni \frac{1}{r(\theta^*)} = \gamma$; $\hat{\theta} \ni e(\hat{\theta}) = Q(L)$

monitoring is chosen if : $C + B > A + B$