

ESSAYS ON BANKING

By

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Abstract

This thesis entitled "Essays on Banking" is comprised of three essays on various aspects of the relationship between a firm or a country and its creditor bank.

The first essay focuses on a firm's choice between borrowing from banks and borrowing from arm's length sources like the bond markets. Banks improve welfare because they help control a firm's investment decisions. However, the private information they acquire in order to do this gives them an information monopoly, which distorts the firm's incentives. Bank financing therefore may be costlier than arm's length financing. In a bank dominated economy, repeated interactions or relationships can reduce the cost of bank finance. The introduction of an arm's length market in such an economy may reduce welfare by destroying relationships. Competition then may take the place of relationships in reducing the costs of bank finance. I obtain implications for the choice of maturity, priority, credit source and the efficiency of financial systems.

The second essay examines the case for separating commercial and investment banking. The Glass Steagall Act has been pilloried by economists for preventing banks from using the economies of scope they have in gathering information. What has been ignored is that banks may be very inefficient underwriters, despite any economies they may enjoy. A bank has risky loans outstanding to the firm, which give it an incentive to certify the firm as being good. The greater the size or riskiness of the loan, the greater the conflict of interest and lower the amount of information it can convey to the market. The inability of the underwriting bank to convey information to the market imposes welfare costs on the firm. If firms had freedom to choose an underwriter, these costs would not matter as the firm would choose the most efficient one. However, banks have access to information about the firm through their lending operations and can monopolize the firm through pre-emptive information acquisition or pre-emptive contracts. The ensuing rents enables them to subsidize inefficient underwriting, thus entrenching these welfare costs. A policy of prohibiting banks from underwriting is one way to eliminate these welfare costs. The essay goes on to examine other ways of resolving the problem.

The last essay explores reasons why firms and countries do not index their debt to contractible measures of their ability to pay. Indexation reduces the states in which the country defaults and hence the costs associated with potential default. Yet indexation has only been marginally used in debt reduction plans. This note shows why the conversion of outstanding straight debt to indexed debt is more difficult than other forms of debt reduction. If creditors each hold small fractions of outstanding debt, substantial default risk has to exist after conversion in order to give them incentives to convert. However, if the fraction each creditor holds is large, the

country can credibly threaten to not invest and get conversion to default free indexed debt. This suggests that a country facing a debt overhang has an incentive to delay till small creditors sell out before it offers an acceptable indexation plan. I explore other reasons why indexation may not take place.

Dissertation Committee

Stewart C. Myers (Chairman), Gordon Y. Billard Professor of Finance.

Donald Lessard, Professor of Management.

Jeremy Stein, Associate Professor of Finance.

David Scharfstein, Associate Professor of Finance.

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Chapter 1 Introduction and Overview

Introduction

The Eighties have brought tremendous changes to financial systems around the world. Markets have been de-regulated, information has become cheaper and more easily processed, and competition has increased. Has all this been for the good? Does de-regulation always increase competition? Does competition increase efficiency?

It is well known to any student of economics, that the answers to the above questions depend on the nature of the industry, the returns to scale, the degree of prior competition and so on. Yet, the competitive paradigm is so well ingrained that the policy debate, over the changes in the financial system, have largely assumed the answers to be in the affirmative. We give two examples of this which are a preview of the essays to follow.

The Japanese corporate bond markets were de-regulated in the late Seventies. Prior to the de-regulation, many firms had close ties to the banks. This was especially true in a *Keiretsu*¹, where the *main* bank served as implicit guarantor to the firms in the grouping. Hoshi, Kashyap and Scharfstein (1990 a) find the investment decisions of these firms were not constrained by cash flows. After the reforms, some firms borrowed extensively from the bond markets thus loosening their ties to the banks. The investment decisions of these firms became liquidity constrained, while the firms that retained close bank ties continued to have easy access to funds. De-regulation of the bond markets lead to more competition in the credit markets. But did this improve welfare?

The study by Hoshi et. al. suggests that there are costs associated with bond market or armslength finance. But if firms had free choice, there must have been costs of bank finance that forced firms to forsake bank relationships and suffer credit constraints in the bond market? What were they? ² According to the literature, bank finance may be costly because banks can incur a discretionary *monitoring cost* in observing the firm. But if costly monitoring raises the cost of bank finance, why do banks not stop monitoring and lend at the un-monitored armslength rate? It is hard

¹ The Japanese term for the big, close-knit, post-war industrial groups.

² It is unlikely that banks had a higher cost of funds because banks were still substantially funded by under-priced core deposits at this time. Also, the banks themselves were not funds constrained, as evidenced by their subsequent international lending.

to explain this phenomenon if we believe the banking system was competitive.

The answer is simple if one is willing to go beyond the competitive paradigm. If bank lending is monopolistic rather than competitive, banks have the potential of extracting rents from the firms they lend to. These rents are kept in check by implicit contracts or *relationships* between the firms and the banks. The introduction of competition breaks these implicit contracts. Some firms are forced to go to the bond markets even though *given the static choice between bond market credit and relationship based bank credit they would prefer bank credit*. Credit market competition can reduce welfare for these firms.

The example shows that competition may increase after de-regulation and yet efficiency may decrease. Competition changes the nature of the credit being offered. So a static examination of the firm's choice tells us nothing about which form of finance is superior. The firm's choice does not indicate that armslength credit is superior to relationship based credit but only that armslength credit is superior to opportunistic bank credit. Yet the movement of firms away from banks in Japan is taken in some policy circles³ as reassurance that the competitive, armslength American system is more efficient.

I base my second example on the debate over repealing the Glass-Steagall act. There are two related and, *a priori*, sensible efficiency arguments for repealing the act⁴; First, banks collect information through their lending operations. This gives them economies of scope over other independent investment banks. Second, investment banking in the United States is an oligopoly making excessive profits. If banks are allowed to enter the industry, competition will increase, pushing down rents and improving welfare.

In these arguments again, it is taken for granted that de-regulation will lead to competition and, as the de-regulated entity has the capacity to be more efficient, welfare must increase. Yet, it is not clear that banks are more efficient underwriters. Despite being better at gathering

³ As I have not had the opportunity to enter these circles, I base this on conversations with Jeremy Stein.

⁴ A host of less sensible reasons have been proposed including giving banks a new franchise since the profitability of their core business has fallen, and the more political call for "levelling the playing field".

information they are less able to communicate it. The reason is simple. Banks have a conflict of interest because they have risky loans outstanding to the firm. They have an incentive to certify the firm as good. This conflict impairs the credibility of the bank's announcements and reduces the amount of information it can convey. Therefore, banks may be less efficient underwriters because of the very loans that give them the supposed economies of scope.

Economists would argue that as firms have freedom of choice, giving them more choice must be weakly better as they can always ignore new inferior alternatives. Therefore the inefficiencies described above are irrelevant to policy.

But firms may not have freedom of choice. The investment banking industry is oligopolistic for good reason; Large sunk costs of acquisition of non-transferable information during the underwriting process, asymmetric information between *inside* investment banks and *outside* investment banks, the ability to pre-empt information acquisition because of prior relationships, the ability to write contracts prohibiting firms from using other underwriters, all give underwriting the features of a natural monopoly. A bank has an advantage over independent investment banks in such a situation, because it has prior access to information through its lending operations. This enables it to monopolize the firm even though the bank may be less efficient an underwriter. The bank can then subsidize its inefficiency in underwriting by giving up some of its monopoly rents. Therefore, even if the firm has the semblance of free choice, it stays with the inefficient bank.

In this example, de-regulation reduces competition and also may reduce efficiency. The reason again is monopoly. The underlying theme of this dissertation, as brought out in these two examples, is that financial intermediation has many of the characteristics of a natural monopoly, which is one reason why it is regulated. The advances in information acquisition, processing and dissemination have made it more competitive. But small and medium sized firms still face monopolistic situations, as do large firms and countries in bad times. This dissertation attempts to understand a borrower's decisions when faced with such monopolistic credit markets. As such, it has important empirical and policy implications.

Overview - Insiders and Outsiders: The Choice between Relationship and Armslength Debt

Banks have traditionally been thought to have a welfare improving effect. A bank reduces the agency problems associated with debt in various ways. Yet in practice, firms rarely borrow from only one bank. Most medium and large firms borrow from a number of banks. At the same time, they may borrow long term from the bond market or financial institutions like insurance companies.

If as the theory suggests, bank debt is such an efficient form of finance, why do we see firms borrowing from other sources? Why does the choice between sources change so dramatically as in the earlier example of Japan?

A key point in this paper is that short term bank debt is costly *even if monitoring costs are small*. When the bank monitors the firm, the private information it acquires gives it an informational monopoly over the firm. Once the bank becomes the sole potential creditor, the short maturity of its loan enables it to translate credit decisions into the firm's investment decisions without the interference of other less-informed potential creditors. But the short maturity also enables the bank to extract rents (strictly speaking quasi-rents) when the loan is re-contracted. These rents distort the incentives of the firm to exert effort, or choose the right project.

In contrast to the earlier literature, we show that the welfare effects of a bank acquiring private information are ambiguous; the benefit of being bank controlled has to be weighed against the costs of distorted firm incentives.

We then argue that the prospect of repeated interaction, i.e a '*relationship*' between the firm and the bank over future projects, reduces the bank's incentive to extract rents especially from firms with high growth opportunities. This is because the firm can threaten to change banks once a project is completed, thus giving the bank an incentive to not be opportunistic.

The introduction of an *armslength* market in a bank dominated economy adds a qualitatively different type of competitor. Firms prefer armslength debt to bank debt for projects with a high chance of success, as the lower control is compensated for by the commitment not to

extract rents.

Therefore, when an armslength market is opened up in a relationship dominated economy, the nature of a firm's projects over time affects the relationship. Firms with a sequence of projects, each having a high probability of success, will move to the armslength markets. Firms with projects having a low chance of success and firms with low discretionary investment will stay with the banks. However, intermediate firms which optimally would start with a bank and then move on to the armslength market cannot commit to staying in the relationship. The relationship breaks down as bank behavior is no longer constrained by the possibility of future interaction. Some of these firms move away, even though they might be liquidity constrained in the armslength market. Other firms stay and face the now more opportunistic banks. The introduction of an armslength market may actually reduce efficiency for some firms. The findings in Hoshi et al. support such an interpretation.

Bank debt, of course, need not be short term. Long term bank debt resolves the problem of rent extraction by the bank, but the bank now cannot simply refuse to re-lend to unprofitable projects. It has to bribe the firm to stop them. The firm thus finds the opportunity to undertake unprofitable investments more attractive. We derive implications for the optimal maturity of bank debt.

Finally, we examine the effects of having uniformed bank competition bidding for every loan in addition to having competition from the long term armslength markets. We obtain the following results:

(i) The basic trade-off still holds. Interim competition reduces rent extraction by the informed bank. At the same time, it reduces the bank's control because uninformed lenders may continue unprofitable projects. The bank's incentive to monitor is also reduced. Thus the welfare effects of interim competition are ambiguous.

(ii) The firm may reduce the size of the initial bank loan (and hence the bank's monopoly power) by borrowing from the armslength market. It thus trades lower control for lower distortion, by borrowing from different sources at the same time. We also obtain implications for the priority

structure of bank debt and public debt.

(iii) The pattern of public and private information revelation over time is important in determining the choice between bank debt and armslength debt.

We conclude with a discussion of the implications our model has for the relative efficiency of banking systems in different countries.

Our paper is not the first to examine the choice between relationship and armslength debt. Berlin and Loeys (1988), Diamond (1989 a) and Diamond (1989b) examine various aspects of this choice. They, however, assume that firms face competitive banks. The implications we obtain under monopoly complement their results and may be viewed as pertaining to small and medium sized firms. Our empirical and policy implications are sometimes dramatically different. Finally, our initial analysis of ex-post bank monopoly is similar in parts to Sharpe (1990)⁵. However, his focus is not on the choice between bank debt and public debt or on the link between monopoly power and control.

Overview - Conflict of Interest and the Separation of Commercial and Investment Banking

As competition in the U.S banking system has increased, pleas both from banks and academics for repealing the Glass-Steagall act have become louder. The Act has been pilloried by economists for inefficiently preventing banks from using the economies of scope they have in gathering information. Yet, despite the criticism for the basis of the act, could it serve a useful purpose? Are there other valid reasons, not clearly articulated so far, for separating commercial lending from investment banking? More specifically, could the existence of conflict of interest stemming from lending affect the efficiency of the investment banking function? These are the questions this paper seeks to answer.

This paper provides an analysis of the welfare effects of, what we believe is, the important

⁵Our work was done independently.

conflict of interest; *the conflict between an investment bank's role as an impartial certifier of firms with the bank's role as a lender to those firms*. The problem we examine in this paper is one faced by a bank which has risky loans outstanding to a firm. If additional bank loans are costly, the firm will fund new investment via the stock market. When a firm uses its bank to certify it to the market (the primary function of the underwriter), the bank has an incentive to certify the firm as being good, if only to get some of its loan paid back or to avoid being forced to fund the firm's investment.

We show that this conflict inhibits the ability of the housebank (a term we use interchangeably with 'bank') to signal the true value of the firm to the market, even if the market is regulated and investors have the possibility of redress. The greater the conflict of interest, the more noisy the information the housebank conveys to the market. Even though investors are not fooled in equilibrium, underwriting is inefficient because the bank is not credible. This has real effects on the mode of financing and hence on investment.

We have argued that the bank may be more inefficient in *transmitting* information. But its economies of scope in *acquiring* information may enable it to overcome the former inefficiency. It can be argued that giving the firm the freedom to choose the bank as underwriter because of the possibility that the bank is indeed more efficient, must be weakly Pareto-improving.

The above argument does not recognize the fact that firms may not be free to make the choice between underwriters. A bank which has lent to the firm is not the same as any independent investment bank. First, the lending process gives the bank *free access* to information, which enables it to choose the timing and the amount of its information acquisition. Underwriting has the characteristics of a natural monopoly, and an incumbent who can make pre-emptive investments can monopolize the market. We show this holds under a variety of assumptions. Second, as a result of contact during the lending process the bank and the firm can *contract* with each other, either

explicitly or, implicitly via a relationship. We show that the bank and the firm may rationally contract to exclude outside independent underwriters. Thus the firm may voluntarily consent to a welfare reducing tie-in, which entrenches the bank's inefficiency in underwriting.

Three implications follow if investment and commercial banking are not separated: First, firms may prefer bank loans to being inefficiently financed in the public markets. This inhibits the growth of public markets. Also, if the bank is a price-setter in the loan market, its ability to monopolize the market for underwriting is enhanced. Second, investment banks would tend to be confined to underwriting issues for independent firms or those with quality high enough to not require investigation. They may be forced to integrate backwards into lending so as to break into the 'middle' market, thus entrenching the economy in a bad equilibrium. Third, because of the above market fore-closure and resulting vertical integration or exit of independent investment banks, commercial banks would monopolize both lending and underwriting for all firms, which would distort investment decisions in the economy.

Note, however, that the banks have no interest in being inefficient underwriters. Instead of imposing costly *exogenous* legal penalties if the banks mislead the market, which may be counter-productive, banks should be given the ability to impose *endogenous* costs and thus signal the value of the firm accurately. One way for the underwriter to do so is to buy junior securities like equity in the firm when making a public offering. We show that under plausible conditions, small equity purchases by the underwriter can perfectly signal the value of the firm. The amount of equity to be purchased increases in the size of previous bank holdings and varies monotonically in the quality of the firm.

This paper shows that repealing Glass-Steagall may have the effect of *reducing* competition and *reducing* welfare because of the inefficiencies associated with low bank credibility. De-

regulating further, by permitting banks to hold equity, may increase bank credibility and despite the existence of bank monopolies, may improve welfare.

Without empirical verification, these ideas may be dismissed as irrelevant illustrations of ivory tower theorizing. Yet, there is no existing study, that I know of, which shows that banks are indeed more efficient at underwriting. Casual empiricism shows that banks internationally have not been very successful at underwriting corporate equities. My work suggests there may be sound economic reasons for this lack of success especially when banks underwrite small and medium firms. It also suggests that more evidence is needed before policies are made.

Overview - A Note on Indexation in the Presence of Debt

In response to the L.D.C. debt crisis, several economists have suggested indexing a country's debt to some measure of its ability to pay, like exports or G.N.P. If the ability to pay is also correlated with the ability of creditors to inflict penalties, indexation leads to better collateralization of the debt. This is beneficial to the country as it improves the country's ex-ante ability to borrow. Indexation also reduces costly renegotiation and improves investment incentives by making the debt write-down in states of default explicit. In addition, Lessard (1987) suggests that countries which are dependant on a single commodity can diversify price risk by issuing bonds which pay a rate varying directly with the commodity price. Finally, Froot, Scharfstein and Stein (1989) show that indexing debt payment to revenues helps separate the countries that truly need debt relief from those that do not.

Despite these potential advantages, indexation has seldom been a part of L.D.C. debt reduction plans. Even if offered it has only been partial in the following sense; First, it has been

offered as only one in a menu of options to old debt holders. The other options usually involve exchanging old bonds for new fixed debt obligations which are lower in face value but better collateralized than the old fixed claims. Second, indexation has taken the form of linking the interest rate above a fixed floor rate to some measure of the ability to pay. To the extent that there is a significant fixed portion of debt after the debt has been converted, a substantial amount of default risk is retained. Indexation, so far, appears to be less a means of risk sharing or reducing the probability of default, than a means of giving the converting creditor some of the upside as an 'equity kicker'.

What accounts for this reluctance to make debt fully indexed?

It is clear that a country has a dis-incentive to issue equity-like instruments, like indexed debt, when it already has a substantial amount of risky debt outstanding. The reason, familiar from the corporate finance literature, is that such an issue results in a transfer from the residual claimants (the country) to old fixed claim holders (the creditor banks). The issue of equity-like instruments reduces default risk thus increasing the value of old risky fixed claims. As the new claimholders break even, the increase in value is paid by the old residual claimants - in this case the country.

But in a debt conversion or reduction plan, all the existing debt is sought to be converted. If so, what accounts for the rarity of indexed schemes?

This note shows why the conversion of outstanding fixed claims to indexed debt is more difficult than other forms of debt reduction or conversion. Unlike a debt reduction plan where creditors (henceforth called banks) write down a portion of the outstanding straight debt to a lower face value, (henceforth called a *write-down*), indexation can improve investment incentives without requiring a decrease in the expected value of the outstanding claims. However, the familiar hold-

out or free-rider problem still occurs; a bank that 'holds-out' and does not convert its claim from straight debt to indexed debt gains, if other banks convert.

The hold-out problem here *differs* from that in a straight debt write-down in important ways. First, if each bank accounts for a small fraction of the loan, its incentive to hold out is much higher than in a write-down. Second, the incentive of the hold-out banks to convert need not be improved by making the converted debt senior. In a write-down, however, banks always convert when faced with such a rule. Third, the firm or country will end up paying more in expectation, as a result of hold-outs, than it expects to pay if no indexation takes place.

If each bank holds a small fraction of the debt, substantial default risk has to exist after conversion in order to give banks an incentive to convert. This, in a sense, nullifies many of the above reasons for converting to indexed debt, hence the use of indexation only as some kind of equity participation. However, when the fraction held by each bank is large, the country can credibly threaten to not invest and get conversion without retaining default risk ex-post. If small holders tend to sell out over time because of high fixed costs of monitoring and renegotiation, the country has an incentive to drag on debt renegotiation, while letting the size of the debt mount. Thus as the country moves into deeper trouble, and as creditors consolidate holdings, the situation approaches that of a bilateral monopoly. This is good because ex-post renegotiation is efficient, but it gives perverse ex-ante incentives to the country. We end by discussing other possible reasons for the rarity of indexed debt.

This paper makes the point that having competitive but small atomistic creditors may be detrimental to a country in trouble because of externalities. As the creditors become large and powerful enough so that their decisions have real impacts, they internalize the cost of the externalities. Facing more monopolistic credit markets may, ex-post, be better for the borrower.

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Chapter 2 Insiders and Outsiders: The Choice between Relationship and Armslength Debt

ABSTRACT

Banks improve welfare because they help control a firm's investment decisions. However, the private information they acquire in order to do this gives them an information monopoly, which distorts the firm's incentives. Bank financing therefore may be costlier than armslength or uninformed financing. In a bank dominated economy, repeated interactions or relationships can reduce the cost of bank finance. The introduction of an armslength market in such an economy may reduce welfare by destroying relationships. Competition then may take the place of relationships in reducing the costs of bank finance. We obtain implications for the choice of maturity, priority, credit source and the efficiency of financial systems.

Introduction

Banks have traditionally been thought to have a welfare improving effect. A bank reduces the agency problems associated with debt in various ways. The bank first screens prospective clients (Diamond (1989a)). Later, by threatening to cut off credit, it provides the firm with the incentives to take the right investments (Stiglitz and Weiss (1983)). As a result of the diminished adverse selection (through information), and the reduced moral hazard (through control of the firm's investment decisions), the bank has the capacity to provide cheap 'informed' funds as opposed to costly 'uninformed' or armslength funds (James (1987)). Finally, a positive loan renewal signal implies that other agents with fixed pay-off claims need not undertake a similar costly evaluation (Easterbrook (1984) and Fama (1985)).

Yet in practice, firms rarely borrow from only one bank. Most medium and large firms borrow from a number of banks. At the same time, they may borrow long term from the bond market or financial institutions like insurance companies. Even small or start-up companies who initially rely on a bank or venture capitalist try to diversify the sources and maturities of their borrowing.

The change in corporate borrowing patterns, when firms are allowed access to other sources is striking. The Japanese bond markets were liberalized in the late 1970's. As seen in Table 1, between 1976-80 in Japan, only 2.5% of corporate borrowing was from the bond market while 91% was from the banks. However, in 1981-85, Japanese firms obtained 27% of their loans from the bond market and 68% from banks.¹ In comparison, 55% of the total borrowing by firms in the United States between 1976-80 was from the bond market while only 36% was from banks. In 1981-85, the corresponding figures were 56% and 44%.

In a study of the Japanese banking system over the period during which the bond markets were liberalized, Hoshi, Kashyap and Scharfstein (1990a,b) show that a firm may benefit by the close relationship it has with a bank, in ways predicted by the theory. Before the liberalization,

¹Hoshi et al.(1990 b.)

firms in a *Keiretsu* (the Japanese term for the big, close-knit, post-war industrial groups) borrowed largely from banks, with the group's main bank taking the responsibility of monitoring and controlling the firm. Hoshi et al. find the investment decisions of these firms were not constrained by cash flows. After the reforms, some firms borrowed extensively from the bond markets thus loosening their ties to the banks. The investment decisions of these firms became liquidity constrained, while the firms that retained close bank ties continued to have easy access to funds.

While this evidence seemingly supports the above theory, Hoshi et al ask why firms weaken bank ties, if indeed bank monitoring and control overcomes information problems and relaxes liquidity constraints. More generally, if as the theory suggests, bank debt is such an efficient form of finance, why do we see firms borrowing from other sources? Also, why does the pattern of firm borrowing change so dramatically over time?

In this paper, we develop a simple model which analyzes these questions. If we abstract from regulatory, legal and cultural issues, the factors that distinguish different types of creditors (or sources of credit) are: first, their ability to acquire information about the debtor firm, and second, their accessibility. A bank which lends to a firm for a project, can acquire information, during the course of lending, that is 'soft' in nature. The firm cannot easily communicate this information to others². Also bank debt is easily renegotiated, because the bank is a monolithic, readily accessible creditor. However, a typical arms-length creditor like the bondholder receives only public information. It is hard to contact these dispersed holders and any renegotiation suffers from information and free-rider problems.

A key point in this paper is that short term bank debt is costly *even if monitoring costs are small*. A bank has influence over the firm's investment decisions if it can *control* the flow of funds to the firm. If the firm faces competitive and symmetrically informed credit markets, control by outside creditors is as effective as control by the bank. Except for the largest firms, however,

²This information may be generated in real-time, during the process of lending. This includes information about the firm's prior projections, ability to meet prior targets, reliability and competence of personnel etc. It is very hard for firms to present hard data on this to outside creditors. However, once a project is completed, there is 'hard' data like sales and profits which can be presented to outside creditors.

credit markets in general are neither competitive nor symmetrically informed. When the bank monitors the firm, the private information it acquires gives it an informational monopoly over the firm. Once the bank becomes the sole potential creditor, the short maturity of its loan enables it to translate credit decisions into the firm's investment decisions without the interference of other less-informed potential creditors. But the short maturity also enables the bank to extract rents (strictly speaking quasi-rents) when the loan is re-contracted. These rents constitute an endogenous and credible reason for the bank to monitor, even when its capital is not at risk. To the extent that they exceed the cost of monitoring, they are paid for up front, in the initial competitive market. But the incentives of the firm to exert effort, or choose the right project, are distorted.

In contrast to the earlier literature, we show that the welfare effects of a bank acquiring private information are ambiguous; the benefit of being bank controlled has to be weighed against the costs of distorted firm incentives.

The bank's informational advantage over the rest of the credit market is not constant. It is highest at an intermediate stage in the project, when the bank has been lending for some time and the firm has no publicly demonstrable results. We first assume that at this point the firm is completely locked in to the bank. But once the project is completed, the firm has publicly verifiable results to show other potential lenders and the credit markets become competitive again. We therefore argue that the prospect of repeated interaction, i.e a '*relationship*' between the firm and the bank over future projects, reduces the bank's incentive to extract rents especially from firms with high growth opportunities. This is because the firm can threaten to change banks once a project is completed, thus giving the bank an incentive to not be opportunistic. This may explain how the Japanese banking system maintained control without distorting incentives, prior to the deregulation of the bond market.

In this world, banks can compete only to lend for new projects. The introduction of an *armslength* market in a bank dominated economy adds a qualitatively different type of competitor. The bond market essentially is a source for long term arms length credit. Though this form of financing is inefficient ex-post since it cannot control the firm's investment, it also cannot be

renegotiated easily. The ability to commit to not renegotiate can outweigh both the loss due to inefficient investment and the distortionary effect of inefficient control on incentives. We show, contrary to intuition, that the efficiency costs of bank debt can be higher than un-monitored arms length debt. Firms prefer armslength debt to bank debt for projects with a high chance of success or with sensitive discretionary investment.

Therefore, when an armslength market is opened up in a relationship dominated economy, the nature of a firm's projects over time affects the relationship. Firms with a sequence of projects, each having a high probability of success, will move to the armslength markets. Firms with projects having a low chance of success and firms with low discretionary investment will stay with the banks. However, intermediate firms which optimally would start with a bank and then move on to the armslength market cannot commit to staying in the relationship. The relationship breaks down as bank behavior is no longer constrained by the possibility of future interaction. Some of these firms move away, even though they might be liquidity constrained in the armslength market. Other firms stay and face the now more opportunistic banks. The introduction of an armslength market may actually reduce efficiency for some firms. The evidence in Hoshi et al. is consistent with such an explanation.

This simple theory of bank behavior resulting from contract incompleteness has other rich implications. We analyze the *long term bank loan* which together with the short term loan spans the space of bank contracts. Long term bank debt resolves the problem of rent extraction by the bank, but creates a new problem. The bank cannot simply refuse to re-lend to unprofitable projects, it now has to bribe the firm to stop them. The firm thus finds the opportunity to undertake unprofitable investments more attractive. The optimal maturity of a firm's bank debt is negatively related to its bargaining power. We show how this can account for the comparatively longer maturity of bank debt in West Germany (Mayer and Alexander (1990)). Some testable empirical implications emerge.

Another direction in which to extend the basic model is to allow competition within a project. We allow uninformed outside lenders to bid for every loan, including those contracted in

the middle of a project. At one level, this confirms our assumption that a degree of lock-in can occur during a project, because of the bank's information monopoly. At another, it models a fundamentally different economy where competition from outside lenders for each loan *transaction* rather than relationships over projects mitigates rent extraction. This we believe, is characteristic of market-oriented financial systems like the United States. We obtain the following results with outside interim competition:

(i) The basic trade-off still holds. Interim competition reduces rent extraction by the informed bank. At the same time, it reduces the bank's control because uninformed lenders may continue unprofitable projects. The bank's incentive to monitor is also reduced. Thus the welfare effects of interim competition are ambiguous.

(ii) Both the ability of the informed bank to control unprofitable investment and its ability to extract rents are positively related to factors which enhance its monopoly power. The firm may reduce the size of the initial bank loan (and hence the bank's monopoly power) by borrowing from the armslength market. It thus trades lower control for lower distortion, by borrowing from different sources at the same time. We also obtain implications for the priority structure of bank debt and public debt.

(iii) The pattern of public and private information revelation over time is important in determining the choice between bank debt and armslength debt.

We conclude with a discussion of the implications our model has for the relative efficiency of banking systems in different countries.

Our paper is not the first to examine the choice between relationship and armslength debt. In Diamond (1989 a) firms build reputation by taking on costly bank monitored debt. Firms that acquire good reputations then move on to the armslength market to save on monitoring costs. There are some important differences in our paper. The cost of bank debt is endogenous in our paper, as described above and stems from the very monitoring that is necessary for welfare improving control. Also, we show that in addition to a backward looking measure of firm behavior like reputation, a forward looking measure like the firm's investment opportunity set determines the

firm's choice of source. Finally, our focus on the firm's ex-ante incentives enables us to derive a theory for the optimal maturity of bank debt.

Berlin and Loeys (1988) view the trade-off as being one between the inefficiencies of rigid bond covenants and the agency costs of having a delegated monitor. Our paper recognizes that rigid covenants may provide better incentives than flexible but incomplete contracts with a monitor. There are no agency costs of monitoring in our paper as the incentive to monitor is endogenous.

In Diamond (1989b), short term debt is costly because incorrect interim information about the firm may cause a withdrawal of credit and result in inefficient liquidation of firm assets. While short term public markets, like commercial paper, may subject the firm to such liquidity shocks it is less plausible to assume the relationship bank has a very different information set from the firm. In our paper, inefficient liquidation does not take place because the informed bank will always lend if outside sources dry up. The control the bank exerts, however, can be reduced by interim noisy information. This is costly because it reduces ex-post efficiency and also distorts incentives. The empirical implications we obtain are substantially different from Diamond and apply to situations where banks have substantially more information than outside credit markets. Finally, our initial analysis of ex-post bank monopoly is similar in parts to Sharpe (1990)³. However, his focus is not on the choice between bank debt and public debt or on the link between monopoly power and control.

Section 1 describes the basic model for a firm with a single project. Section 2 analyzes short term bank debt assuming ex-post lock-in. The basic trade-off is demonstrated by comparing bank debt with long term armslength debt. Long term bank debt is then analyzed. Section 3 examines the possibility of a 'relationship' over several projects as a means of reducing bank opportunism. The effects of introducing an armslength market in a relationship based system are examined. In Section 4, the assumption about lock-in is relaxed. The basic trade-off still holds, even with outside competition. Implications are obtained for a more competitive financial system.

³Our work was done independently.

Section 5 concludes with suggestive empirical evidence. Proofs are largely relegated to the appendix.

Section 1. The Model

The Project

We consider an owner-managed firm with a single project idea. At the initial date 0, the owner has to invest a fixed amount I_0 , say for R&D. He then expends personal effort β at a unit cost of 1. Effort increases the expected value of future returns in a way to be specified. The assets purchased at date 0 can be liquidated at date 1 for value L_0 where $L_0 \leq I_0$. At date 2, these assets depreciate to value zero.

There are two possible states at date 1. The state can be good, G, with probability q and bad, B, with probability $(1-q)$. If a further fixed investment I_1 is made at date 1, at date 2 in the good state the project pays out X with probability 1 and in the bad state it pays out X with probability p_B . If the firm does not invest at date 1, the assets are liquidated. We assume that

$$X > (I_0 + I_1) \geq I_1 + L_0 > p_B X.$$

Private effort $\beta \in [0, \infty)$ along with an exogenous parameter $\theta \in [0, 1]$, affects the probability q of the good state occurring. For a small firm, β is the physical or mental exertion by the management. For a large firm, β can be thought of as discretionary investment (see Appendix). Everyone knows θ , henceforth called quality, and it represents those determinants of the likelihood of the project being good which are beyond the owner's control. For example, a project to modify a successful car model for the new year has a high θ while the search for commercial superconductors is a low θ project. Assume $q = q(\beta, \theta)$, where q has the following properties

$$q_1(\beta, \theta) > 0, q_{11}(\beta, \theta) < 0, q_2(\beta, \theta) > 0 \quad (\text{A.1})$$

$$q_1(0, \theta) > 1/X, q_1(\infty, \theta) = 0 \quad (\text{A.2})$$

where the subscript k denotes the partial with respect to the kth argument⁴.

⁴We also use subscripts to denote the date. The difference is clear from the context.

Assumption (A.1) states that the probability of the good state being realized is increasing and concave in the effort of the owner and is increasing in the quality θ . Assumption (A.2) states that the marginal benefit of effort decreases to zero from a large number.

In summary;

Date 0	Date 1	Date 2
Investment I_0 made. Effort β exerted after investment made.	State realized. Owner can invest I_1 . If he does not, the project is closed down and the assets sold for L_0	Project pays out X in the good state, $p_g X$ in the bad state. Assets are worthless.

Financing

This is a risk-neutral world and the riskless interest rate is 0. The owner has no money of his own. He must borrow to finance the project. There are two types of lenders in the market;

- i) Banks enter the market at each date to acquire information and make loans. If a bank makes a loan to a firm at date 0, it gains access to the internal books the firm maintains (and henceforth it will be referred to as the inside bank). The bank examines the internal books, over the period, by incurring the costs m . The costs can be that of personnel for regular site inspection and for tailoring services to the firm. The act of monitoring is assumed to be observable, though not contractible⁵. Note that it is through the process of lending that the banks acquire information, which is consistent with the empirical evidence in Lummer and McConnell (1989). Finally, banks which do not lend cannot get this information even if the firm wants to give it to them.
- ii) Passive Investors lend at date 0 and return to collect repayments at date 2. Even if they lend, they do not examine the books. This may be because they have a high private cost of monitoring as compared to the banks or because the size of each investor's loan is small, resulting in a free-rider problem.

We distinguish between the closure of the company through the voluntary sale of

⁵ This is not to say that the depositor in a bank or the shareholder can observe monitoring. As we show later, all that is required for the incentives to monitor to be endogenous is that institutions like other banks in the industry should be able to observe, or correctly surmise from the relationship, that the bank is monitoring the firm.

assets/output and liquidation through bankruptcy. If the owner does not repay creditors, they can force him into a costly bankruptcy court. The court seizes the output of the project before the owner can consume it, but this destroys the output. Thus liquidation at date 2 provides no information about the project returns. This assumption, though somewhat extreme, is standard in the literature (Diamond (1989a), Gale and Hellwig (1985)) and lets us focus on debt contracts. Finally, we restrict the owner-manager to only having a residual claim. This ensures that the simple agency problem we explore in this paper stays meaningful.⁶

We assume that contracts cannot be made contingent on investment, effort and the state. Myers (1977) discusses in detail why it may not be possible to make contracts contingent on investment. Effort and the state can be observed only by the owner and anybody privy to inside information, but not by the courts. The courts, however, can observe and verify the monetary transfers that the parties choose to record.

We consider pure discount debt contracts, that is, contracts where the firm borrows an amount M_i at date i and is required to make a *single* repayment D_{ij} at date j . We call contracts over a single period ($j-i=1$) *short term contracts* and those over two periods ($j-i=2$) *long term contracts*. There is no loss of generality in restricting contracts with the bank to be convex combinations of short and long term contracts. As the passive investor is not present at date 1, contracts with this investor can only be long term. Finally, it is convenient to restrict the face value promised D_{ij} to be (weakly) greater than the amount lent M_i .

Information

The owner knows the state of the world at date 1, before investing amount I_1 . The inside bank can learn the state and effort provided, as described above. Passive investors and outside banks observe only public signals, which are assumed uninformative unless otherwise specified.

⁶The problem is that if the owner manager has a senior debt claim in the firm, his incentive to over-invest disappears (as it would if he put sufficient equity up front). Of course, such senior claims would not be optimal if there was some amount of adverse selection in the economy. We do not model this and hence assume this possibility away.

Section 2: The Basic Trade-off

Henceforth the terms ex-ante and ex-post are with reference to the time the contract is agreed to. The following subscripts are used: 'L'..long term; 'S'..short term; 'B'..bank ; 'A'..armslength. 'B' also stands for the bad state but the difference will be clear.

The owner decides : (i) what type of lender to approach and maturity to borrow (ii) what effort level β to exert, after contracting (iii) whether to invest I_1 , after seeing the state at date 1. The lender decides: (i) the contract terms offered at date 0 (ii) whether to monitor, if able (iii) to renegotiate, cut-off credit, continue with old contract or offer a new contract at date 1. The first best solution is now characterized.

First Best Solution

At date 1, the owner should invest in the good state and close the project down in the bad state. Let $I = I_0 + I_1$ be the total amount invested. The expected surplus is

$q(\beta, \theta)(X - I) - (1 - q(\beta, \theta))(I_0 - L_0) - \beta$ at date 0. The first term is the surplus in the good state, the second is the depreciation losses in the bad, while the third is the cost of effort. The effort β_{FB}^* , which maximizes this surplus, is obtained by solving the first order condition (F.O.C)

$$q_1(\beta, \theta) = \frac{1}{X - L_0 - I_1} \quad \text{for } \beta = \beta_{FB}^* \quad (2.1)$$

Assumptions A1 and A2 ensure existence and uniqueness of the solution.⁷

In what follows, we repeatedly use the following ideas; (a) Given limited liability, the owner will always invest in the bad state unless refused credit or bribed to forego investment (b) The competitive date 0 market for credit implies that each lender's individual rationality condition is met with equality. Hence all inefficiencies are ultimately borne by the owner.

We first analyze short term contracts with the bank, in the simplest setting possible. We

⁷If $L_0 < I_0$, no contract can achieve the first best solution. By limited liability, the owner does not face the full cost of the bad state. No contract can efficiently correct for this without ex-ante transfers to the lender (to satisfy its I.R constraint). The owner's liquidity constraint rules out such transfers.

compare it with the long term arms-length contract with the passive investor and identify the basic trade-off.

Short Term Bank Contract

Assume that at date 0, many banks compete to lend, but once the owner contracts with a bank which then monitors, no other lender is available, at the interim date 1. As seen later, this lock-in could arise for informational reasons. It could also be contractual⁸, result from the inside bank's ability to pre-empt information acquisition by outside banks (see Rajan(1991)) or stem from the bank cross-selling various products to tie the firm in.

The timing is

Date 0	Date 1	Date 2
Loan of I_0 made by bank	Inside bank can monitor interim signals. Inside bank either (a) rolls over initial loan and lends a further amount for date 1 investment or (b) refuses further credit, the owner closes down the project and pays off the bank.	If loan made at date 1, bank gets paid in good state, gets partial payment in bad state.

At date 1, in the bad state the project is liquidated and the bank recovers L_0 .⁹ In the good state, the date 0 contract does not oblige the bank to lend. It can use this discretion to hold-up the owner and demand a share of the surplus in return for the funds needed for investment. Solving the bargaining game, the owner gets $\mu_G(X-L_0-I_1)$ while the lender gets $(1-\mu_G)(X-L_0-I_1) + L_0 + I_1$, where $\mu_G \in [0,1]$ is the bargained share (or bargaining power) of the owner in the good state.¹⁰ Let q^* denote the probability of reaching the good state with the induced effort. The F.O.C for the owner's effort decision at date 0 is

⁸ A venture capital contract prohibiting 'de-novo' financing elsewhere could be an example of contractual lock-in.

⁹ As the lender has all the power to decide cut off, neither the timing of the loans nor the amount of repayment matter, so long as the required repayment exceeds the liquidation value.

¹⁰ In a Rubinstein game with alternating offers $\mu_G = \log(\delta_L)/[\log(\delta_G) + \log(\delta_L)]$ where δ_L is the discount factor of the lender and δ_G is the discount factor of the owner.

$$q_1(\beta, \theta) = \frac{1}{\mu_G(X - (L_0 + I_1))} \quad \text{for } \beta = \beta_{ss}^* \quad (2.2)$$

provided $\left(1 - \frac{I_0 - L_0 + m}{q_{ss}^*(X - L_0 - I_1)} \right) - \mu_G \geq 0 \quad --(I.R) \quad (1 - \mu_G) q_{ss}^*(X - L_0 - I_1) \geq m \quad --(I.C)$

The conditions are that it be individually rational for the bank to lend and that it have an incentive to monitor. If μ_G is high (≈ 1) the bank will not be able to recover the depreciation losses $(1 - q_{ss}^*)(I_0 - L_0)$. If μ_G is low (≈ 0) and effort is essential, the owner faced with poor incentives, will not exert much effort so that q_{ss}^* will be low. It will not be rational for the bank to lend in either case. For intermediate values of μ_G , the bank will lend. But comparing (2.2) and (2.1), and using the monotonicity and concavity of q , there will be underprovision of effort compared to the First Best.

Note that if lock-in is caused by information, bank monitoring provides its own reward. Thus if monitoring is observable but not contractible, this resolves the question "who monitors the monitor?". Also, the short term bank contract is complete (specifies all eventualities) in the bad state where the bank should cut off credit. In the good state where the bank should continue lending, the contract specifies nothing, resulting in bargaining and incentive distortions. This suggests the form of the optimal contract: the bank should have control over the continuation decision but it should not be able to use this discretionary power to lever rents. The owner should have all the bargaining power in the good state, while the bank must be protected against a date 1 offer from the owner which falls below its ex-ante I.R condition. Such contracts are not possible in the absence of an external mechanism (e.g Hart and Moore (1988)) and will not be explored further (but see note 12).¹¹ ¹²We now compare bank debt with the long term armslength contract

¹¹ In the absence of a commitment by the bank to relend at date 1 and the commitment mechanisms in note 12, fixing the face value conditional on relending in the good state is vacuous, as it will always be renegotiated. Also positive payments by the bank at date 2, conditional on net repayment at date 1 (which should occur if the state is bad), are sub-optimal as they increase the attractiveness of the bad state and through the I.R condition, further reduce the incentives for effort. When there is no commitment to relend, we can restrict ourselves without loss of generality to short term contracts.

with the passive investor which is the standard of comparison throughout this paper.

Long Term Armslength Contract

The owner borrows amount $I = (I_0 + I_1)$ at date 0 and promises to repay D_{02} at date 2.¹³ As discussed before, the owner will always invest I_1 at date 1, even though it is inefficient to do so. The passive lender is not present to influence this decision. Thus in choosing the optimal effort level, ex-post contract at date 0, the owner solves

$$\max_{\beta} q(\beta, \theta)(X - D_{02}) + (1 - q(\beta, \theta))p_B(X - D_{02}) - \beta \quad -(2.3)$$

Let β_A^* solve the corresponding F.O.C. The lender's individual rationality (I.R) condition must also be satisfied. If the lender conjectures that ex-post contract, the (unobservable) effort exerted by the owner will be β_A^c , the lender will demand D_{02} where

$$[q(\beta_A^c, \theta) + (1 - q(\beta_A^c, \theta))p_B]D_{02} = I \quad -(2.4)$$

In a Rational Expectations Equilibrium, the lender's conjecture must be correct i.e $\beta_A^c = \beta_A^*$ (2.4)b.

¹² Such contracts are possible through the appropriate design of governing mechanisms (see Aghion, Dewatripont and Rey (1989), Macleod and Malcolmson (1989) or Hart and Moore (1988)). These mechanisms work by constraining the bargaining process and hence suffer from limitations as parties could always make unobservable offers (or threats made credible from) outside the process. The specific mechanisms described in those papers will not work because a) there is no obvious way in which the parties can specify a non-renegotiable default option b) the owner is liquidity constrained c) there is no last moment after which the gains from trade will disappear. Of course, if we make assumptions about the nature of the available mechanisms, the first best contract can be achieved. For example, assume that the project is no longer available after a specific time at date 1. A contract which specifies that the bank has control over the re-lending decision and which fixes the date 2 terms for re-lending at the minimum compatible with bank rationality achieves the first best. The reason is that at the last instant, the owner can offer a contract to borrow at the above rate. The bank can do no better than accept. The owner cannot credibly commit to a lower rate as the bank can assure itself of the rate in the initial contract and knows that it is in the interest of the owner to borrow. See Hart and Moore (1988) for details. Such a contract would be similar to lines of credit callable at the option of the bank under 'materially adverse circumstances'. Of course, if there are many possible states, the terms of the long term contract will usually be renegotiated.

¹³ As the arms-length investor does not enter the market at the interim date, the long term contract is equivalent to the short term contract. Also, the two period contract is effectively a single period contract and under these circumstances, the optimal contract is one with a single fixed repayment.

So the F.O.C obtained from (2.3), (2.4) and the equilibrium condition (2.4)b taken together imply the optimal effort β_A^* is defined implicitly by

$$q_1(\beta, \theta) = \frac{1}{\left[X - I - \frac{(1 - q(\beta_A^*, \theta))(1 - p_B)I}{q(\beta_A^*, \theta) + (1 - q(\beta_A^*, \theta))p_B} \right] (1 - p_B)} \quad \text{for } \beta = \beta_A^* \quad (2.5)$$

It is immediate that $\beta_A^* < \beta_{FB}^*$. The rationale is simple. The owner continues to invest in the bad state, forcing the rational lender to demand a higher face value than if investment were efficient. This reduces the surplus available to the owner in the good state. Also the private benefits from overinvestment increases the attractiveness of the bad state, further reducing effort. All inefficiency stems from the inability of the owner to commit to not continue the project in the bad state.¹⁴

If effort is necessary for the good state to have non-zero probability, by continuity it is possible that at low values of θ there may not exist a solution β_A^* to (2.5). Given the intrinsic poor quality of the project θ , the face value demanded could be so high as to depress the incentive to provide effort below the minimum required to satisfy the lender's IR condition i.e the returns to the lender could decrease with increasing face value. Credit rationing then occurs because of poor incentives for effort. Also as credit rationing with short term bank debt stems from extremes of firm bargaining power, armslength debt could be available when short term bank debt is rationed.

In the rest of the paper, *short term* bank debt will be referred to as bank debt, while *long term* armslength debt will be referred to as armslength debt. We will refer to *long term bank debt* in full.

¹⁴Equation (2.5) is a fixed point problem. The existence of a solution is not always assured and intuitively, for low quality projects (low θ), no solution should exist. Assumption A.1, A.2 together with a single crossing condition would ensure that if a solution exists to (2.5), it is unique. In the example that we construct, a unique solution always exists for the range of project qualities that we examine. All the results hold even if there are multiple solutions (as in the Laffer curve theories of the L.D.C. debt problem). We then define the solution to be the highest value of β , which implies that the face-value is set at the lowest level compatible with lender individual rationality.

Choice between Contracts

Even though the armslength lender cannot prevent overinvestment (of capital), the ability of the lender to commit not to renegotiate could have a beneficial effect on the underprovision (of effort). Comparing (2.2) and (2.5), the provision of effort with bank financing is less than that with armslength finance, if

$$\mu_G < \overline{\mu}_G = \frac{1 - p_B}{X - I_0 - L_0} \left[X - I - \frac{(1 - q_A^*) (1 - p_B) I}{q_A^* + (1 - q_A^*) p_B} \right]$$

The owner chooses between contracts on an ex-ante basis. The ex-post rents extracted by the bank will be pre-paid to the owner after deducting the cost of monitoring. Assume for simplicity that the owner pays these to himself at date 0 as dividends. Thus the owner's ex-ante expected utility with bank financing is:

$$U_{SB} = q_{SB}^* (X - I) - (1 - q_{SB}^*) (I_0 - L_0) - m - \beta_{SB}^* \quad (2.6)$$

The owner's ex-ante contract expected utility with armslength financing:

$$U_A = q_A^* (X - I) - (1 - q_A^*) (I - p_B X) - \beta_A^* \quad (2.7)$$

The first term in (2.6) and (2.7) is the expected surplus in the good state. The second term in (2.7) is the cost of inefficient continuation, while in (2.6) it is just the depreciation losses (as control is efficient). The third term in (2.6) is the cost of monitoring. A bank loan is preferred if $(2.6) > (2.7)$

$$(1 - q_A^*) (I_1 + L_0 - p_B X) - (q_A^* - q_{SB}^*) (I_0 - L_0) - ((q_A^* - q_{SB}^*) (X - I) - (\beta_A^* - \beta_{SB}^*)) - m \geq 0 \quad (2.8)$$

The choice between contracts depends on the following factors: First, μ_G , the bargained share, which is intrinsic to the owner or firm. Second, θ , which is a measure of the quality of the project and third, the function $q(.,\theta)$ which determines how sensitive the success of the project is to effort or discretionary investment. The last two factors are intrinsic to the project.

If $\mu_o \geq \bar{\mu}_o$, bank financing dominates armslength. The interesting case is when $\mu_o < \bar{\mu}_o$, i.e. when $q_A^* > q_{AS}^*$ because the provision of effort with bank financing is less than that with armslength financing. The first term in (2.8) is the ex-ante benefit of bank control which is positive as $p_b X < I_1 + L_0$, the second is the additional loss due to depreciation as the bad state is reached more often with bank debt, the third is the loss in surplus because of differential ex-post effort distortion. When the owner has little bargaining power, the ex-ante cost of the relative underprovision of effort from the second and third term can outweigh the benefit of control (the first term). Bank finance can be less efficient than armslength finance even when monitoring costs are negligible.

The distortion in the owner's incentives decreases in his bargaining power μ_o . As the cost of armslength debt is independent of μ ,

Lemma 2.1: *For a given project, there is a $\hat{\mu}_G \in [0,1]$, such that armslength debt is preferred ex-ante to bank debt by any firm with $\mu_G \leq \hat{\mu}_G$*

In order to proceed further, we assume $q_{12}(\beta, \theta) = 0$ --(A.3). This separability assumption simplifies some results, though it is not always necessary. Provided it is individually rational for both types of lenders to lend, it is easily shown that for a given value of bargaining power μ_G :

Proposition 2.1 : *There exists a project quality $\bar{\theta} \in [0,1]$ such that (i) bank debt is preferred to armslength debt when $\theta \leq \bar{\theta}$ and (ii) armslength debt is preferred to bank debt when $\theta \geq \bar{\theta}$.*

Proof: See Appendix

The intuition is simple: Conditional on the good state, the bank extracts the same amount, regardless of project quality. This is due to the absence of interim date competition and the assumption that bargaining power is exogenous. In contrast, as the project quality improves, control becomes less important. The face value demanded by armslength lenders falls, improving incentives for effort. The owner's ex-ante utility with either kind of financing is increasing in quality but increases at a faster rate with armslength financing, hence the proposition.

Firms with higher quality prefer armslength debt, a result similar to Diamond (1989a) where firms with a higher reputation borrow from the armslength market. Our result, however, is because high quality firms find bank debt relatively more onerous and it holds even if monitoring costs are small.

Finally if $q(.,\theta)$ is highly concave, then the owner's effort (or discretionary investment) is not sensitive to incentives. Consider the stylized example of a firm investing in the S&P index. A certain amount of discretionary effort is required from management but it takes a tremendous amount of disincentive for the firm to deliberately stop exerting this effort. Bank debt dominates for such firms, as the difference in induced effort for different forms of financing is low.

If $q(.,\theta)$ is only mildly concave, the owner's effort is very sensitive to incentives. An example is a small bio-technology research project, led by a temperamental scientist. If the owner/project leader has a lot of bargaining power and θ is low, then bank debt is very attractive, while if the reverse situation holds armslength debt is preferred. Small differences in ex-post cost are magnified.

Obviously, a firm does not have a single project. But before we examine the effect of sequential projects, we analyze the long term bank loan. With this, we span the set of possible bank contracts. The efficiency of this contract is negatively related to the bargaining power of the firm. The determinants of the maturity of bank debt and of bargaining power are then discussed.

Long Term Bank Contract

Let the firm sign a long term contract with the bank i.e at date 1 the loan is renewed automatically and at date 2 the required repayment is D_{02B} . This differs from the arms length contract because of the possibility of renegotiation, after the bank monitors. At date 1, in the good state, the optimal decision is to continue. As the surplus is fully allocated by the initial contract, there will be no renegotiation. In the bad state, the contract is renegotiated, as the bank cannot unilaterally close the project down. The surplus (from taking the efficient decision) that they bargain over is $L_0 + I_1 - p_B X$. If μ_B is the owner's share from bargaining in the bad state, the owner

gets $p_B(X-D_{02B}) + \mu_B(L_0 + I_1 - p_B X)$ while the lender gets $p_B D_{02B} + (1-\mu_B)(L_0 + I_1 - p_B X)$, with the first term in each expression being the amount allocated by the initial contract. The bank's I.R and I.C constraint are:

$$D_{02B} = \frac{I+m - (1-q_{LB}^*)(1-\mu_B)(L_0 + I_1 - p_B X)}{q_{LB}^* + (1-q_{LB}^*)p_B} \quad (I.R) \quad \text{and} \quad (1-q_{LB}^*)(1-\mu_B)(L_0 + I_1 + p_B X) \geq m \quad (I.C)$$

The face value demanded increases with the bargaining power of the owner, first because the bank gets less of the surplus in the bad state and second because the owner's increased share in the bad state reduces his incentive to exert effort.

Comparing the incentives that long term bank debt and armslength debt provide post, it can be shown that there is a $\bar{\mu}_B \in [0,1]$ such that the owner's effort when financed with long term bank debt is lower than when financed with arms-length debt for $\mu_B \geq \bar{\mu}_B$. Here, effort distortion increases with bargaining power. Ex-ante, the difference between the long term bank contract and the armslength contract is as in (2.8), with q_{SB}^* replaced by q_{LB}^* . It follows that

Lemma 2.2: *For a given project, there is a $\hat{\mu}_B \in [0,1]$, such that armslength debt is preferred ex-ante to long term bank debt by any firm with $\mu_B \geq \hat{\mu}_B$.*

As an extreme example, let effort be necessary for the project to succeed with non-zero probability, $\mu_B=1$, $p_B=0$ and $I > X-I$. The owner, when financed with long term bank debt prefers to exert no effort and attain the bad state for sure. No bank will lend long term.

Note that with short term bank debt the distortion in the owner's incentives decreases as his bargaining power increases, just the opposite of the case with long term bank debt. Assuming monitoring costs small so that the bank always monitors¹⁵, and assuming the firm's bargaining power is independent of the state i.e $\mu = \mu_G = \mu_B$, we state

¹⁵ In the case of long term bank debt, the bank may not need to monitor as the firm may have the incentive to tell the truth. This is not true only when the firm gets a greater profit in the bad state. If effort is not essential, there is some chance that the firm reaches the good state, where paradoxically, the firm is tempted to lie.

Proposition 2.2: (i) If $\hat{\mu}_G \geq \hat{\mu}_B$ for a given project, the firm chooses short term bank debt if $1 \geq \mu > \hat{\mu}_G$, armslength debt if $\hat{\mu}_G \geq \mu \geq \hat{\mu}_B$ and long term bank debt if $\hat{\mu}_B > \mu \geq 0$ (ii) If $\hat{\mu}_B > \hat{\mu}_G$ for the project, then the firm never chooses armslength debt, borrows short term from the bank for $\mu \geq \hat{\mu}_{BG}$ and borrows long term if $\mu > \hat{\mu}_{BG}$, where $\hat{\mu}_{BG} \in (\hat{\mu}_G, \hat{\mu}_B)$.

Proposition 2.2 suggests that the maturity of bank borrowing is negatively related to μ , the share the owner obtains from bargaining. Note that the bank's control over firm investment is independent of maturity. This is just the Coase Theorem. Maturity, however, alters the states in which bargaining takes place and hence the distortion to incentives.

Bargaining power μ can be something intrinsic to the owner-firm such as relative impatience or indispensability. It is more plausible to treat μ as a measure of the residual rights of control in states of contract incompleteness (Grossman and Hart (1986)). For example, a bank which votes a large fraction of the firm's equity has the residual rights of control. As μ is small, the firm should be financed with long term bank debt.

Another interpretation is that μ is determined in reduced form by the environment. One possibility, explored in the next section, is the prospect of repeated interactions over future projects. This results in a high μ in reduced form when short term bank debt is used. Another possibility, which we explore in the subsequent section, is that competition from outside potential lenders during a project can determine μ .

It is natural to think that if a project is successful, the firm should have access to a follow-on project. The firm may interact with the same bank over successive projects, which we term 'relationship' banking. The prospect of future repeated interaction can mitigate opportunism. In order for future projects to influence current behavior, there have to be links between projects. This is provided by 'reputation'. We obtain interesting implications when an armslength market is opened in a 'relationship' dominated economy.

Section 3: Relationship Banking

Bank Dominated Economy

We assume at first that there are only banks in this economy. We maintain the assumption that the firm is locked in to a bank for the duration of a project i.e there is no interim competition. However, it is less realistic to think that information asymmetry carries over projects. A firm would usually have verifiable results at the end of a project. Hence, we assume it need not be locked in to the same bank across projects.

If the good state occurs, let the owner have access to a *future* project F between dates 2 and 4. Project F differs from the *current* project C only in that it has a different quality θ_F , and all other parameters in project F are scaled by a growth factor g (see Fig 1). Assume the state at date 3 is independent of the state at date 1. The bank learns the state at date 3, by monitoring anew. For simplicity, let the owner consume his profits from the current project C, at date 2 and let the monitoring costs be negligible for the rest of this section. Two further simplifying assumptions that we carry to the next section are : $\mu = 0$ -(A.4) and $I_0 = L_0$ -(A.5). Assumption (A.4) is innocuous, as our focus here is on bargaining power in reduced form. Assumption (A.5) is easily relaxed. Note that there is no information asymmetry carrying over projects, as the state for project C is completely revealed at date 2.

Assume two types of banks; 'loyal' banks which always charge the rate that a similarly informed competitive credit market would charge and 'selfish' banks which maximize profits. Let the owner's date 0 prior that a bank is 'loyal' be π_C . Also let the transfers between the owner and the bank be private. For example, the maintenance of compensating balances would be one form of transfer which would not be publicly known. Therefore, the owner can update his prior on the bank being 'loyal' only through personal experience.

Solving backwards, a 'selfish' bank will always be 'selfish' at date 3. However at date 1, it may have an incentive to act 'loyal' (invest in reputation) so as to extort larger rents later. Let the bank act loyal with probability σ , conditional on the good state at date 1. If the realized action

is that the bank acted loyal by charging I, the owner updates his prior using Bayes rule: $\pi_{F|I} = \pi_C / [\pi_C + (1-\pi_C)\sigma]$. As $\pi_{F|I} \geq \pi_C$, the owner has no incentive to change banks at date 2, even if he could, as he has learnt something good about the bank. However, if the bank acted 'selfish', charging X, then $\pi_{F|I} = 0 < \pi_C$, and the firm would want to change banks. We assume that it can do so (nothing depends on this).¹⁶ Any project that reaches the bad state is closed.

At date 2, the effort exerted by the owner ex-post the new contract, given the date 2 prior π_F , is

$$\beta_F^*(\pi_F) = q_1^{-1} \left(\frac{1}{\pi_F(X-I)} \right) \quad (2.9)$$

The effort provided increases in π_F . At date 0, the effort exerted, given the strategy σ of the bank:

$$\beta_c^*(\sigma) = q_1^{-1} \left(\frac{1}{(\pi_C + \sigma(1-\pi_C))(X-I + U_{SBF}(\pi_{F|I})) + (1-\sigma)(1-\pi_C)U_{SBF}(\pi_C)} \right) \quad (2.10)$$

where $U_{SBF}(\pi_F) = g[q(\beta_F^*(\pi_F), \theta_F)(X-I) - \beta_F^*]$ is the expected ex-ante surplus to the owner from the new project given a date 2 prior π_F . Now consider the actions of the 'selfish' bank; At date 2, it prepays the owner only the rents it is expected to extract. By acting loyal at date 1, the bank gets an expected surplus of $q(\beta_F^*(\pi_F), \theta_F) \pi_F g(X-I)$ from the future project. By acting 'selfish' at date 1 it gets nothing from the future project, but it gets $(X-I)$ for sure at date 2. Solving, knowing that q increases in β_F^* , which increases in π_F , we get in equilibrium:

If $q(\beta_F^*(\pi_C), \theta_F) g \pi_C > 1$, the Bank acts loyal (or pools) by setting $\sigma=1$ at date 1

$q(\beta_F^*(1), \theta_F) g < 1$, the Bank acts 'selfish' (or separates) by setting $\sigma=0$ at date 1

$q(\beta_F^*(1), \theta_F) g \geq 1 \geq q(\beta_F^*(\pi_C), \theta_F) g \pi_C$, the Bank plays mixed strategies, $\sigma = \pi_C(1-\bar{\pi}_F)/(1-\pi_C)\bar{\pi}_F$

where $\bar{\pi}_F$ is such that $q(\beta_F^*(\bar{\pi}_F), \theta_F) g \bar{\pi}_F = 1$ (by monotonicity, $\bar{\pi}_F$ is unique). It follows that

¹⁶ In a two project model, firms borrow for the future project simultaneously with other firms. Hence a change of banks, though observable, is not informationally relevant. In a many project model, similar results are obtained under the more realistic assumption that banks have differing abilities to supply a firm's needs. A change of banks will not perfectly reveal the bank's type. The flavor of the results will be the same.

Lemma 2.3: *The loyalty σ of the selfish bank, at date 1, (weakly) increases with the future project quality: $d\sigma/d\theta_F \geq 0$.*

Also higher the growth rate g , greater the incentive for the bank to be loyal in the hope of future business. In reduced form therefore, the 'bargaining power' of firms with such projects is high and bank relationships promote efficiency. Note that the prior π_C , which is a measure of trust, is self-enforcing in two ways; First, higher trust leads to higher future investment which reinforces the gains to waiting. Second, because the bank pre-pays any rents it is expected to extract ex-post, higher trust increases the amount that can be obtained by cheating in the future.

The long term bank contract is incomplete in the bad state, when the project has failed. This is precisely when one would not expect the firm to have future opportunities. Therefore a relationship over several projects cannot influence the bargaining power in states where the long term contract is incomplete. Finally, relationships do not work for low growth firms or firms with low quality projects.

We now study the effect of the introduction of an armslength securities market in an economy dominated by banking relationships.

Introduction of armslength financing

Now the owner has the choice, at date 0 and date 2, between financing through armslength debt and bank debt. Let π_F denote the owner's prior at date 2. Let subscript ' $_+$ ' denote variables in the new equilibrium, after the introduction of the market, and let U_{AF} be the ex-ante utility with armslength debt.

By lemma 2.3, in the old equilibrium, for a given current quality θ_C and prior π_C , σ increases in θ_F . Using the definition, π_F decreases with θ_F . Using proposition 2.1 and equation (3.1), under bank behavior in the old equilibrium, there is a project quality $\bar{\theta}_F(\theta_C, \pi_C) \in [0, 1]$ such that armslength debt is preferred to bank debt at date 2, if $\theta_F > \bar{\theta}_F$. Therefore, if $\theta_F > \bar{\theta}_F$, then $U_{AF} > U_{SBF}(\pi_F)$, and the old equilibrium does not survive the introduction of the armslength

market. If $\theta_F < \bar{\theta}_F$, the option to take on armslength debt at date 2, is inferior to the old equilibrium outcome and does not affect it. Therefore;

Proposition 2.3: *The introduction of the armslength market causes the selfish bank to act (weakly) less loyal: If (i) $U_{AF} \geq U_{SBF}(1)$ then $\sigma_+ = 0$ (ii) $U_{SBF}(1) > U_{AF} > U_{SBF}(\pi_F)$ then $\sigma_+ < \sigma$ (iii) $U_{SBF}(\pi_F) > U_{AF}$ then $\sigma_+ = \sigma$.*

Proof: See Appendix.

If (i) holds, the bank will always act 'selfish' at date 1, because even with the highest amount of trust, firms prefer armslength debt at date 2. Reputation ceases to have effect. If (ii) holds, in order to compete with armslength credit, paradoxically the bank has to act 'selfish' with higher probability early on, so as to improve the learning process. If (iii) holds, armslength debt is not an option at date 2.

The new equilibrium level of σ_+ is set such that the firm is indifferent between bank debt and armslength financing, at date 2, for $\theta_F \in (\bar{\theta}_F, 1]$. For this to hold and knowing from proposition 2.1 that $dU_{AF}/d\theta_F > dU_{SBF}/d\theta_F$, and from (2.9) that β_{F+}^* is independent of θ_F , it must be that $d\pi_{F+}/d\theta_F > 0$. For a given current prior π_C , this implies that $d\sigma_+/d\theta_F < 0$ in the range $\theta_F \in (\bar{\theta}_F, 1]$. Combining this with lemma 2.3, we state

Proposition 2.4: *When an arms-length market is introduced, bank loyalty decreases in both absolute and relative terms towards those firms with better future projects if those future projects lie in the range $(\bar{\theta}_F, 1]$. i.e if $\theta_F' > \theta_F''$ then $\sigma_+' < \sigma_+''$ and $\sigma_+'/\sigma' < \sigma_+''/\sigma''$ for all $\theta_F', \theta_F'' \in (\bar{\theta}_F, 1]$.*

The content of propositions 2.3 and 2.4 is that relationships (weakly) deteriorate with the introduction of armslength markets. Further, the duration of these relationships falls. Finally, relationships deteriorate most for firms which have high quality future projects, the very firms for whom relationships worked best prior to the introduction of the arms-length market. In summary, prior to the introduction of the armslength market, bank loyalty increases with future project

quality. After the introduction, it first increases then decreases.

At date 0, for a given θ_F and prior π_C , σ_+ is fixed. By proposition 2.1, armslength financing is preferred only by firms with $\theta_C > \bar{\theta}_C(\theta_F, \pi_C)$, $\bar{\theta}_C \in [0,1]$.

The welfare effects of the introduction of armslength markets are ambiguous:

- i) Firms with *uniformly high quality* projects benefit as they borrow armslength for all projects.
- ii) Firms with *uniformly low quality* are not affected; Bank credit is preferred for both projects and the introduction of armslength credit does not change the equilibrium.
- iii) For firms with a *low quality current* project and a *high quality future* project, the implications are less obvious. The first project has to be bank financed, and the increased bank opportunism directly reduces the provision of effort at date 0, from (2.10). However at date 2, the firm can access the armslength market which improves the ex-ante value of the future project. This feeds back to increase the effort provision at date 0. The firm can be worse off if the former effect outweighs the latter.¹⁷

The increased bank opportunism forces some firms to access the armslength market at date 0, for their low quality projects, though ideally they would borrow from the bank. Others, with still lower quality current projects remain with the bank. The effort or discretionary investment of these firms is highly distorted.

- (iv) Firms with *high quality current* project and *low quality future* project would tend to go to the armslength markets for their current projects. However, they have to return to the bank for their future project. The firm may then stay with the bank for its current project also, in order to learn more about the bank.

The quality of future projects, therefore, modifies current behavior. High quality future projects accelerates the movement towards the armslength markets while low quality future projects increases the preference for banks. Efficiency has increased for firms which were subject to opportunism, but now can access the armslength market. It has decreased because of the increased

¹⁷An example of a firm that becomes less efficient with the introduction of an armslength market, is available with the author.

opportunism towards all firms and the resultant distortions. The opening of armslength markets can lead to a loss in welfare.

Thus far, we maintained the assumption that complete lock-in occurs during a project. This is probably the natural assumption in economies which are relationship dominated. Disclosure requirements are not exacting because there are few armslength investors to protect. There are large information asymmetries between insiders and outsiders. The ability of the inside bank to preempt information acquisition because of its access to the firm's books, may add to the monopoly power it obtains from informational asymmetries (see Rajan (1991)). Yet monopoly may not be inefficient because of relationships. The introduction of an armslength market changes this by causing relationships to break down. The firm changes banks more frequently and there is competition from the armslength markets. More information is publicly available, first because of more stringent disclosure requirements and second because armslength investors seek it.

We now show that the bank's interim informational advantage can endogenously lock the firm in, even when there is a competitive outside credit market. At one level, this justifies our previous ad-hoc assumption about lock-in. At another, it models a more *market-oriented* or '*transactions*' oriented system where each loan, within a project, is treated as a separate transaction to be competed for. Competition within a project rather than relationships over projects reduces opportunism.

The basic trade-off still holds when outside uninformed potential lenders compete to lend with the inside bank at the interim date. Competition mitigates rent extraction though at the expense of control. Also the bank's incentives to monitor fall. There are qualitatively different results with interim competition; the size of the bank loan matters. In order to reduce the power of the bank, the firm may borrow *simultaneously* from the bank and the armslength market. The private and public flow of information determines the effectiveness of interim competition.

Section 4: Interim Competition and Multiple Initial Lenders

Bank Debt with Interim Competition

In what follows, we revert to a firm with a single project. One way to think about this is that with the break down of relationships, future projects do not affect current behavior. For simplicity, all banks are assumed to be profit maximizing. Let a bank lend the amount I_0 at date 0. This bank can monitor the project. At date 1, the owner has to roll over the repayment on the date 0 loan, D_{01} as well as borrow I_1 . Instead of being locked in to the initial lender at this point, the owner bargains for the best terms with all potential lenders (including the initial one).

Restating assumption (A.4): the potential lenders make all the offers —(A.4b). This is relaxed in the Appendix by giving the owner the power to set a reservation loan rate.

As the loan is riskless, let the Date 1 repayment $D_{01} = I_0$.¹⁸ The amount to be borrowed by the owner at date 1 is $I_1 = I = (I_0 + I_1)$. We assume that the owner cannot divide his borrowing between lenders¹⁹. At date 1, the owner asks both the inside bank and a single outside bank²⁰ to submit a sealed bid to the owner. The bid is the fraction of the date 2 payout that the bank will allow the owner to retain and is inversely related to the expected return to the bank. The highest such bid is accepted.²¹ The solution to the bidding game determines the expected date 2 face value, for the loan made at date 1.²² The equilibrium solution is

¹⁸ D_{01} is determined by the individual rationality/zero profit condition for the initial short term lender. As we see later, the lender will have to pay the owner a sum d_0 up front (which we assume the owner will take out of the firm), in addition to I_0 so as to compensate the owner for the rents the lender will extract ex-post. The possibility of an initial payment introduces some flexibility in the choice of D_{01} .

¹⁹ A share auction in the presence of symmetrically informed bidders would reduce the amount the auctioneer gets. With asymmetrically informed bidders, it is less clear which way the results go.

²⁰ More outside bidders will not change the result.

²¹ This is equivalent to specifying an interest rate. If the lender demands a face value of D_{12} , it is equivalent, given the nature of our technology, to offering the owner a share $[1-D_{12}/X]$. Also note that a blank or zero bid is submitted when the lender does not want to bid, so that the action of not bidding is not observable.

²² None of the results are dependant on the exact form of the bargaining game. We defend our choice based on what we believe is common practice. For example, "what is being contemplated in 'obtaining competitive quotations' is an approach to a limited number of banks on an open basis. Each should be told that a competitive quotation is being taken

Proposition 2.5: (i) No equilibrium exists in pure strategies. (ii) There exists an equilibrium in mixed strategies where: (a) The outside bank plays a mixed strategy, and offers to lend money independent of the state. It will not bid at all with probability G_N . It makes zero expected profits.

It makes positive expected profits conditional on the good state of

$$\frac{1-q}{q}(I_s - p_B D)(1 - G_N) \quad -(2.11) \text{ where } G_N = \frac{(1-q)(1-p_B)I_s}{(q + (1-q)p_B)(X - I_s)} \quad -(2.12), \text{ } D \text{ is its}$$

average bid and q is the outside bank's conjectured probability of the good state. (b) The inside bank offers to lend only in the good state. If the outside bank bids with positive probability ($G_N < 1$), the inside bank makes a conditional expected profit of $\frac{(1-q)(1-p_B)I_s}{q + (1-q)p_B} \quad -(2.13)$. If the outside bank does not bid, the inside bank captures all the project surplus.

Proof: See Appendix.

Remark: If the outside bank's strategy were pure and therefore predictable, the inside bank would charge a lower rate in the good states and not bid in the bad states, leaving the outsider with all the bad projects. This is the problem of the Winner's Curse, which is why the outsider plays a mixed strategy. If the outside bank bids in the bad state, it gets to lend with certainty as the inside bank does not bid. The probability of this happening is $(1-q)(1-G_N)$ and the loss is $I_s - p_B D$. The outsider recovers the loss by making a profit in the good state. (2.11) is then obtained by conditioning on the good state.

In the earlier case of complete lock-in, the informed bank exerts control directly by cutting off credit in the bad state. But now, if the inside bank refuses the bad project credit, it will be shut down only with probability G_N , as the uninformed outside bank may decide to lend. Therefore, G_N is a measure of the control exercised by the inside bank at date 1.

The inside bank bids only in the good state where the loan is riskless. It can optimally charge a premium as the outside bank is less well informed. If the outside bank bids in the bad

from another bank, but not the name of the bank." -'The Medium Term Loan Market', Donaldson and Donaldson (1982).

state, the owner will use part of the loaned amount to pay off the inside bank. If it does not, the project is shut down and the proceeds used to payoff the inside bank.

Proposition 2.5 is reassuring for our previous results as it implies that information asymmetry can lead to lock-in. First, no equilibrium exists in pure strategies and even allowing for noise, the outsider does not bid if its informational disadvantage is bad enough.²³ We now explore the implications of interim competition.

Comparing bank debt with interim competition to the earlier case of complete lock-in, the project control decision is (weakly) less efficient [$G_N \leq 1$], the rents extracted by the informed bank are (weakly) lower [$(1-q)I/q \leq (X-I)$] and as a result, the incentive for the bank to monitor is (weakly) lower. If $G_N < 1$, the inequalities are strict.

As there is uninformed interim competition, public information and the size of the bank loan now matter.

Proposition 2.6: (i) Both the conditional expected profits extracted by the inside bank and the control exercised by it decrease in q , increase in the difference between the probabilities of success ($1-p_B$) and increase in I_s (the amount rolled over at date 1). (ii) The control exercised by the inside bank decreases with the surplus $X-I_s$.

Proof: Follows directly by differentiating (2.12) and (2.13).

The monopoly power of the inside bank arises because of (a) its *informational advantage*, which decreases in q , of being able to distinguish between states (b) the *value* of being able to distinguish between states, which increases in $(1-p_B)$ and I_s . Thus control, which is effected indirectly through monopoly power, and rent extraction vary similarly with all parameters except available surplus. A reduction in available surplus does not affect rents because the effect of lowering the amount available for banks to bid for is exactly balanced, in our simple model, by reduced competition from the outsider. When the available surplus is reduced, control improves

²³ $G_N=1$ if the project has negative NPV conditional only on the outsider's information.

without simultaneously affecting rents. This has implications for the optimal priority of bank debt.

The Trade-off Revisited

We now show that the trade-off between bank debt and armslength debt still holds. Assume, to simplify the presentation, that $p_B = \epsilon \approx 0$ (A.6). Proposition 2.5 determines the expected date 2 face value conditional on the good state, which by limited liability and assumption (A.6) fully determines the owner's ex-post problem. The conditional expected face value is the sum of the conditional expected profits of the lenders and the invested amount I . The F.O.C with short term bank debt is

$$q_1(\beta, \theta) = \frac{1}{(X - I) - \frac{1 - q_{SB}^*}{q_{SB}^*}I - \frac{1 - q_{SA}^*}{q_{SA}^*}I(1 - G_N)} \text{ for } \beta = \beta_{SB}^* \quad (2.14)$$

Rewriting the F.O.C for armslength debt from (2.5) for the case $p_B=0$,

$$q_1(\beta, \theta) = \frac{1}{X - I - \frac{(1 - q_A^*)I}{q_A^*}} \text{ for } \beta = \beta_A^* \quad (2.15)$$

Bank debt is ex-post costlier than armslength debt, even in the presence of uninformed competition. It is immediate then from (2.14) and (2.15) that the effort exerted by the owner if he borrows from the bank is always less than that exerted if he borrows from the arms length lender. Ex-ante, the owner prefers bank debt to armslength debt if

$(1 - q_{SB}^*)IG_N - ((q_A^* - q_{SB}^*)X - (\beta_A^* - \beta_{SB}^*)) - m \geq 0$ --(2.16). The first term in (2.16) is the ex-ante benefit of bank control, the second is the result of ex-post effort distortion, while the third is the monitoring cost.

The inside bank's informational advantage decreases in project quality. Competition, though uninformed, forces down the rate for high quality projects. If monitoring costs are small, bank debt is as efficient as armslength debt for high quality firms. Contrast this with the case of lock-in where bank debt was relatively more onerous for high quality companies. As θ decreases (and the

probability of the bad state increases), both relative underinvestment and control become more important. The choice between arms length contracts and bank contracts then depends on the form of the q function. As the intuition is the same as before, we just present an example, relaxing the separability assumption:

Example 1: Assume $X=3$, $I=1$, $m=0$ and $q(\beta, \theta) = \theta - \theta e^{-\theta}$. This example pertains to firms with moderate discretionary investment. As quality decreases, effort provided with bank debt falls off rapidly (Fig 2). Bank debt initially provides little control, but this increases rapidly as θ decreases (Fig 3). The net effect is that for high quality projects, arms length debt has a slight edge (Fig 4). For medium quality projects, the benefit of control outweighs the relative underprovision of effort, so bank debt dominates arms length debt. Arms length debt dominates for low quality firms, because both the marginal cost of the relative underprovision at low levels of effort and the magnitude of relative underprovision become significant.

In this example the basic trade-off still holds, though it is affected by the level of interim information asymmetry as determined by project quality. Next we see how the public interim revelation of information matters. Finally, we allow the owner to borrow simultaneously from multiple lenders. Interim competition can substantially alter our previous results for these two cases.

Interim Public Information

Let a public signal W about the state be seen at date 1 before the bargaining game. The outsider's posterior is $q^+ = E[q^*|W]$. We can incorporate new information easily by replacing q^* with q^+ in all our results from the bargaining game, and taking expectations over W at date 0. The ex-post expected utility is

$$\max_{\beta} q(\beta, \theta) \left[X - I - E_W \left[\frac{(1-q^*)I}{q^*} + \frac{(1-q^*)I(1-G_N)}{q^*} \mid \text{Good State} \right] \right] - \beta \quad (2.17)$$

The rents at date 1 are based on the outsider's posterior beliefs. At date 0, the owner internalizes the expected cost of debt, conditional on the good state having occurred. If the signal

is informative, we expect the posterior q^+ conditional on the good state to be high. However, the excess payment (within square brackets in (2.17)) is convex when q^+ is low. If the prior is low and the interim signal is informative but not very much so, the conditional expected excess payment may be higher than if there was no signal. An informative public signal *can make the firm worse off*.

Example 2: If the firm is in the good state, let the public signal be w_G with probability α_G and w_B with probability $(1-\alpha_G)$. In the bad state, let it be w_G with probability $1-\alpha_B$ and w_B with probability

α_B . If the signal is good $q^+ = \frac{q^* \alpha_G}{q^* \alpha_G + (1-q^*)(1-\alpha_B)}$ while if the signal is bad

$q^+ = \frac{q^*(1-\alpha_G)}{q^*(1-\alpha_G) + (1-q^*)\alpha_B}$ The conditional expected excess payments then are

$$\frac{1-q^*}{q^*} + \frac{1-q^*}{q^*} \left(1 - \left(\frac{1-q^*}{q^*} \right) \left(\frac{I}{X-I} \right) \left[\frac{(1-p_B)^2}{p_G} + \frac{p_B^2}{1-p_G} \right] \right) \quad (2.18)$$

With no interim signal, the payments are as in (2.18) except that the expression in square brackets is 1. The interim signal does not change the expected rents (the first term in (2.18)) extracted by the informed bank. However, the expected cost of inefficient continuation (the second term in (2.18)) depends on the informativeness of the signal. A signal raises this cost if the expression in square brackets is less than 1. If $p_B=1$ so that a good signal identifies the good state, the cost of inefficient continuation is lower with the signal. On the other hand, if $p_B=0.5+\epsilon$ and $p_G=0.5+\epsilon$ where ϵ is small, then the cost of inefficient continuation is higher. The intuition is that if the public signal is good, the inside bank's control decreases considerably. This is costly when there is significant probability that the firm may actually be in a bad state.

Our result that noisy interim information may be costly is similar to Diamond (1989b) but the conditions are diametrically opposite. Our result obtains without ex-ante asymmetric information. More important, in Diamond, the cost is imposed on the firm when the interim signal is bad and the firm is inefficiently liquidated. In our model, the presence of the informed bank ensures that there is no inefficient liquidation. If the signal is good, however, there may be

excessive continuation by uninformed outsiders. This loss of control, in addition to any increase in expected rents is the cost of noisy interim information.

Provided ex-post incentives are improved by the signal we have

Proposition 2.7: If $dU_{ss}/d\beta_{ss}^* \geq 0$,²⁴ the ex-ante advantage to bank debt in the presence of outside potential lenders increases with the informativeness of an interim public signal.

Proof: For a given choice of β , interim public information enters the owner's ex-ante expected utility U_{ss} only through the 'control' term $(1-q^+)I(1-G_N)$.²⁵ U_{ss} is therefore convex in q^+ and

$$E[U_{ss}(q^+)] \geq U_{ss}(E[q^+]) = U_{ss}(E[E[q^+ | W]]) = U_{ss}(q^+) \quad (2.19)$$

where the first inequality is by Jensen's inequality. Because β_{ss}^* increases with the accuracy of interim information, the ex-ante utility increases with the informativeness of the public signal. In the limit, of course, perfect interim public information would achieve the first best as at date 1 all the creditors would be perfectly informed.

In our model, unlike Diamond (1989b), whether information is privately or publicly revealed is important. For example if a plant is being constructed, a substantial portion of the uncertainty is resolved when certain publicly visible output criteria are met. This could explain why such a project is financed initially with bank debt, which is then replaced by arms length debt.²⁶ On the other hand, the Industrial Organization literature is replete with stories why interim asymmetric information characterizes a firm's product market strategy. A firm embarking on such a strategy would find it very costly to roll over bank debt even in the absence of interim public information. Hence the adage 'borrow to match the maturity of product market strategies'.

²⁴Note that despite underinvestment relative to the first best, $dU_{ss}/d\beta_{ss}^*$ is not necessarily positive. The reason is that control is not perfect here and it is possible that an increase in effort reduce control so much that ex-ante utility falls.

²⁵Note that G_N is also a function of q^+

²⁶ See Kelor Chemicals , Harvard Business School Case

Multiple Lenders

So far we have not given a rationale for why a firm may want to borrow from multiple lenders *at the same time*. Note that with lock-in, reducing the amount rolled over with the inside bank at date 1 will not reduce the rent extracted. The bank can hold up the project even with a minuscule fraction of the initial loan. Furthermore, if arms length debt is junior, the bank not only bargains over the surplus but also the amount owed to arms length debt, thus increasing rent extraction.

Proposition 2.6 shows that interim competition changes this as the monopoly power of the inside bank is proportional to the amount rolled over at date 1. The owner may borrow a fraction of the amount required from the long term armslength market, at the initial date. Armslength debt free-rides on the bank's monitoring. The reduction in the amount rolled over with the bank, at the interim date, lowers the rent extracted and also the control of the informed bank. We plot (in figure 5 for the data in example 1) the optimal source choice that results from this trade-off.

The relative priority of claims matters, with multiple creditors. Subordination of the armslength claim leaves the size of the available surplus that the bank bargains over at the interim date unaffected. Also the date 0 armslength lender demands a higher rate as she can be dispossessed ex-post. The size of the available surplus at date 1 is reduced, if it is bonded away to the initial armslength lender at date 0, by giving her claims the highest priority at date 2. Efficiency improves as a result of the improved control (proposition 2.6) and the lower rate demanded by the armslength lender. Therefore we claim

Proposition 2.8: *It is optimal for arms length debt to be senior to bank debt when they are used together.*

Proof: See Appendix.

This result suggests that considerations of ex-post bargaining are an important determinant of capital structure. If the only difference between debt and equity is priority, proposition 2.8 suggests that debt is preferred even if there are no information asymmetries separating management

and investors at date 0. Diamond(1991) obtains the opposite priority rule, because in his model the problem is one of excessive liquidation by the uninformed bank. If the bank has higher priority, it can dispossess the armslength creditor, giving the bank an incentive to avoid liquidation. In a sense, giving the bank priority makes armslength debt state contingent. Symmetrically informed competition prevents the bank from getting too much power. Our assumption that the bank is an insider and better informed than other potential creditors is crucial to the difference in our results. Proposition 2.8 should hold for small and medium firms for which our assumption is more plausible.

So far we have restricted ourselves to one bank getting informed. If the owner trusts banks not to disclose information to its product market competition, he may borrow from more than one bank at the initial date, so as to give them access to private information. If one of the banks has marginally easier access to the firm's books, it can pre-empt the others by investing the monitoring costs. As competition at date 1 is Bertrand, the other banks have no incentive to invest in monitoring. Thus small monitoring costs coupled with unequal access are enough to restore monopoly, even when the firm gives access to many banks. The situation is different when banks have identical access. The owner eliminates ex-post opportunism if monitoring costs are negligible. However, if they are sizeable, new inefficiencies arise because bank monitoring resembles a natural monopoly.

For simplicity, let just two banks be given access to the firm's books. Assume that the decision to acquire the information is simultaneous and visible to everyone. When both banks monitor, they bid away profits. Outside banks therefore will not bid and the continuation decision will be efficient. However both banks suffer losses because monitoring costs are sunk. If only one bank monitors, we return to the one inside lender situation. If no bank monitors, there is no control, a situation equivalent to having arms length debt. Therefore in equilibrium, it is easily shown that we could get over-monitoring or under-monitoring. Over-monitoring occurs when monitoring costs are low compared to the potential rents. It is good as it reduces rent extraction but the owner also pays for the potentially excessive monitoring costs. Under-monitoring occurs

when monitoring costs are high compared to the rents and could lead to too little control. Therefore a firm may borrow from multiple initial banks rather than a single one but this decision depends on the project and the monitoring costs.

We have shown that the basic trade-off analyzed under lock-in still goes through with the introduction of interim competition. The important differences are that bank control is weaker. Incentives for effort improve while incentives to monitor fall. The effect on efficiency is ambiguous. Two qualitative differences emerge: The flow of private and public information is important and firms may be financed with multiple lenders.

Section 5: Conclusion

The main point of this paper has been that there is a fundamental trade-off between bank debt and armslength debt, even when monitoring costs are small. This arises because bank debt can acquire and act on the basis of private information while armslength debt can commit not to renegotiate. The firm weighs the ex-ante costs of ex-post renegotiation with bank financing against the ex-ante benefits of control. Relationships are one way of improving the efficiency of bank debt. Yet relationships are unstable because the factors that promote them are the ones that make a firm attractive to armslength markets. Relationships deteriorate when faced with competition from armslength markets. Competition rather than relationships then influence the trade-off.

There is some empirical evidence that banks in Japan do indeed charge a higher rate for firms with which they have close links than from other firms. Caves and Uekasa (1976) document how group-affiliated companies earn 1.5 percent less net profit on equity (after other factors are taken into account) than do independent companies. They estimate that the rents extracted by the banks could range from 0.2-0.5%. Of course, some of this may be a payment for the implicit guarantees and coordination that the main bank provides other fixed claim holders. There is scope for empirical work here.

Since we motivated this paper with the work done by Hoshi et al. we now see how well our theory explains the data. We expect firms that move to the armslength market to invest more

than those who stay with the banks because; First, the firms that move, do so because their discretionary investment (effort) is distorted with bank debt. Once they move, they undertake larger discretionary investment. Also, they could have pent-up investment resulting from previous underinvestment when financed with bank debt. Second, firms that stay with the expectation of moving later are subject to increased opportunism, leading to underinvestment. Third, firms with low discretionary investment stay with the banks. Hoshi et al. find that the real capital stock of firms that moved increased at a median rate of 6% between 1977 and 1986 while that of firms that stayed increased by only 1%. Also real investment in 1986 as a fraction of capital was 26% more for firms that moved than for firms that stayed.

Firms that move are liquidity constrained, which is consistent with our predictions. As noted earlier, some firms would stay but for the increased opportunism. These 'involuntary quits' are not able to access the armslength markets easily and would account for the observed liquidity constraint. Finally, the model predicts that firms with better future opportunities are more likely to break away. Under some assumptions, Tobin's q is a measure of future opportunities. Hoshi et al. find the median Tobin's q in 1986 for firms that break away to be 1.74, while it is 1.46 for firms that stay.²⁷

Obviously some of these facts are consistent with other theories. The simplest explanation is that bank debt is costlier than armslength debt because of fixed monitoring costs. A more subtle reasoning, similar in spirit to ours, views monitoring as a lump sum ex-ante discretionary cost. Ex-ante, the bank knows which firms will eventually move to the armslength markets. If it does not expect to recover its fixed investment in monitoring, it will not lend even if these firms needed monitored bank credit. These firms then are forced to move to the armslength markets. But this explanation begs the question. If the costs of monitoring are high, why does the bank not stop monitoring and lend at the armslength rate? Why do the firms have to go to the armslength market

²⁷ A cautionary note about the Hoshi, Kashyap and Scharfstein findings is that they assume the choice between bank debt and bond market debt to be exogenous. What we show here is that it is intimately connected to the nature of the investment opportunities that the firm has.

to get un-monitored credit? Further, what are these costs that drive a firm to the armslength markets? In a sense, our model endogenizes these costs. Conclusive support for any of the theories will come only from further empirical analysis. However, our model has other interesting implications which we examine after discussing important assumptions.

The objective of the management need not be to maximize the residual value of the firm. All the results go through if, for example, the management is thought to have an incentive to build empires. Even though management may not have clear incentives to maximize stock price, assuming that they want to maximize the ability to take discretionary actions will have the same implications.

The problem of opportunism stemming from lock-in is sometimes theoretically resolved using mechanism design. A commonly observed mechanism is the 'usury' law which is a legislated cap on the interest rate that can be charged. In certain situations (see note 12) a bank debt line of credit resembles the optimal contract, under this law. If enforceable, the law could reduce opportunism, though it may freeze a few firms out of the credit market. The more likely event is that bargaining and transfers take place outside the mechanism. This is a general problem with using mechanism design to solve problems of ex-post opportunism (Hart and Moore (1989)). Aoki (1989) documents how Japanese banks get around the problem of interest rate ceilings. He suggests that the high ratio of cash to assets observed for Japanese firms incurring high debt stems from the banks requiring firms to maintain 'compensating balances'. The level of these balances is determined by bilateral negotiation. By adjusting the level of these balances, the bank can adjust the interest rate even if nominally fixed. Aoki documents that this 'overborrowing' fell with the increased access of firms to arms length markets in the late seventies.²⁸

We exaggerate the agency problem in this paper by not allowing for inside equity. All the results hold if the owner's equity stake is small compared to the size of the investment. A more interesting question is whether outside equity holdings can mitigate the problem of contract

²⁸ This is not inconsistent with our hypothesis that the opportunism of the banks would have weakly tended to increase, as the firms most subject to opportunism would 'escape' to the bond markets.

incompleteness.

We showed that the maturity of the bank contract is negatively related to the amount (or concessions) firms bargain for in states of contract incompleteness. Outside equity is one means of affecting this amount. If the bank is a major stock-holder or controls essential suppliers or buyers then the surplus the firm gets is small. This is the case in (West) Germany where the 'Universal' banks not only own equity in firms but also vote proxies for many equity holders. Bank loans in such cases should be long term because; first, the bank has control over investment because of its equity holding and second, short term bank debt is very inefficient because banks have so much bargaining power. Bank loans in Germany are indeed largely long term. Mayer and Alexander (1990) find that 52.4% of bank loans to German firms in 1985 were for 4 years or more and a further 9.1% between 1 and 4 years. There is some casual evidence that German firms in which banks do not have a substantial equity stake, cannot borrow long term as easily.²⁹ In contrast two-thirds of bank lending to British industry in 1980 was less than 1 year.³⁰

The Japanese group banks have some equity control through cross-holdings, even though they have been permitted to hold only 5% (down from the earlier 10%) of a firm's equity. Yet in table 1, between 1976-80 only 7% of firm borrowing from banks were long term. The question then is why the Japanese banks do not lend longer term to firms, as short term bank debt is very inefficient if the bank has a lot of power. Apart from regulatory reasons, it may be that the banks do not have as much control as in Germany, witness the decision of group firms to move away to the bond market.³¹ ³²Moreover, in Japan the 'main' bank is only part of a lending coalition.³³

²⁹ "Banking Systems Abroad", (1980), Interbank Research Organization, London.

³⁰ Reported in Mayer and Alexander (1990).

³¹ Also the city banks were enjoined by the Government to lend short term, leaving long-term finance to institutions like the Industrial Bank of Japan.

³² An interesting empirical question is whether firms in groups with large cross-holdings find it harder to leave, thus implying that tie-in could occur because of equity holdings.

³³ Group banks accounted for only 30% of a firm's bank borrowing in 1977 (HKS 1990 a).

Lending coalitions may be a source of more informed competition. Even if banks collude (which is likely), coalitions can reduce opportunism in the following way; if all lenders tie their rates to that charged by the 'main' bank, every yen that the 'main' bank extracts as rent is levered up by the amount extracted by the other banks. This has a substantial impact on the 'main' bank's equity stake, even if that stake is small. An interesting area for research is to explore the alignment of interests through equity.

Yet the alignment of interests cannot be all good. The problem of course, is that it may conflict with the bank's role as the delegated monitor for other stakeholders in the firm. Note that if the bank is the only other major stakeholder as in most of our model and arguably in Germany, this problem does not arise. But if the firm has other fixed claim creditors, the option value of equity may cause the bank to postpone liquidation too long. Mellor (1990) suggests this was partly responsible for the banking crisis in Chile in 1983. Banks in the big Chilean groups made a large number of loans to members of their own group which eventually turned sour. Even without an equity stake, the bank may postpone liquidation too long if its claim is junior. Yet there are reasons in our model why bank debt should have lower priority than armslength debt, for priority enables the owner to bond away cash flows. Another reason for the seniority of armslength debt stems from the difficulty in renegotiating it; the ability to renegotiate risky debt is valuable, in order to reduce the Myers underinvestment problem. Thus debt which is difficult to renegotiate, should be senior. Debt which is easy to renegotiate or by virtue of maturity comes up for renegotiation every period, should bear as much of the risk as possible.

Given that bank debt is of lower priority, its incentives to control overinvestment are improved if its incentives to liquidate are increased. This could be a function performed by collateral. Let bank debt be collateralized with short term wasting assets like inventory while armslength debt be collateralized with land. If the bank learns that the firm will do badly in the future, so that the efficient decision is to shut it down now, the collateral enables it to recover a large part of its loan. If it delays liquidation, outside monitors like suppliers eventually realize the firm is going under and stop shipping inventories. When the firm does go bankrupt, the bank is

treated on par with the other unsecured creditors, which reduces its share drastically. Thus collateralization on assets whose value depends on the actions of less efficient monitors improves the bank's incentives to control the firm.

We also draw insights from our model on the difference between largely relationship based banking systems like Japan and more competitive 'transactions' based systems like the United States. Our model with interim competition essentially represents a transactions based system with a dominant inside lender, where each new loan is bid for by the market and the dominant lender.

In a relationship system, high quality firms are relatively most affected by ex-post opportunism. To the extent that they are also growing and future prospects are good, opportunism is reduced by future prospects. But in general, these firms may subsidize the banking system. In a more competitive system, the highest quality firms get bank rates commensurate with their credit standing. This is because the information asymmetry is least for these firms. If in addition, monitoring costs are sizeable, these firms will move to the armslength markets. Also, bank control is weaker in a competitive system, because uninformed banks undermine the credit decisions of informed banks. For both the above reasons, the average credit rating of bank portfolios deteriorates as the credit system becomes more competitive. This demand side explanation is a complement to supply side explanations which stress that higher funding costs because of competition for deposits forces the bank to take higher risks (Bryan (1988)).

Even though bank control decreases, the movement towards competition can improve the access of certain firms to credit, especially those for whom the relationship does not work. This is contrary to popular intuition because the earlier literature has focused on the beneficial role of monitoring in resolving the problem of credit rationing. The underlying assumption is that control of managerial actions like overinvestment is good (e.g Stiglitz and Weiss (1983)). As we have shown, such control could endogenously distort managerial incentives (a result similar to Grossman and Hart (1986) except that the distortion is exogenous there). The ability to threaten termination is not always a solution for the problem of credit rationing and in fact may make it worse.

Another major difference between the two systems is the importance of public information.

In a competitive system, accurate public revelation of information improves the efficiency of the credit decision. This, however, may pressure firms into emphasizing short term public results thus distorting investment decisions (Stein (1988)). We also show that noisy interim information can raise the cost of bank debt. One remedy in these systems, is for the firm to choose a 'strategic' partner with deep pockets. An example is Genentech selling itself to Hoffman-La Roche, with the latter exercising control through its 60% equity stake. In a relationship system, public information is irrelevant during the course of the relationship. In fact, there is an incentive for the banking system to oppose public disclosure requirements as it tempts outside potential lenders to interfere in the relationship. But it is not always correct that relationships enable the firm to take a long term view. As shown, relationships do not work for some firms, especially those with a speculative future.

Our model is not limited to commercial bank-lender relationships. Eccles and Crane (1988) have empirically documented similar issues in the investment banking industry. We could adapt some aspects of our model to the situation described there as follows: The investment bank provides new ideas (instead of control) to the firm. The ability to provide appropriate ideas depends on private firm specific information. This information is also a source of monopolistic rents. Introducing competition among the investment banks reduces rents but also reduces the quality and firm-specificity of the ideas.

For reasons of tractability, our model is simple. Yet it demonstrates that the sources and composition of firm finance are important and vary significantly between firms. This is a fruitful area for further research.

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TABLE 1

Composition of Borrowings by firms in Japan and the United States

	Japan ¹		United States ²	
Borrowings	1976-80	1981-85	1976-80	1981-85
Bonds	2.5	26.8	55	56
Financial Institutions	91.3	67.6	35.7	44
of which short term	53.4	58.6	22.7	10.9
long term	6.6	9	13	33
notes	31.3	-	-	-
Other Borrowings	6.1	6.1	9.1	-

¹ Hoshi, Kashyap and Scharfstein (1990 a)

² O.E.C.D Financial Statistics of Non-Financial Companies 1988

FIG 1. REPEATED PROJECTS

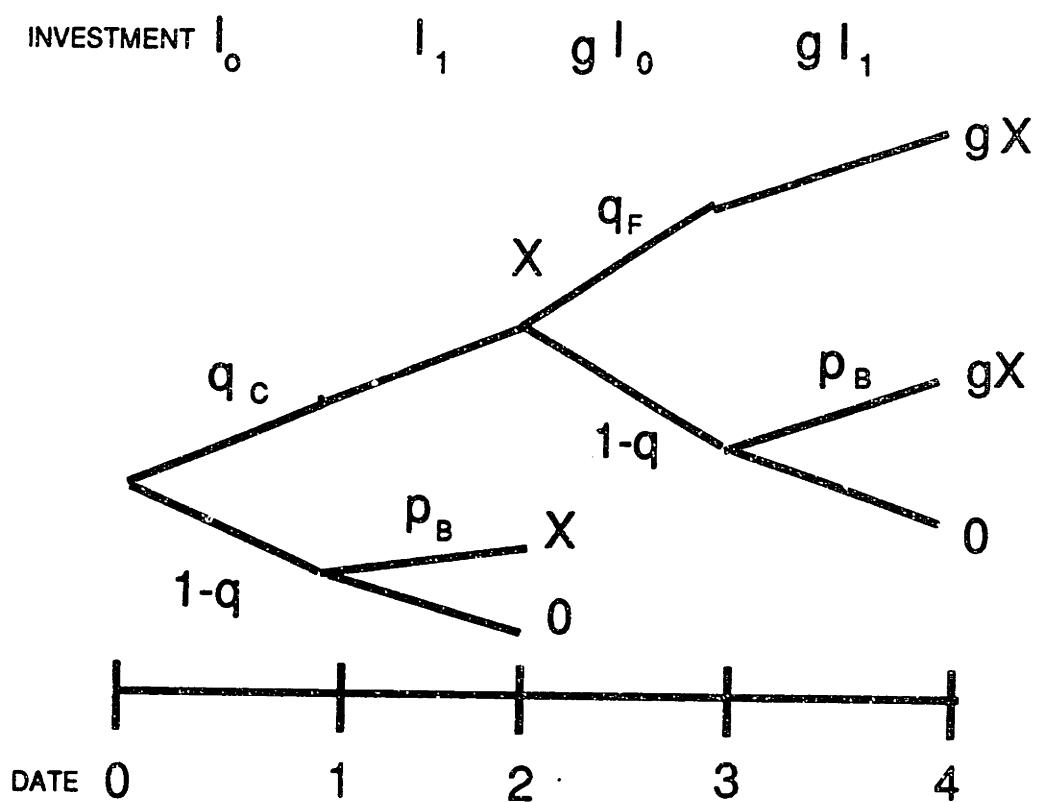


FIG 2 : VARIATION OF OPTIMAL BETA VS
THETA FOR EXAMPLE 1

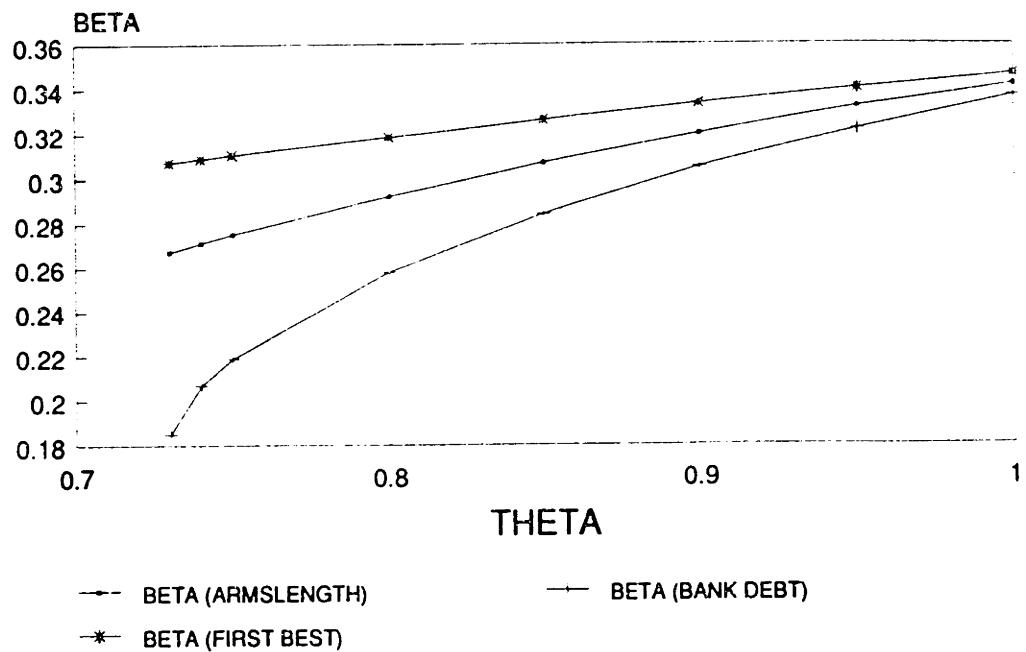


FIG 3: PLOT OF CONTROL VS THETA
EXAMPLE 1

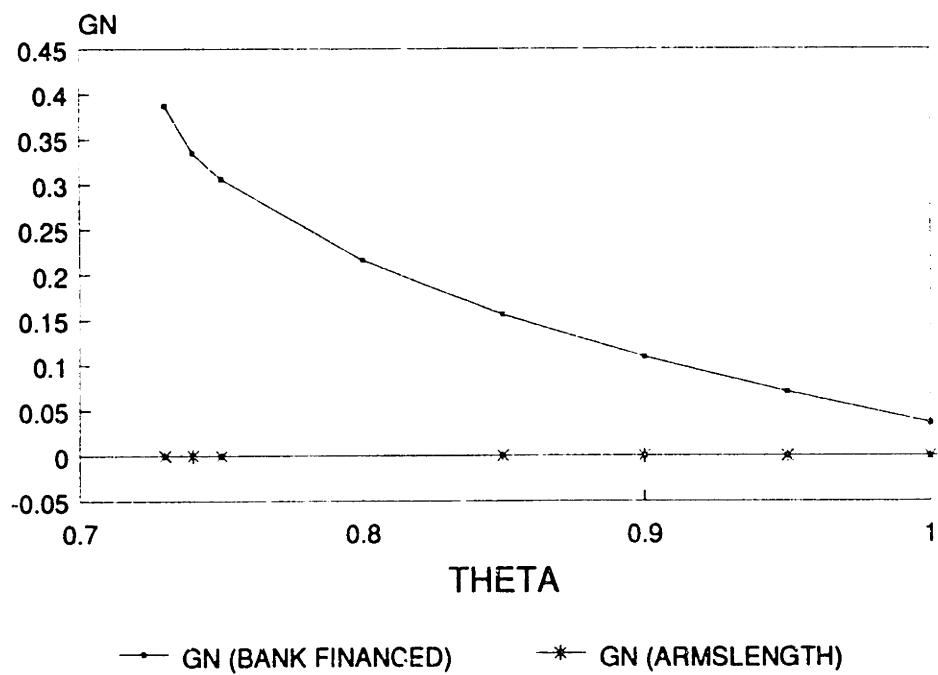


FIG 4 : EX-ANTE FIRM UTILITY VS THETA
EXAMPLE 1

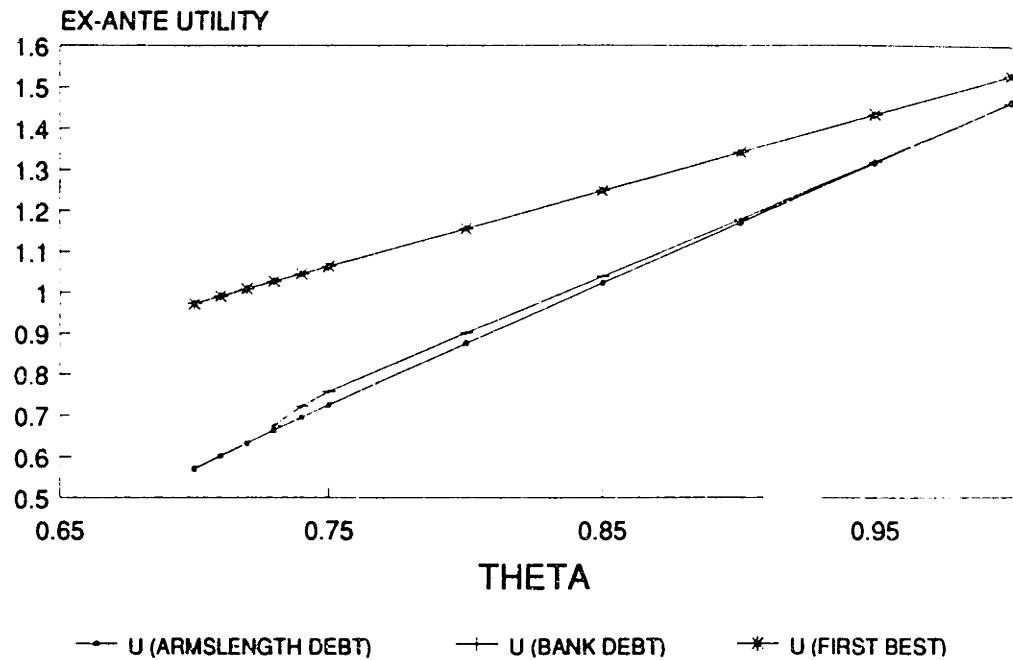
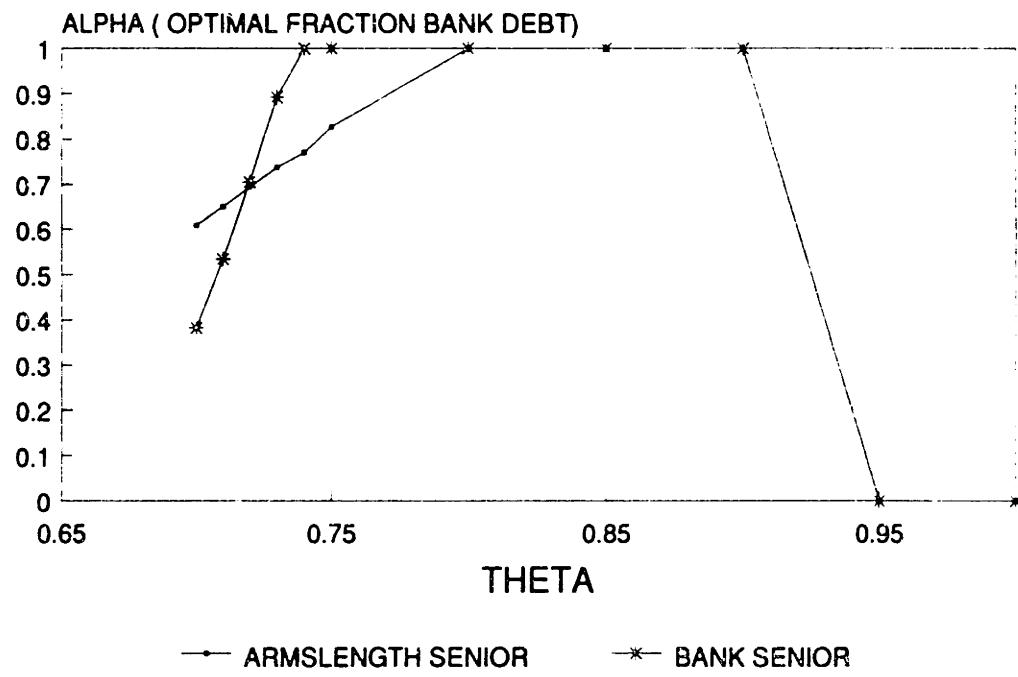


FIG 5 : OPTIMAL FRACTION OF BANK DEBT
WITH DIFFERENT PRIORITY STRUCTURES



Appendix

Example to show effort choice is isomorphic to a choice between investments

This example shows that the entire problem can be couched as a choice between two investments rather than a choice of effort level. That is why we call effort 'discretionary investment'. In what follows we assume interim date competition.

Instead of having to choose effort β after signing the contract at date 0, assume the owner has to invest I_0 in one of two mutually exclusive projects A and B. Conditional on a further investment of I_1 at date 1, Project A pays R for sure at date 2. Project B is identical to the project discussed in the text except that q is not dependant on effort. Outsiders know which project the owner has invested in but not the state at date 1.

Assume that $qX - I > R - I \geq 0$ i.e It is more efficient to invest in project B than A even if overinvestment in project B is not controlled. If financed with armslength debt, the owner will always choose the risky project: if D_{02} is the face value demanded, he chooses the risky project if $q(X - D_{02}) \geq R - D_{02}$ i.e if $qX \geq R - (1-q)D_{02}$ which is always true.

If financed with short term bank debt, the owner chooses the risky project only if

$$q(X - I - I(1-q)/q - I(1-G_N)(1-q)/q) \geq R - I$$

$$\text{i.e only if } qX > R + (1-q)I(1-G_N)$$

Hence there is a range of risky projects $R + (1-q)I(1-G_N) \geq qX > R$ which will be foregone by the owner in favour of the less remunerative safe project. Note also that the optimal fraction α of short term bank debt in the firm's debt structure is immediate: it is the highest fraction of bank debt that just gives the owner the incentive to take project B ex-post. ♦ ♦

Proof of Proposition 2.1:

We are done if we can show that the ex-ante utilities are increasing in θ and the utility with armslength financing increases at a faster rate. Differentiating the ex-ante utilities with respect to θ , we get

$$\frac{dU_A}{d\theta} = X(1-p_B) \left(\frac{\delta q}{\delta \beta_A^*} \frac{\delta \beta_A^*}{\delta \theta} + \frac{\delta q}{\delta \theta} \right) \quad (\text{A.1})$$

$$\frac{dU_{SB}}{d\theta} = (X - I_1 - L_0) \left(\frac{\delta q}{\delta \beta_{SB}^*} \frac{\delta \beta_{SB}^*}{\delta \theta} + \frac{\delta q}{\delta \theta} \right) \quad (\text{A.2})$$

Implicitly differentiating the first order condition and setting $\delta q/\delta \theta \delta \beta = 0$ we get

$$\frac{\delta \beta_A^*}{\delta \theta} > 0 \quad \frac{\delta \beta_{SB}^*}{\delta \theta} = 0 \quad (\text{A.3})$$

By direct comparison and knowing that $p_B X < I$, $dU_A/d\theta > dU_{SB}/d\theta$.

Proof of Proposition 2.3:

If $U_{AF} \geq U_{SBF}(1)$ then the firm will always switch to armslength credit at date 2, regardless of the actions of the bank at date 1. The bank then has no incentive to act 'loyal' : $\sigma_+ = 0$.

If $U_{SBF}(1) > U_{AF} > U_{SBF}(\bar{\pi}_F)$, then in the new equilibrium, it must be that $U_{SBF}(\bar{\pi}_{F+}) = U_{AF}$. This can only occur if the owner invests a higher effort at date 2. As this depends on his beliefs at date 2, the bank will have to act more opportunistic at date 1 in order to improve the posterior, conditional on acting loyal. Hence $\sigma_+ < \sigma$. Also note that the firm will have to play mixed strategies, alternating between switching to long term debt and staying with the bank, conditional on the bank acting 'loyal' at date 1.

If $U_{SBF}(\bar{\pi}_F) \geq U_{AF}$ then the old equilibrium is not disturbed.

Proof of Proposition 2.5

I derive a more general solution to the bargaining game than for the specific model in the text. I later specialize it. The proof extends and applies EMW (1983) and Hendricks and Porter (1988) to our contingent bid common value auction with asymmetrically informed bidders.

The bargaining takes place at date 1 in the model. The owner knows the value of the project which is the random variable V . V takes values in \mathbb{R} (set of real numbers) and has finite

expectation. The owner has to finance this project. There are two potential lenders, an informed inside lender (henceforth the insider) and an uninformed outside potential lender (outsider). The random variable Z is the private information of the insider about the value of the project. Both the insider and the outsider know the joint distribution of (V, Z) .

Each lender submits a sealed bid r , which is the fraction of the project he is willing to allow the owner to retain. The owner accepts the highest bid, so long as it is above his reservation bid r_* . If the bid r wins, the winner lends amount I at date 1 and in exchange gets $V(1-r)$ at date 2.

The insider's problem after observing $Z=z$ is to choose r to maximise

$$\text{Prob}(r \text{ wins}) \left(E[V | Z=z] (1-r) - I \right)$$

The insider's private information Z enters his decision problem only through $H = E[V | Z]$. We assume without loss of generality that the insider observes the real valued random variable H rather than Z . The insider after observing the private information can be characterised by his information induced 'type' h .

Our solution method requires a one to one mapping between the information induced type of the insider and his equilibrium bid. If H has a discrete distribution, we must 'smooth' out the types. We do this by allowing the insider to play mixed strategies. We define a mixed strategy for the informed inside lender by introducing a randomising device i.e a random variable U that is independent of (V, Z) and has an atomless distribution on $[0,1]$. The insider observes U and uses it whenever he needs to randomise his bids. A mixed strategy σ for the informed bidder is a function from $R \times [0,1] \rightarrow [0,1]$ and $\sigma(h,u)$ is the bid when $H=h$ and $U=u$. We assume that σ is non-decreasing in u for fixed values of h . Now instead of using h as the information induced type which takes discrete values, we derive the type t from the joint distribution of h and u which is continuous; Let $\{(H,U) < (h,u)\}$ denote the event $\{(H < h) \text{ or } (H=h \text{ and } U < u)\}$. Let $T(h,u)$ be the probability of that event and define $T = T(H,U)$. T is the insider's distributional type and is uniformly distributed on $[0,1]$. Also note that $H(t) = \inf\{h | \text{Prob}(H \leq h) > t\}$, $H = H(T)$ a.s. This implies that T carries all the information that H does but has the advantage of being a continuous

distribution.

To summarize, we started with information Z , found the conditional H , 'smoothed' it out with U and thus obtained T . The equilibrium strategy σ is now a function from the space of types $t \in [0,1]$ to the space of bids $[0,1]$ and is assumed to be non-decreasing in t .

The uninformed outside lender (outsider) gets no signal. His bidding strategy can be described by a distribution G over $[0,1]$ representing his random choice of bids.¹ Finally we define σ^{-1} as the generalized inverse of σ , i.e σ^{-1} is a function from the space of bids to the space of types.

Proposition I.A1: *The strategies (σ, G) are a Bayesian Nash equilibrium if the inside lender bids:*

$$\sigma(t) = \frac{E[H(T) | T \leq t] - I}{E[H(T) | T \leq t]} \quad \text{for } t \geq t_o$$

$$\sigma(t) = 0 \quad \text{for } t < t_o \tag{A.7}$$

where r_o is the reservation bid set by the owner (possibly zero)

$$t_o \text{ is sup } \{t: \{E[H(T) | T \leq t] - I\} / E[H(T) | T \leq t] = r_o\}$$

$$\text{and } t_l \text{ is inf } \{t: H(t) \geq I\}$$

the distribution of the uninformed bid is

¹ While we introduced mixed strategies for the informed for technical reasons, the mixed strategies for the outsider are a direct consequence of the assumption that the insider knows everything the outsider knows. If the outsider tried to play according to a pure and therefore predictable strategy, the insider will respond by bidding slightly higher if worthwhile and nothing if not. On average, the uninformed will lose, which cannot happen by individual rationality.

$$G(r) = 1 \quad \text{if } r \geq \frac{H - I}{H} = \bar{r}$$

$$G(r) = \frac{\int_0^{\sigma^{-1}(r)} h(s)ds}{\int_0^1 h(s)ds} \quad \text{for } \frac{H - I}{H} > r > r_o$$

$$G(r) = \frac{\int_0^{r_o} h(s)ds}{\int_0^1 h(s)ds} \quad \text{for } r_o > r > 0$$

where $H = E[H]$

Proof. The equilibrium strategy is such that the expected payoff to each lender conditional on his information set should be maximised given the strategy of the other lender. We show the following steps;

(1) The equilibrium bids have identical support. (2) The uninformed outsider makes zero profits in equilibrium. (3) Setting the outsider's profit function to zero gives us the optimal bid for the informed.(4) We then use the optimizing behaviour of the informed to derive the bidding strategy for the uninformed.

The support of G is $\{0, [r_o, \bar{r}]\}$ in equilibrium.² We want to show that this interval is also the range of σ . Assume the uninformed bidder adopts her equilibrium strategy. Consider now a non-zero bid r by the insider after learning $T=t$. If $r < r_o$, he will surely lose and get a payoff of zero. If $r > \bar{r}$, then a bid of precisely \bar{r} would be strictly preferred (either bid would win with certainty). Hence an optimal bid lies in the range of σ . Similiarly we can prove that an optimal bid lies in the support of G and that G has only optimal bids in its support.

We now explain why the uninformed outside potential lender makes zero expected profits in equilibrium, referring the reader to EMW(1983) for details. Consider the lowest non-zero bid

² We treat a bid of zero as no bid in what follows.

that the outsider makes with positive probability. If the outsider makes non-zero expected profits by making this bid, the informed insider could bid a little above this if worthwhile (given his information) and not at all if not i.e Such a strategy by the informed bidder would improve on any other possible strategy. Therefore the expected profits of the outsider must be zero at this bid. As the uninformed outside lender plays mixed strategies, it must be that she is indifferent between her bids. Hence in equilibrium, she makes zero expected profits.

The expected profits of the outsider conditional on winning with a bid r (and where t is the corresponding informed type such that $\sigma(t) = r$) is $E[H(T)(1-r)-I | T \leq t]$. Setting this equal to zero

$$r = \sigma(t) = \frac{E[H(T) | T \leq t] - I}{E[H(T) | T \leq t]} \quad (\text{A.12})$$

This expression holds when $t > t_o$, (where t_o is the type 'corresponding' to a bid of r_o as earlier defined). When $t_o \geq t > \underline{t}$, the optimal bid for the informed is r_o , as \underline{t} is the lowest information type at which the insider still makes profits by bidding r_o . Below \underline{t} , the insider will not bid (a zero bid) as he makes losses by bidding.

The strategy of the outsider is chosen so as to induce the insider to bid according to σ . The insider after seeing t maximizes $G(r)[H(t)(1-r) - I]$ w.r.t r where $r = \sigma(t)$
differentiating w.r.t r

$$\frac{dG(r)}{dr} [H(t)(1-r) - I] - G(r)H(t) + \lambda_1 - \lambda_2 = 0 \quad (\text{A.13})$$

where λ_1 is the Lagrangian multiplier for constraint $r \geq r_o$ and λ_2 is that for $r \leq \bar{r}$. Rearranging we get (when $\lambda_1 = \lambda_2 = 0$)

$$\frac{G'(r)}{G(r)} = \frac{H(t)dr}{H(t)(1-r) - I} \quad (\text{A.14})$$

$$\text{Also } r = \sigma(t) = \frac{\int_0^t H(s)ds - tI}{\int_0^t H(s)ds} \quad (\text{A.15})$$

$$dr = \sigma'(t)dt = \frac{I(tH(t) - \int_0^t H(s)ds)}{\left(\int_0^t H(s)ds\right)^2} dt \quad (\text{A.16})$$

Substituting in (A.14) from (A.15) and (A.16) we get

$$\frac{G'(r)}{G(r)} = \frac{H(t)dt}{\int_0^t H(s)ds} \quad (\text{A.17})$$

Integrating between t and 1 (for $t > t_o$) and applying the boundary condition that $G(\sigma(1)) = 1$, we get

$$G(\sigma(t)) = \frac{\int_0^t H(s)ds}{\int_0^1 H(s)ds} \quad (\text{A.18})$$

For any bid by the outsider corresponding to an informed type less than t_o , the outsider expects losses. Hence $G(r_o) = G(\sigma(t_o)) = G(0)$ i.e the outsider does not bid with positive probability. The value $G_N = G(r_o)$ is the probability that the outsider does not bid. Q.E.D

Now consider the model in the text. In the good states (probability q) the project is worth X and in the bad (probability $1-q$) it is worth $p_B X$.³ The insider knows the value of the project exactly i.e $H = X$ or $p_B X$, the outsider knows the distribution. Assume w.l.o.g that U is uniform on $[0,1]$.

$$t(h,u) = \text{prob } \{H < h, \text{ or } H = h \text{ and } U < u\}$$

$$t(h=p_B X, u) = u(1-q) \quad \text{and} \quad t(h=X, u) = (1-q) + uq$$

$$H(t) = \inf \{h \mid \text{Prob}(H \leq h) > t\}$$

$$H(t) = p_B X \text{ for } t \leq 1-q \quad \text{and} \quad H(t) = X \text{ for } t > 1-q$$

³ We assume that the value of the output from the project in the bad state is less than I .

$$\sigma(t) = \frac{(1-q)p_B X + uqX - I(1-q + uq)}{(1-q)p_B X + uqX} \quad \text{for } t > t_o \quad (\text{A.19})$$

$$G(\sigma(t)) = \frac{(1-q)p_B X + uqX}{(1-q)p_B X + qX} \quad \text{for } t > t_o \quad (\text{A.20})$$

$$G(\sigma(t)) = G(\sigma(t')) = \frac{(1-q)I(X - p_B X)}{(1-r_o)X - I) ((1-q)p_B X + qX)} \quad \text{for } t \leq t_o \quad (\text{A.21})$$

The first two equations follow from definitions and $G(\sigma(t_o))$ is obtained by obtaining t_o (the value of t at which the optimal bid of the insider is r_o) and substituting into $G(\sigma(t))$. $G(\sigma(t_o))$ is the probability that the outsider does not bid and henceforth will be referred to as G_N . $G_N = 1$ when

$$q\{X(1-r_o)-I\} - (1-q)\{I-p_B X (1-r_o)\} \leq 0$$

i.e the outsider cannot make profits in expectation even if he were the sole bidder (and hence not exposed to the winner's curse). The outsider thus chooses not to bid and the insider grabs all the rents upto r_o . An equivalent condition is $t_o = 1$.

Profit of the insider given t , the Good State and $G_N < 1$ is:

$$(X(1 - \sigma(t)) - I) G(\sigma(t)) = \frac{I(X - p_B X)(1-q)}{(1-q)p_B X + qX} \quad \text{for } t \geq t=q \quad (\text{A.22})$$

Profit of the Insider given t , the Good State and $G_N = 1$ is :

$$X(1 - r_o) - I \quad (\text{A.23})$$

Note that (A.22) and (A.23) are independant of u as should be true for mixed strategies. (A.23) stems from the fact that the insider extracts all the rents when the outsider does not bid.

The profit to the outsider is on average zero. If $G_N < 1$, the outsider bids with positive probability whenever the project is bad. As the insider does not bid in these states, the outsider makes losses whenever she does. The zero profit condition implies that these losses are equal in expectation to the profits she makes in the good state.

Loss to the outsider from continuing the project when bad

$$= (1-q)(I - p_b X(1 - E(r)))(1 - G_N) \quad (\text{A.24})$$

Specializing the model further, we set $p_b X = 0$ and $r_o = 0$ in (A.22) and (A.24) to get

Profit of the insider conditional on good state:

$$= (1-q)I/q \quad \text{when } G_N < 1$$

$$= X - I \quad \text{when } G_N = 1$$

$$\text{where } G_N = \frac{(1-q)I}{q(X - I)}$$

Loss to uninformed from bidding in bad state:

$$= (1-q)I(1-G_N)$$

Proof of Proposition 2.8

Assume fraction α of the total investment is financed through the bank and arms length debt is subordinate to bank debt. The owner has an ex-ante problem of choosing the fraction α and an ex-post problem of deciding the effort level β . The ex-post problem follows immediately, once we derive the expected date 2 face value demanded by the lenders. The expected face value demanded by bank follows from proposition (2.5)

$$\alpha I + \frac{(1 - q_{BSEN}^*)}{q_{BSEN}^*} \alpha I + \frac{(1 - q_{BSEN}^*)}{q_{BSEN}^*} (1 - G_{NBSEN}) \alpha I \quad (\text{A.26})$$

$$\text{where } q_{BSEN}^* = q(\beta_{BSEN}^*, \theta) ; G_{NBSEN} = \frac{(1 - q_{BSEN}^*) \alpha I}{q_{BSEN}^*(X - \alpha I)} ; 0 \leq \alpha \leq 1 \quad (\text{A.27})$$

Both the rents extracted and the control exerted⁴ by the bank have decreased because the amount rolled over has decreased. The control exerted by the bank enables the arms length lender to recover his money when the inefficient project is terminated at date 1. The face value demanded

⁴The seniority of short term debt is important here, for it allows the short term lenders at date 1 to bargain over the entire surplus they see in the good state, $(X - \alpha I)$, without having to account for the amount promised to long term debt.

by the arms length lender can then be derived from his IR condition;

$$(1 - \alpha)I = D_{02} q_{BSEN}^* + (1 - q_{BSEN}^*) G_{NBSEN}(1 - \alpha)I - h(D_{02}, \alpha, q_{BSEN}^*, X, I) \quad (\text{A.28})$$

h is the expected amount by which the senior bank debt can dispossess arms length debt ex-post. We assume h to be small.⁵ As the effect of h is to increase the face value demanded by arms length debt, relaxing the assumption only strengthens the arguments when we discuss the optimal seniority.

Solving for D_{02} from (A.28) and adding to (A.26), we get the total expected face value of debt at date 2, whence the ex-post problem follows. The ex-ante problem of the owner is to choose α to maximize his ex-ante utility, keeping in mind that everyone knows he will be solving the ex-post problem after signing the contract. The owner solves ex-ante

$$\max_{\alpha} U_{BSEN} = q_{BSEN}^*(X - I) - (1 - q_{BSEN}^*)I(1 - G_{NBSEN}) - c\beta_{BSEN}^* - m \cdot 1_{[\alpha > 0]} \quad (\text{A.29})$$

where β_{BSEN}^* solves the ex-post problem and (A.27) holds.

Under regularity conditions which ensure a unique solution, we substitute the F.O.C for the ex-post problem.

$$q_1 \left[X - I - \frac{(1 - q_{BSEN}^*)I}{q_{BSEN}^*} - \frac{(1 - q_{BSEN}^*)\alpha I}{q_{BSEN}^*} \left(1 - \frac{G_{NBSEN}}{\alpha} \right) \right] - c = 0 \text{ for } \beta = \beta_{BSEN}^* \quad (\text{A.30})$$

The program (A.27), (A.30) and (A.29) is in the Standard Principal Agent framework and can be solved explicitly for α^* and β_{BSEN}^* .

If arms length debt is senior, the value of the project that the short term lenders bid for at date 1

⁵If D_{12} is the face value that the short term lender who wins the bargaining game asks from the owner at date 1, then

$$h = (1 - q_{BSEN}^*) \sum_{D_{12}} 1_{[X - D_{12} < D_{02}]} (D_{02} - (X - D_{12})) \text{Prob}(D_{12})$$

h is a complicated term as it involves the distribution of the winning bid. If α is small or X large compared to I , the probability that $X - D_{12} < D_{02}$ is small, i.e if the amount of short term debt is small or the available surplus large, there is little chance that the short term lender will dispossess the long term lender. Alternatively, if α is large, then D_{02} is small. As h is the product of a fractional quantity with two probabilities it will generally be second order.

is $(X - D_{02})$. We substitute this for X in proposition 2.5. The control provided by short term debt is now given by

$$G_{NASEN} = \frac{(1 - q_{ASEN}^*)\alpha I}{q_{ASEN}^*(X - D_{02} - \alpha I)} \quad (\text{A.31})$$

where subscript 'ASEN' refers to the combination of maturities with armslength senior. Obviously G_{NASEN} in (A.31) exceeds G_{NBSEN} in (A.27). The structure of the owner's problem remains the same. However the increased control reduces the compensatory rents demanded by the outside bank (see (A.26)), improves investment efficiency (from (A.30)) as well as increases the ex-ante surplus (see (A.29)). The second effect is that $h = 0$ in (A.28), as banks cannot appropriate any of the payoffs promised to the arms length lender. Therefore the face value demanded by arms length debt D_{02} , is lower than when bank debt is senior. This again improves the investment of effort. For any value of α , $\beta_{ASEN}^* > \beta_{BSEN}^*$. For any value of β , as G_{NASEN} is higher than G_{NBSEN} , a revealed preference argument establishes the superiority of making arms length debt senior.

Chapter 3 **Conflict of Interest and the Separation of Commercial and Investment Banking**

ABSTRACT

The Glass-Steagall Act prohibits banks from underwriting corporate securities. It has been pilloried by economists for preventing banks from using the economies of scope they have in gathering information. What has been ignored is that banks may be very inefficient underwriters, despite any economies they may enjoy. A bank has risky loans outstanding to the firm, which gives it an incentive to certify the firm as being good. The greater the size or riskiness of the loan, the greater the conflict of interest and lower the amount of information it can convey to the market. The inability of the underwriting bank to convey information to the market imposes welfare costs on the firm. If firms had freedom to choose an underwriter, these costs would not matter as the firm would choose the most efficient one. However, banks have access to information about the firm through their lending operations and can monopolize the firm through pre-emptive information acquisition or pre-emptive contracts. The ensuing rents enables them to subsidize inefficient underwriting, thus entrenching these welfare costs. A policy of prohibiting banks from underwriting is one way to eliminate these welfare costs. The essay goes on to examine other ways of resolving the problem.

Introduction

As competition in the U.S banking system has increased, pleas both from banks and academics for repealing the Glass-Steagall act have become louder. They suggest that the act "in hindsight appears¹ as a policy aberration, an oddity triggered by fears that careful historical analysis shows were based largely on myths."² Yet, despite the criticism for the basis of the act, could it serve a useful purpose? Are there other valid reasons, not clearly articulated so far, for separating commercial lending from investment banking? More specifically, could the existence of conflict of interest stemming from lending affect the efficiency of the investment banking function? These are the questions this paper seeks to answer.

Banks in the United States are prohibited from under-writing corporate securities under the Glass-Steagall act, which consists of four provisions of the Banking act of 1933. A major concern motivating the framers of the act was the need to resolve the 'conflict of interest' problem inherent when a bank is allowed to serve both as a commercial as well as an investment bank (see Kelly (1985) for a survey). For example in 1971, the President's Commission on Financial Structure and Regulation stated that the decision to separate commercial and investment banking " was prompted by the *conflicts of interests that developed when the same organization handles two functions.*" It asserted "The possibility of conflict of interest would still exist if banks were again permitted to underwrite ... the Commission strongly recommends the continued prohibition against bank underwriting of private securities issues."

The specific conflicts of interest cited were (see Benston (1990)) (i) Banks were investing their own assets in securities with consequent risk to commercial and savings deposits.(ii) Unsound loans were made to shore up the price of securities or the financial position of companies in which a bank had invested its own assets.(iii) A commercial bank's financial interest in the ownership, price, or distribution of securities tempted bank officials to press their banking customers into

¹ In comparison to deposit insurance and securities regulation.

² Walter (1985)

investing in them. The underlying theme in these arguments is a concern about the incentives created by the conflicts on the stability of, and confidence in, the banking system.

In recent years, however, economists have dismissed the above arguments. First, banks do not need to invest in securities in order to hold risky assets, as the present crisis in the banking system demonstrates. In fact prohibiting banks from investing in risky securities may force them to satisfy a preference for high returns by investing in risky real assets thus distorting decisions in the economy even more. The problem here is not conflict of interest but moral hazard. Second, whether to 'stabilize' the issue price or not is a business decision that an investment bank faces whenever it underwrites a new issue. Also, banks bail out distressed firms for profitable well-understood reasons. It is not clear how any problem associated with either activity is diminished by the separation of activities. Finally, institutional investors are informed about the commercial bank's financial interest and will appropriately discount for it. These investors cannot lose.³ Economists (Walter (1985), Benston(1990)) therefore suggest that the act was largely a political response to public hysteria surrounding the Great Crash of 1929 and the subsequent bank failures.

Yet even if speculative excesses are contained, does efficiency dictate repealing the act? This paper provides an analysis of the welfare effects of, what we believe is, the important conflict of interest; *the conflict between an investment bank's role as an impartial certifier of firms with the bank's role as a lender to those firms*. We show the existence of a conflict of interest does not hurt the investor but the issuing firms, by compromising their ability to be certified to the market. Further, the firm may not be able to freely choose an impartial certifier if it is already borrowing from a bank. By preventing an informed but compromised lender from serving as an underwriter, the act may actually improve the efficiency of the investment banking function. Repealing the Glass-Steagall act may not only reduce efficiency but also reduce competition in the financial system. However, if the act is repealed, we show that in the interests of efficiency, it may be sensible to go further and remove the prohibition on the bank ownership of equity.

³ Empirical work by Simon(1989) confirms that investors on the NYSE, before the Securities act of 1933, did not make abnormal returns, which one would expect if investors were being defrauded.

The problem we examine in this paper is one faced by a bank which has risky loans outstanding to a firm. If additional bank loans are costly, the firm will fund new investment via the stock market. When a firm uses its bank to certify it to the market (the primary function of the underwriter), the bank has an incentive to certify the firm as being good, if only to get some of its loan paid back or to avoid being forced to fund the firm's investment. This conflict of interest is pervasive in economies where banks perform both roles.⁴ For example:

"It is the Hausbank (in Germany) which traditionally leads the issuing consortium of banks for an equity issue. Some claim this is a conflict of interest because funds raised through such issues are often used to repay the loans provided by the same Hausbanks." Euromoney (Nov 1986 p104).

Also "J.P Morgan will shortly underwrite a \$56 million equity issue by Amsco International...the first underwriting of a common stock by a commercial bank since the Glass-Steagall act...The Amsco prospectus innocently relates that \$10.4 million of the proceeds will be used to reduce debt to Morgan Guaranty Trust and Morgan Bank of Delaware." The Economist (2nd March 1991 p70).

We show that this conflict inhibits the ability of the housebank (a term we use interchangeably with 'bank') to signal the true value of the firm to the market, even if the market is regulated and investors have the possibility of redress. The greater the conflict of interest, the more noisy the information the housebank conveys to the market. Even though investors are not fooled in equilibrium, underwriting is inefficient because the bank is not credible. This has real effects on the mode of financing and hence on investment.

The immediate question is why this inefficiency in transmitting information should matter. The bank has lower costs of acquiring information than an independent investment bank because the bank has been intimately associated with the firm during the earlier lending process. These economies of scope may be enough to compensate for its inefficiency in transmitting information.

⁴ Even in the U.S., when banks were allowed to underwrite securities, bank debt was retired at an extra-ordinary rate via stock issues. Curry Lauchlin (1934) documents in a study of 729 large corporations that the volume of bank loans to them fell from \$929 million in 1920 to \$582 million in 1928. He suggests 'the usual process through which bank loans have been reduced is through excess earnings over dividends or through new stock issues.' We do not have any evidence to document whether this reduction was driven by the banks or by easy availability of funds from the market. A similar effect for risky firms would be supportive of our hypothesis.

Further, independent investment banks may get a noisier signal about firm quality, even after expending higher costs in the due diligence³ process. If allowed free-choice, the trade-off for a firm between being underwritten by an investment bank and staying with the housebank is precisely one between noisy information acquisition by the former and noisy transmission by the latter. The costs of information acquisition could tip the choice in favor of the housebank. At any rate, it can be argued that giving the firm the ability to choose, by doing away with the act, must be weakly Pareto-improving.

The above argument does not recognize the fact that firms may not be free to make the choice between underwriters. A bank which has lent to the firm is not the same as any independent investment bank. First, the lending process gives the bank *free access* to information, which enables it to choose the timing and the amount of its information acquisition. Underwriting has the characteristics of a natural monopoly, and an incumbent who can make pre-emptive investments can monopolize the market. We show this holds under a variety of assumptions. Second, as a result of contact during the lending process the bank and the firm can *contract* with each other, either explicitly or, implicitly via a relationship. We show that the bank and the firm may rationally contract to exclude outside independent underwriters. Thus the firm may voluntarily consent to a welfare reducing tie-in, which entrenches the bank's inefficiency in underwriting. Others (for example Dixit(1980), Aghion and Bolton(1987)), have noted the effects of sunk costs and contracts on industrial structure, but our paper explores the efficiency of intermediation in the presence of these costs.

Earlier work (Sharpe(1990) and Rajan(1990)) appeal to asymmetric information between

³ Once a preliminary agreement has been signed between a firm and an underwriter, it has to make a detailed and costly investigation of the firm and its plans. This investigation is required under the Securities Act of 1933 and is called 'due diligence'.

an inside financier and an outside financier to explain the monopolistic character of banking relationships. Our explanation is complimentary and may indeed better characterize underwriting for large firms where substantial costs have to be sunk in the process of investigating the firm. The underlying theme in all these explanations is that the very information and access that give banks economies of scope also create lock-in and inefficiency.

Three implications follow if investment and commercial banking are not separated: First, firms may prefer bank loans to being inefficiently financed in the public markets. This inhibits the growth of public markets. Also, if the bank is a price-setter in the loan market, its ability to monopolize the market for underwriting is enhanced. Second, investment banks would tend to be confined to underwriting issues for independent firms or those with quality high enough to not require investigation. They may be forced to integrate backwards into lending so as to break into the 'middle' market, thus entrenching the economy in a bad equilibrium. Third, because of the above market fore-closure and resulting vertical integration or exit of independent investment banks (see Whinston(1989)), banks would monopolize both lending and underwriting for all firms, which would distort investment decisions in the economy.

Note, however, that the banks have no interest in being inefficient underwriters. Instead of imposing costly *exogenous* legal penalties if the banks mislead the market, which may be counter-productive, banks should be given the ability to impose *endogenous* costs and thus signal the value of the firm accurately. One way for the underwriter to do so is to buy junior securities like equity in the firm when making a public offering. Unlike earlier models (Heinkel (1982), Brennan and Kraus(1987), Constantinides and Grundy (1989)), the signaller is not the equity holder. We show that under plausible conditions, small equity purchases by the underwriter can perfectly signal the value of the firm. The amount of equity to be purchased increases in the size

of previous bank holdings and varies monotonically in the quality of the firm. If legislators repeal the act on the currently popular grounds of giving banks profitable franchises, in the interest of efficient underwriting they could de-regulate further and allow banks to hold small amounts of equity. The effects on stability and incentives of banks (if at all) would be second order, while the effect on underwriting is first order.

The paper begins by laying out the structure of the model in section 1. In section 2 we make the basic point, that because of conflicts of interest, a bank may be an inefficient certifier for a firm, and this inefficiency becomes entrenched because of the bank's ability to monopolize the firm. In section 3, we show that the point is robust to the introduction of a regulatory or legal system. Only coarse or partition equilibria exist and the extent of information transmitted decreases in the conflict of interest. Our coarse signaling model is different from previous models in that the shape of the signaler's preferences are endogenous. Section 4 shows the existence of a non-dissipative signaling equilibrium if the bank is allowed to purchase and hold stock. Section 5 concludes with evidence and suggestions for further research.

Section 1: The Model

Consider a risk neutral world where a bank has extended a line of credit to a firm. The line of credit has been contracted with the following terms: The firm can borrow up to a (large) amount. In return, it has to repay R per dollar borrowed, at a specified future date. The risk-free interest rate is 0, and $R \geq 1$. The amount outstanding against this line of credit at date 0 is D .

We assume the firm is a start-up and owner managed. The firm has invested in R&D and exhausted all its money and assets in the process. However, it now has a commercially viable idea. This gives the firm an opportunity to invest an additional indivisible amount $I(\theta)$ which will

generate, at date 1, a random revenue Y where⁶ $y \in \Psi = \{y^0, y^1, \dots, y^k\}$. Ψ is discretely distributed with $P(Y \in A) = \sum_A f(y, \theta)$. The quality θ , $\theta \in \Theta = [\underline{\theta}, \bar{\theta}]$ orders the distribution of Ψ in a first order stochastic sense. Every element in the support of y occurs with positive probability for all θ and f has the monotone likelihood property. The distribution of θ is $G(\theta)$.

Let $V(\theta) = \sum_y y f(y, \theta)$ be the expected value of the firm, conditional on the investment being made. The technological opportunities are such that

$$I'(\theta) \geq 0 \text{ (i)} \quad V'(\theta) - I'(\theta) \geq 0 \text{ (ii)} \quad V^E(\theta, D) = \sum_y \max[y - D, 0] f(y, \theta) \geq I(\theta) \text{ (iii)}$$

i.e Firms with higher quality have investment opportunities which require greater investment. However, the incremental investment has positive net present value. Finally, the project has value for the owners despite the debt overhang. Let $V^D(\theta, D) = \sum_y \max[y, D] f(y, \theta)$ be the expected value of the bank's debt if the firm is of quality θ . Then

Assumption 1:

$$\alpha I(\theta) + D \geq \alpha I(\theta) + V^D(\theta, D) \geq V^D(\theta, \alpha R I(\theta) + D) \geq \alpha I(\theta) \quad \text{where } \alpha \in [0, 1]$$

The first inequality indicates that bank debt is risky even after the new investment, the second inequality indicates that the interest rate the bank has committed to is too low to make new lending viable if the project will anyway be financed. The third inequality suggests that the bank will lend if such lending is necessary for the project to be taken up. Thus the bank is reluctant to lend to the new project if it can be financed elsewhere.

Firm management also does not want to take on bank debt for the new project. Too much bank debt can impose dead-weight costs as in Diamond (1990) where excessive short term bank debt can result in inefficient liquidation and Rajan (1990) where bank debt distorts investment incentives. These papers make the point that there is an optimal level of bank debt beyond which

⁶ We use the convention that random variables are in bold capitals while their realizations are in small letters.

managerial discretion may be inefficiently constrained. For simplicity, we assume that any additional bank debt contracted for the new project imposes a non-pecuniary cost⁷ on firm management of r_b for every dollar borrowed. This is in addition to the contracted rate R . If this cost is high enough, neither the bank nor the firm want to lend or borrow more, they have to fund the project elsewhere.

The only other source of funds in this economy is the stock market (we could also analyze the public issue of any other claim). We now describe the mechanics of a public stock issue in this model.

The Issue Process

We model the issue process as two sets of subgames: the choice subgame where the underwriter is selected, followed by the signaling subgames where the chosen underwriter signals to the market, investment is undertaken and firm value realized. The basic issues are revealed by this simple model after which in Section 3 we add a final set of subgames where the investor can seek redress from the courts.

At date 0, the firm chooses an intermediary to underwrite and distribute the issue. In addition to distribution, the intermediary certifies firm quality to the investor. The firm cannot vouch for itself because lying will typically be discovered when the firm, protected by limited liability, has little ability to pay. An intermediary is needed to determine firm quality and convey this to the investor. It then backs its certification with the ability to indemnify those who relied on the certification, if it proves incorrect. We first describe the issue process. We allow two potential underwriters; the housebank and an independent investment bank.

Usually, the terms of a stock issue are the outcome of negotiation between the underwriter

⁷ The assumption that these costs are non-pecuniary is merely to simplify the exposition.

and the firm, based on information the underwriter provides about the market. Instead of modelling this negotiation directly, which would make the model intractable, we constrain the preferences of the market in plausible ways so as to incorporate the influence of the firm owners on the terms of the offer. We believe this assumption about limited firm power at the time of the issue mirrors the real world, where firms are in general captive to the underwriter's description of the market.

Housebank's Preferences

In order to analyze the housebank's incentives, we first describe what happens to the money raised in the stock issue. First, amount $I(\theta)$ is required for the indivisible investment. If the amount raised, I , is greater than $I(\theta)$, the excess is used to repay the outstanding line of credit. Repayment is only for notational convenience. Even if the money stayed in the firm, the housebank captures this amount by virtue of its seniority.⁸ Of course, if the amount issued is less than the amount required for investment, the housebank makes up the difference. Thus the line of credit from the housebank is a residual source or use of funds. Myers (1989) describes why it is difficult to distinguish between cash flows and investment. We therefore assume that the line of credit is not contractible.

The higher the amount issued, the more the housebank's risky outstanding loan is paid back at face value (or the less the investment it has to finance) and the higher the capital gain to the bank (or lower the capital loss). By issuing amount I of stock, the bank gets

⁸ In general, the short maturity of bank loans and the priority of debt combine to give the bank the most senior claim on the firm's free cash flow.

$$\begin{aligned}
 (I - I(\theta)) + V^D[\theta, D - (I - I(\theta))] &\geq V^D(\theta, D) && \text{when } I \geq I(\theta) \\
 -(I(\theta) - I) + V^D[\theta, D + R(I(\theta) - I)] &\leq V^D(\theta, D) && \text{when } I \leq I(\theta)
 \end{aligned} \tag{3.1}$$

The inequalities follow from Assumption 1. The terms on the left side of the first inequality represent the bank's position if the amount raised is higher than the required investment. Of this, the first term is the repayment to the bank after the issue. The second term is the present value of outstanding debt while the term on the right hand side is the value of debt if the issue size just meets investment requirements. The second inequality is the bank's position if the amount raised is lower than the required investment. It follows from (3.1) that as the bank is senior to the issued equity⁹, it has an incentive to issue the largest amount possible regardless of the issue price. Finally, we simplify (3.1) by assuming $R = 1$, i.e the line of credit has been contracted at the risk-free rate. The bank gets

$$I - I(\theta) + V^D[\theta, D - (I - I(\theta))] \tag{3.2}$$

regardless of the level of I . This is an innocuous assumption and saves on tedious notation later.

We model the certification function of the underwriter by restricting its actions to announcing the quality of the firm.¹⁰ It declares firm quality to be $\hat{\theta}$, where $\hat{\theta} \in \Theta$. This information is transmitted to the investor through the prospectus, road-shows and private communication. We assume that the underwriter knows θ exactly after the 'due diligence' analysis and hence any difference between true quality θ and announced quality $\hat{\theta}$ is intentional.

⁹ Of course in a multi-period model, the price at which equity is issued matters as dividends paid before the firm is liquidated are senior to bank principal.

¹⁰ The distribution activity is assumed to be performed equally well by the bank and the investment bank and is left unmodelled.

Investment Bank's Preferences

The investment bank suffers no conflict of interest. If we preclude side-payments¹¹, it will be indifferent to the quality it announces. Infinitesimal reputational costs will break this indifference and we assume then that it announces θ exactly.

The Market Investor's Preferences

The market consists of a number of symmetric institutional equity investors who are *competitive*. Apart from the assumption that the market is competitive, we do not distinguish between the individual components of the market and hence refer to it in the aggregate as a representative *investor*. The investor initially knows only the distribution of firm types $G(\theta)$.

We assume that the market investor determines the size of the issue I after she updates her prior about the quality of the firm using signal $\hat{\theta}$. As the market investor is competitive, the price is determined given the size of the issue and her beliefs about firm quality. The assumption, that the size of the issue is endogenously determined by the market, is consistent with the stylized facts that the bank consults the main clients and institutional investors in its distribution network about the amount they are willing to invest. However, as the price is also endogenous it would appear that the size of the issue is indeterminate- till such time as old equity is completely diluted, there is always a price that clears the market.

Yet in practice, outside equity investors, though eager for stock in new firms, have a preference over the amount they wish to invest in that firm. This could be for diversification or consumption smoothing reasons. Much recent work has suggested a different reason; the value that can be given to outside claim-holders is limited by managerial perk consumption (Jensen and Meckling(1976)), negative NPV investments (Jensen (1986)), managerial surplus extraction (Myers

¹¹ Nothing in this model requires criminal intent. We therefore assume that agents in this model, though rational, are not criminal.

(1990)), managerial reputation and credibility (Diamond (1990)) and the inability of management to commit to pay outsiders (Hart and Moore(1989)). Thus management possesses some non-transferable control rents or managerial surplus. It is natural to assume that the transferable value of the firm increases in firm quality.

We appeal to any one of the above views to postulate that the market investor has a preference function over the amount she invests in the firm. It may appear less innocuous to go from this to assuming that the investor completely determines the issue size. But the issue size can be viewed as the outcome of a bargaining game between the underwriter and the investor. As we do not constrain the signals the underwriter can send and there is no discounting, there is no loss of generality in this.

All that we require for the analysis is that the funds the market investor optimally wishes to invest increase in firm quality.¹² To simplify the notational burden, however, we assume that the investor responds with the exactly the amount required for investment by a firm with quality equal to the average of the investor's posterior beliefs.

Assumption 2: Investor's Preferences: (i) The market investor invests $I(\theta)$ in the equity of the firm of quality θ . (ii) If her beliefs about the firm are given by the distribution $H(\theta)$, she invests $I(\theta^{AVG})$ where $\theta^{AVG} = \int \theta h(\theta) d\theta$.

We now analyze the signaling subgame at an informal level, postponing the formalization till section 3. We then analyze the choice subgame. Only pure strategy equilibria are considered. The sequence of events described so far are in Table 2.

¹² We could incorporate the market's preference in the form of a VNM Utility function. All that is essential is that the market prefer a higher investment response for higher θ . An interpretation which does not rely on agency problems is Kumar(1988) where investors smooth a random income stream by investing in the market. Yet another possibility is that the bank's distribution network are old shareholders themselves who seek to do what is in the best interest of the firm.

Section 2: The Basic Problem

The Public Issue

The investment bank can convey information perfectly. On the other hand, if the bank's claim D is risky, the bank cannot communicate any information that changes the investor's average prior beliefs. The intuition is straightforward. Suppose an equilibrium exists where the investor's average beliefs are changed by at least one signal sent in equilibrium. Call the signal which generates the highest average equilibrium belief, signal A¹³. From (3.2), we see that the bank always wants to attract a higher amount from the investor, and by assumption 2, signal A generates the highest amount. The housebank then sends signal A regardless of the quality of the firm. By Bayes rule, the investor's prior beliefs cannot change: a contradiction. Note that this result holds because there are no costs to lying and risky debt gives the bank an incentive to lie.

Let $\Delta I(\theta', \theta) = I(\theta') - I(\theta)$. It follows that if the bank underwrites a firm of quality θ , its gain or loss from its lending operations is

$\Delta I(\theta^{AVG}, \theta) + V^D[\theta, D - \Delta I(\theta^{AVG}, \theta)] - V^D(\theta, D)$ where $\theta^{AVG} = \int_0^1 \theta g(\theta) d\theta$. The bank expects a gain from lending or $\Delta B = \int_0^1 \{\Delta I(\theta^{AVG}, \theta) + V^D[\theta, D - \Delta I(\theta^{AVG}, \theta)] - V^D(\theta, D)\} g(\theta) d\theta$ at the time of the proposal. Assume without loss of generality that ΔB is positive. The firm expects a dead-weight loss from excessive bank debt of $\Delta w = \int_{\theta^{AVG}}^1 r_B \Delta I(\theta^{AVG}, \theta) g(\theta) d\theta$. Note that Δw is the net welfare loss from bank underwriting, all else being merely transfers.

As the rational competitive investor makes zero profits in any equilibrium, ex-ante, the

¹³ We can break ties by assuming that if two signals generate the same funding response, the housebank weakly prefers a higher nominal signal.

firm bears the cost $\Delta B + \Delta w$ if it chooses the housebank. The firm bears no cost if it chooses the independent investment bank. We now step back to analyze the firm's choice of underwriter.

Choosing the Underwriter

The process of choosing the underwriter begins with the firm asking its housebank and an independent investment bank to submit proposals. Information acquisition in this model is costly. Before submitting a proposal with some ex-ante chance of winning, the intermediary *must* conduct a preliminary investigation.¹⁴

"The preliminary investigation includes analysis of the company's financial statement, its position in industry, the types of products and services it offers...Investment bankers ... visit the plants to verify balance sheet values and interview middle management; their attorneys look into a company's patent position and the size of the market. In pursuing this evaluative role, the investment banker will employ outside firms that are specialists in technology, engineering, accounting, patent law, and economics." (Perez (1984) p43)

We assume that the cost of this investigation is C_p . Of course, the intermediary may not investigate and then submit a proposal which it knows will not win.

After the firm chooses its underwriter on the basis of the proposals, it negotiates a preliminary agreement with it. But all elements of this agreement are not binding. The investment bank (though not the housebank) has not had an opportunity to perform a detailed 'inside' analysis of the firm when it is asked to specify the terms on which it will be willing to underwrite. The price at which the offering is made as well as the size of the issue depend on the outcome of the due-diligence analysis and the conditions in the market at the time of the offering.¹⁵

In this situation, what can the firm and the potential underwriter agree on? The underwriter

¹⁴ A plausible reason is that there is an un-modelled 'bad' firm which is discovered during the preliminary investigation and weeded out. Underwriting this firm would be very costly for the intermediary, because of potential legal penalties (see later).

¹⁵ "Price will be determined by the market at the time of the offering. But whether there is to be an offering depends on the content of the registration statement." - p63 Auerbach and Hayes (1986). Also, in the preliminary agreement before due diligence "the underwriter usually includes a 'market out' clause, which states that the proposal is based on existing market conditions and is therefore subject to change." -p46 Perez (1984).

will incur costs of due diligence and the costs of potential litigation if the underwriter errs (described later). The firm will suffer the costs of any underpricing. None of this is generally observable or verifiable. It is difficult to write contracts contingent on these costs. We therefore assume that the firm asks investment banks and housebank to simultaneously submit a binding proposal specifying only a fixed fee S , which is amortized over the actual size of the issue as an underwriting spread.

After receiving the proposals, the firm chooses the proposal with the lowest all-in cost only if it is below the firm's reservation option S^R of borrowing from the bank. The chosen intermediary then performs a further investigation or 'due diligence' analysis of the firm.

"This process entails leaving no question unasked that experienced, sophisticated persons should ask, and leaving no answer intellectually unchallenged. Every answer must be tested to ascertain whether it, in turn raises a pertinent question...At a minimum these [questions] cover all matters bearing on the issuer's organization and standing: its past financial affairs and predictions as to future ones;; its operations...contracts,insurance...contingent liabilities, and taxes." (Auerbach and Hayes (1986) p63, p65).

A major portion of this analysis consists of meeting the requirements imposed by state and federal agencies regulating the issue. We therefore assume that the intermediary has to invest a cumulative non-discretionary cost of $C_P + C_D$ before taking the firm to the market. We assume $S^R \geq C_P + C_D$, to make issuing meaningful.

The informational assumptions are that neither the firm nor the potential underwriters know firm quality at the time the underwriter is chosen but firm quality is uncovered by the due diligence process. The market only holds the common prior $G(\theta)$ which it updates based on the underwriter's announcement.

In the analysis that follows, a crucial element will be that the housebank has limited access to private information about the firm, obtained through its position as principal lender to the firm. It can therefore acquire a substantial portion of the information required for the due-

diligence analysis even *before* the firm chooses it to underwrite. Outside independent investment banks, however, can acquire the sensitive inside information only *after* being selected to underwrite. Further, we assume for simplicity that there is only one investment bank, which may emerge from several contenders. How this investment bank emerges is in itself an interesting problem (but beyond the scope of this paper) which Gilbert and Harris (1984) term the 'nomination' problem.

The choice subgame starts at date -2 when the housebank decides the pre-emptive amount C^{PRE} it invests in information gathering before the firm asks for proposals. At present, we assume that the housebank can invest almost (but not quite) $C_p + C_D$ so that it cannot know firm quality at the time of bidding. Once the firm asks for proposals, the investment bank must investigate at cost C_p at date -1 in order to make a proposal. All investments are common knowledge. Proposals are submitted and evaluated at date 0. The sequence of events is given in Table 2.

Three situations could arise at date 0, (i) both the bank and investment bank have conducted the preliminary investigation (ii) only the bank investigated (iii) only the investment bank investigated.

Consider, first, an equilibrium where both the bank and the investment bank have conducted the preliminary investigation before bidding. Let the investment bank propose a fee of S^{IB} . It must be that $C_D \leq S^{IB} \leq S^R$. The first inequality is individual rationality (IR) for the investment bank while the second inequality represents rationality for the firm. The housebank can win only if it compensates the firm for its losses in addition to matching the investment bank's bid i.e only if it bids $S^{IB} - \Delta B - \Delta w$. At this point, the housebank has already sunk C^{PRE} and only has to invest $C_p + C_D - C^{PRE}$ if it wins the bidding game. Also, it gains ΔB from expected changes in lending. Therefore the bank will bear a net cost of $C_p + C_D - C^{PRE} - \Delta B$ conditional on winning. The

housebank will always win the bidding game if its lowest rational bid is lower than the lowest bid the investment bank can make, C_D . It follows that this condition is $C_D - \Delta B - \Delta w \geq C_p + C_D - C^{PRE} - \Delta B$, or

$$C^{PRE} \geq C_p + \Delta w \quad (3.3)$$

That is, by making a pre-emptive investment C^{PRE} in information of at least $C_p + \Delta w$ at date -2, the housebank can commit to bidding so aggressively at date 0, so as to always win. Stepping back to date -1, the investment bank faced with the prospect of never winning at date 0, will not conduct the costly preliminary investigation. Our conjectured equilibrium breaks down if (3.3) holds. But stepping back to date -2, the housebank will invest C^{PRE} to satisfy (3.3) if the fee it extracts by monopolizing the firm, $S^R - \Delta B - \Delta w$, is enough to compensate it for its costs $C_p + C_D - \Delta B$ i.e if $S^R - C_p - C_D \geq \Delta w$. Finally note that (3.3) is satisfied only if the bank is able to make a sufficiently high investment i.e if $C_D \geq \Delta w$. We state

Proposition 3.1: *The housebank can lock the firm in and extract a monopoly fee of $S^R - \Delta B - \Delta w$ if (i) $C_D \geq \Delta w$ and (ii) $S^R - C_p - C_D \geq \Delta w$. If (ii) does not hold, the investment bank monopolizes the firm and extracts a fee of S^R . If (ii) holds but (i) does not, there is no equilibrium in pure strategies.*

Keeping the welfare costs of bank underwriting and monopoly profits constant, the more that has to be invested in learning about the firm, the greater the bank's advantage of prior access and greater the bank's ability to monopolize the firm. Naturally, the lower the bank's inefficiency in underwriting the higher the bank's ability to monopolize.

More interesting, remember that the firm's reservation option of borrowing, which determines S^R is a result of an earlier contract with the bank. If the bank is a price-setter in the loan market, *its ability to set a high price for loans gives it credible incentives to monopolize the market for underwriting*. Both markets are substitutes, of course, but the monopolist can now

finance the firm through whichever market is privately optimal ex-post. Undoubtedly, it will pay for this ex-ante when it begins a relationship with the firm, but the firm's investment incentives will be distorted.

In summary, there are two important potential effects of breaking the walls between commercial and investment banking: First, the bank's ability to monopolize the market for underwriting entrenches the bank's inefficiencies. Second, if the market for loans is also monopolistic (as is arguably true for small firms), the bank can choose a mode of financing for the firm which may not be socially optimal. We now argue that this result is robust to changing many of the assumptions.

Allowing Firm to pay for Information Acquisition

The firm has an incentive to induce competition. Could the firm encourage the investment bank to invest the costs of the preliminary investigation by paying for proposals? This is a common practice for little known firms.¹⁶ In our model, this has no effect. If (3.3) and (ii) hold, the investment bank knows it has no chance of winning at date 0. As the costs of investigation are not contractible, it merely submits a meaningless bid greater than S^R , without investigating, and collects a fee from the firm. The firm can provide incentives only by contracting to pay a fee conditional on the investment bank winning, because the investment bank will not submit a serious bid without investigation. But here, either the probability of winning is zero or the investment bank is a monopolist, hence contingent fees are useless. We see a situation shortly where contingent fees work.

Ex-Post Renegotiation

Allowing the bank and the investment bank to renegotiate after the bidding at date 0 has no effect here. The reason is simple. In order for the bank to have any bargaining power at date 0, it has to have invested at least $C_p + \Delta w$, else the investment bank will undercut its bid. But because investment in information is non-transferable, the bank is now more efficient than the

¹⁶ "These proposals are frequently done for a fee of \$25,000 to \$50,000 and constitute a blue-print of suggested financing for the firm." (Perez 1984)

investment bank. Excessive irreversible investment overcomes any prior inefficiency and renegotiation has no bite.

Uncertainty about relative efficiency

So far we have assumed that the bank and investment bank are equally efficient in collecting information. Yet the investment bank may have higher costs or get a noisier signal about firm quality during its investigation. Alternatively, the investment bank may be more efficient because of specialization. We therefore assume that the investment bank's costs of due diligence are now c_D and are distributed uniformly between 0 and $2(C_D + \Delta w)$.¹⁷ This means that the investment bank is as efficient overall as the bank in expected value terms. Further, we assume that it learns this cost (which becomes common knowledge) only after it performs the preliminary investigation.

The crucial difference in this case is as follows: Pre-emptive investment is limited above by $C_p + C_D$. When $c_D < \Delta w$, the investment bank can commit to undercut the bank, whatever the level of pre-emptive investment. The investment bank has some chance of winning at date 0. This provides it enough incentive to investigate at date -1 if the expected value of the monopoly profits it makes on winning are enough to compensate it for the cost of investigation i.e if $\frac{1}{2(C_D + \Delta w)} \int_0^{\Delta w} (S^R - c_D) dc_D > C_p$. Note that even if this condition does not hold, the firm has an incentive to contract to pay the investment bank a fee conditional on it winning, in order to get it to investigate.¹⁸

Once the bank knows it cannot prevent the investment bank from conducting the preliminary investigation, it is optimal for the bank to not incur excessive pre-emptive investigation costs i.e $C^{PRE} = C_p$. The reason is simple. Pre-emptive investment is useful only in deterring the investment bank from conducting the preliminary investigation. If the investment bank is not deterred and wins, any pre-emptive investment is a dead-weight loss to the bank.

¹⁷ We choose this distribution only for notational convenience.

¹⁸ The size of the contingent fee is limited by the firm's assets, while the expected value of the fee is limited by the reservation price.

Bertrand competition implies that the bank charges the firm $c_D - \Delta B - \Delta w$ when it wins and the investment bank charges $C_D + \Delta w$ when it wins. The investment bank wins whenever $c_D \leq C_D + \Delta w$, implying that the firm stays with the bank with probability 1/2. Measuring firm surplus with respect to its reservation value, it is easily verified that

$$\begin{aligned} \text{Firm Surplus} &= \frac{S^R}{4C}^2 - \frac{C}{4} & \text{Bank Surplus} &= \frac{(S^R - C)^2}{4C} + \frac{(S^R - C)(2C - S^R)}{2C} - C_p \\ \text{Investment Bank Surplus} &= \frac{C}{4} - C_p & \text{where } C &= C_D + \Delta w \end{aligned}$$

It appears then that once the investment bank has enough incentive to investigate, efficiency is restored. Paradoxically, bank inefficiency gives the investment bank an opportunity to win and thus have the incentive to overcome the initial sunk cost hurdle and re-establish ex-post efficiency. Note that this result requires that there be a significant probability that the investment bank is so much more efficient than the bank that pre-emption is ineffective. With smaller differences in efficiency, our earlier result holds.

Unfortunately the restoration of efficiency is not robust. If the bank and firm can contract either explicitly or implicitly prior to the bidding, the firm will accept a contract which locks it in to the bank even when the bank is inefficient.

Contracts

Let the bank offer a contract to underwrite at a fixed fee of $S - \Delta B - \Delta w$ at date -2. If the firm goes to the investment bank instead, it has to pay the bank liquidated damages of S_L . This contract may be explicit¹⁹ or implicit, via a prior relationship and specific investment.

At date 0, the firm gets a surplus of $(S^R - S)$ if it stays with the bank. The investment bank has to offer the bank the same surplus to get it to switch, which means it has to bid lower than $S - S_L$. This is rational for the investment bank only if $S - S_L \geq c_D$. Then the probability that the

¹⁹ The contract on an initial financing "includes a clause requiring the corporation to offer all additional securities through the originating underwriter for a specified period. These are called "first right of refusal" or "preferential right" clauses." (Perez (1984)). Also, venture capital contracts have a clause prohibiting de-novo financing from elsewhere.

investment bank wins is $\pi = \max [0, \frac{S-S_L}{2C}]$. The bank then faces the problem

$$\max_{S, S^L} \quad \pi S^L + (1 - \pi)(S - C)$$

$$\text{such that } S^R - S \geq \frac{S^R}{4C} - \frac{C}{4} \quad \text{--(i)} \quad S > S^L \quad \text{--(ii)} \quad \frac{(S - S^L)^2}{4C} \geq C_p \quad \text{--(iii)}$$

Constraint (i) makes it rational for the firm to accept while constraint (ii) requires that the investment bank win with positive probability and constraint (iii) that it be incentive compatible for the investment bank to investigate.²⁰ Let us set $S^R = 2C$ for simplicity. The solution can be verified to be $S = 5C/4$, $S^L = 3C/4$ if $C_p \leq C/8$. Bank surplus goes up. Firm surplus remains the same while investment bank surplus goes down. The probability that the firm stays with the bank goes up from 1/2 to 3/4. Note that the bank underwrites the firm even when it is inefficient, and the firm accepts even though ex-ante it can freely choose more efficient alternatives.

The intuition behind this contract is that it extracts some of the investment bank's surplus and gives it to the bank-firm coalition. This idea is not new (see Diamond and Maskin (1979), Aghion and Bolton (1987)) but the implications are powerful. Even if given free choice, the firm may prefer to be locked in inefficiently, in order to exact transfers from third parties. The important message here is that sunk costs in underwriting make both inside financiers and outside financiers oligopolists. This creates strong incentives for the firm to build up bargaining position. Inside financiers have a greater ability to form coalitions with the firm because of previous relationships. Thus inefficient inside financiers can have major welfare effects because these inefficiencies get entrenched.

²⁰ If we allow the firm to subsidize entry for the investment bank, constraint (i) and (iii) collapse to

$$(S^R - S) - \max[C_p - \frac{(S - S^L)^2}{4C}, 0] \geq \left[\frac{S^R}{4C} - \frac{C}{4} \right] - \max[C_p - \frac{C}{4}, 0]$$

One shortcoming of our analysis so far is that it leaves out the legal system. We now introduce a third stage where investors can seek redress from the courts. The bank can now communicate some information to the market, though it has to add noise to its signal both to make it credible and to give investors an opportunity to impose costs on it. We show that the information the bank can communicate is decreasing in the size of the risky debt i.e in the magnitude of the conflict of interest. We also show that higher penalties do not improve information transmission.

Section 3: Information Transmission when Investors can seek Legal Redress

Post-Issue Litigation

Apart from the firm's reservation option of borrowing, nothing thus far constrains the announcements the bank can make about firm quality. In recent empirical work, Tinic (1988) and Ritter (1991) have suggested that the underwriter's announcements are constrained by the fear of litigation. We now allow the investor to seek redress from the court if he believes the bank has misreported the true θ .

At date 1, the value y of the firm is realized and becomes common knowledge. The firm pays all claimants in order of absolute priority till the revenues run out. Based on y and the reported $\hat{\theta}$, the investor decides whether to sue the housebank for misreporting.²¹ The investor bears some costs c_1 (for example the non-pecuniary costs of time and effort spent in litigation) in moving the courts, regardless of the outcome of the suit. If the law suit is successful, the housebank pays the investor damages.

The courts do not have direct access to all the information provided by the bank. However they know the amount raised and the price in the competitive market, both of which depend on the information communicated by the bank. We assume that the courts work backward from the

²¹ We can also allow the investor to sue only if he suffers losses, which is consistent with the U.S legal system.

amount raised, I^* , to determine the average beliefs of the investor at the time of the issue.²² The courts assume that the bank communicated quality $\theta^c = I^{-1}(I^*)$. The virtue of such backward deduction according to the legal literature is that it captures all communicated information and it demonstrates that the investor relied on it.

We assume that the expected value of legal penalties is given by a increasing, convex, non-negative function of the difference between the deduced beliefs about quality and the actual quality.

i.e Expected Penalties = $L(\theta^c - \theta)$ where (i) $L' > 0$ (ii) $L'' > 0$ (iii) $L(0) > 0$.

Intuitively, penalties must be increasing in the error $\theta^c - \theta$. Also the chances of discovering the error increase with the size of the error. Both these imply the convexity assumption. Finally, there is a positive probability of wrongful punishment, hence (iii). Alternatively, $L(0)$ could be thought of as the costs of an out of court settlement.

As the judicial system is given exogenously,²³ a natural requirement is that there be no free lunch i.e if the bank announces the truth and is known to do so, there should be no incentive for the investor to sue and make profits in expectation. So, in order that an investor not litigate frivolously

Assumption 3: $L(0) \leq c_l$

The sequence of events is given in Table 2.

The Game When Bank Underwrite Stocks

We consider an information transmission game where the costs to the sender of signalling information are endogenous and based on the actions of the receivers. The equilibrium concept we

²² Basing legal penalties on the information actually announced by the bank has a serious flaw, even if it were possible,. In an economy or equilibrium where everyone is optimistic, the bank has to make optimistic announcements even though everyone discounts them. In this rat-race equilibrium, a legal system which levied penalties based on announcements would impose unnecessary costs. It is not what is said that is important but what is understood.

²³ One could take one extreme view that the judicial system is the result of an optimal mechanism design problem. The other extreme is that it is the outcome of popular quasi-rational sentiments like justice and equality.

will use is that of sequential equilibrium. We restrict ourselves to pure strategies.

Bank's Problem: The bank learns the quality θ of the firm, drawn from a set Θ , according to some probability distribution G over Θ that is common knowledge. For simplicity let θ be the 'type' of the bank. It then sends a signal $\hat{\theta}$ to the market. We constrain this without loss of generality (w.l.o.g) to belong to Θ . In choosing the signal to send the bank maximizes

$$\begin{aligned} \max_{\hat{\theta} \in \Theta} & U^B(I(\hat{\theta}^{AVG}), \theta, D) \\ &= \max_{\hat{\theta} \in \Theta} \left[\Delta I(\hat{\theta}^{AVG}, \theta) + V^D[\theta, D - \Delta I(\hat{\theta}^{AVG}, \theta)] \right] - E_Y[\sigma(\hat{\theta}, Y) L(\hat{\theta}^{AVG} - \theta)] \end{aligned} \quad (3.4)$$

$$\text{where } \hat{\theta}^{AVG} = \int_{\Theta} \theta h(\hat{\theta} | \theta) d\theta$$

where $H(\hat{\theta} | \theta)$ are the investor's posterior beliefs and $\sigma \in \{0,1\}$ is the investor's decision to sue. The term in large square brackets is the benefit from premature debt repayment while the last term in (3.4) is the expected cost of litigation with the expectation taken over the realizable values of Y . We denote the bank's strategy by $q(\hat{\theta} | \theta)$ where q is a probability distribution with a single point support and $\hat{\theta}$ solves (3.4).²⁴

Note that an announcement $\hat{\theta}$ that raises more funds affects the bank in two ways. First, the risky loan is repaid at face value, a benefit which decreases in marginal value as the outstanding debt amount falls. Second, the expected penalties conditional on litigation, increase in a convex fashion with the funds raised. For a fixed suing strategy, U^B is strictly concave in $I(\hat{\theta}^{AVG})$.

In order to make the problem interesting, we assume that despite the legal (or reputational)

²⁴ If the solution is not unique, then we define $\hat{\theta}$ to be the minimum of such θ .

penalties the system imposes, the bank has an incentive to raise more funds than what the market investor feels is optimal. This is true if the bank has sufficiently risky debt outstanding to the firm²⁵.

Assumption 4: Conflict of Interest; $U_i^B|_{I(\theta)} > 0 \quad \text{for all } \theta$

Market's problem: Having heard the signal, the market decides to offer amount

$$I(\hat{\theta}^{AVG}) \quad \text{where } \hat{\theta}^{AVG} = \int_{\underline{\theta}}^{\bar{\theta}} \left(\frac{\theta q(\hat{\theta}|\theta) g(\theta)}{\int_{\underline{\theta}}^{\bar{\theta}} q(\hat{\theta}|s)g(s)ds} \right) d\theta$$

The number of shares issued (and hence the issue price) are competitively determined. The indivisible investment is made and value y is realized. The investor now can file suit. His actions are to sue ($\sigma=1$) or not to sue ($\sigma=0$). He chooses

$$\begin{aligned} \sigma(\hat{\theta}, y) &= 1 \text{ if } \int_{\underline{\theta}}^{\bar{\theta}} L(\hat{\theta}^{AVG} - \theta) h(\theta|\hat{\theta}, y) d\theta - c_1 \geq 0 \text{ where } h(\theta|\hat{\theta}, y) = \frac{g(\theta)q(\hat{\theta}|\theta)f(y|\theta)}{\int_{\underline{\theta}}^{\bar{\theta}} g(s)q(\hat{\theta}|s)f(y|s)ds} \\ &= 0 \text{ if } \quad \quad \quad < 0 \end{aligned}$$

We proceed to characterize the equilibria of this game.

Characterising the Equilibria

We specify a sequential equilibrium by strategies (q^*, I^*, σ^*) and beliefs H which are derived from Bayes rule whenever possible. For signals that are sent with zero probability in equilibrium, there must be some consistent beliefs which sustain the equilibrium. We look for:

Fully Revealing Signalling Equilibria where the equilibrium signal $\hat{\theta}^*(\theta)$ is invertible in θ .

Partition or Coarse Signalling Equilibria where there exists a finite partition of Θ ,

²⁵ This would also hold if the market's optimal response is much less than the required investment.

$A(N) = (\underline{\theta} = a_0, a_1, a_2, \dots,$

$a_{N-1}, a_N = \bar{\theta})$, with $\underline{\theta} = a_0 < a_1 < a_2 < \dots < a_{N-1} < a_N = \bar{\theta}$ such that $\hat{\theta}^*(\theta) = \hat{\theta}_i$ for each $\theta \in [a_i(N), a_{i+1}(N))$, $i = 0, 1, \dots, N-2$, and $\hat{\theta}^*(\theta) = \hat{\theta}_{N-1}$ for each $\theta \in [a_{N-1}(N), \bar{\theta}]$. We call each interval of the partition a *step*.

Proposition 3.2 *There does not exist a sequential fully revealing signalling equilibrium.*

Proof: Proof by contradiction; Assume a fully revealing equilibrium exists. Consider type θ_1 and type θ_2 , $\theta_1 < \theta_2$, who send different signals $\hat{\theta}_1$ and $\hat{\theta}_2$. The response of the investor is to provide $I(\theta_1)$ and $I(\theta_2)$ respectively. By strict monotonicity of the investor's preferences, $I(\theta_1) < I(\theta_2)$. Also, as the equilibrium is fully revealing, the courts deduce the same quality from the market response as the true quality. Under these circumstances, by Assumption 3, suing is not profitable. In any sequentially rational equilibrium, the investor will not sue on the equilibrium path and litigation cannot be an equilibrium response. There is a conflict of interest and the bank wants to raise more funds than the market is willing to offer for a given type. In the absence of litigation, the bank of type θ_1 will announce $\hat{\theta}_2$ and the equilibrium breaks down.

The interesting aspect to Proposition 3.2 is that there has to be some noise in the signal in order to give the investor the incentive to litigate. This is not a result of our restriction to pure strategies but a requirement of sequential rationality or subgame perfection. Unlike Crawford and Sobel (1982) where the interior optimum in the Sender's preferred reaction is exogenously given, the interior optimum occurs here only because the receiver imposes costs on the sender. Therefore in equilibrium, as we shall see noise is needed both to build credibility in the sender's signal as well as to give the receiver an incentive to make it credible. The following results are useful later;

Lemma 3.1: *If in response to some announced $\hat{\theta}$ and some realization y' the investor sues, she will also sue when the realization is y'' where $y'' \leq y'$.*

Proof: This follows from the Monotone Likelihood Ratio Property and the fact that damages increase monotonically in the difference between $\hat{\theta}^{AVG}$ and θ .

Lemma 3.2: *Consider an equilibrium where the investor receives a signal $\hat{\theta}_2$ sent with positive*

probability and forms posterior average beliefs θ_2 . If it is an equilibrium response for the investor to not sue for any realization of Y after receiving this signal, then it cannot be an equilibrium response for her to sue, for any realization of y , if she receives a signal $\hat{\theta}_1$ which she believes is sent by average types $\theta_1 \leq \theta_2$.

Proof: The investor offers $I(\theta_2)$ when she encounters the signal $\hat{\theta}_2$. If her beliefs on encountering a signal $\hat{\theta}_1$ are (weakly) lower, she will offer $I(\theta_1) \leq I(\theta_2)$. As it is an equilibrium response for her not to sue when she encounters θ_2 for any realization of Y , type θ_1 strictly prefers to send signal $\hat{\theta}_2$ unless it is an equilibrium response for the investor to not sue when she receives signal $\hat{\theta}_1$.

Corollary 1: *If there is some step in a partition equilibrium where the investor, in equilibrium, does not sue for any realization of Y when she encounters signals from the step, the step can only be the lowest step.*

Proof: Direct from Corollary 1.

The content of lemma 3.2 is that in order to specify an equilibrium litigation response for the investor, for every signal $\hat{\theta}_i$ sent in equilibrium one need only specify the highest realization y_i for which the investor can and will sue. Corollary 1 suggests that it is not possible for high types to be perfectly revealed when low types are not. Also, the level below which the investor sues, y_i , is (trivially) monotonic in the types only when y takes on only two values - there is a cut-off average bank type (identified by the signal they send) below which the investor will never sue and above which he will always sue when he sees the low realization of y . This monotonicity need not hold when y can take on many values.

Existence of Coarse Equilibrium

In order to prove the existence of partition equilibria, we need the following condition which holds under very plausible conditions. This condition is necessary for separating the types and is similar to the Spence Mirrlees single sorting condition for costly signalling games.

Assumption 5: $U_1^B(I, \theta_1, D) < U_1^B(I, \theta_2, D)$ for all $\theta_2 > \theta_1$ and all I

A sufficient condition²⁶ for this to hold is that

$$V_2^D(\theta_1, D+I(\theta_1)-I) > V_2^D(\theta_2, D+I(\theta_2)-I) \text{ for all } \theta_2 > \theta_1 \text{ and all } I$$

The sufficient condition is intuitive and satisfied under general conditions. The value of being repaid an extra dollar is always better for the low type θ_1 given the same face value of debt claim as the high type. However, when the low type has raised more funds and paid down some of the debt, the marginal value of paying down a dollar of debt decreases because the outstanding debt has decreased and become less risky. Now, if the amount raised, I , is below the required level $I(\theta_2)$ for the high type bank, it has to lend to make up the shortfall. Outstanding debt now is more than the initial face value. The marginal value of raising more funds, for this type, increases because the debt is now more risky. Hence, the sufficient condition requires that the marginal value of attracting more funds be higher for a higher type at any level of investment response. We now state the main result in this section;

Proposition 3.3: There exists a finite positive integer N and a sequence of signals $\hat{\theta} = (\hat{\theta}_0, \hat{\theta}_1, \hat{\theta}_2, \dots, \hat{\theta}_N), \hat{\theta}_i \in \Theta$ such that a coarse signaling equilibrium $A(N) = (\underline{\theta} = a_0(N), a_1(N), \dots, a_N(N) = \bar{\theta})$ exists where

1. $q^*(\hat{\theta}_i | \theta) = 1 \text{ if } \theta \in [a_i(N), a_{i+1}(N)] \quad i=0,1,\dots,N-2$
1. $q^*(\hat{\theta}_{N-1} | \theta) = 1 \text{ if } \theta \in [a_{N-1}(N), a_N(N)]$
and zero otherwise

²⁶ Unfortunately assumption 5 is predicated on the equilibrium behavior of the investor and hence is not very satisfactory. However, the sufficient condition depends only on the technology and hence is more appealing.

2.

$$I^*(\hat{\theta}_i) = I(\theta^{AVG}(a_i(N), a_{i+1}(N))) \text{ where } \theta^{AVG}(a_i(N), a_{i+1}(N)) = \frac{\int_{a_i(N)}^{a_{i+1}(N)} \theta g(\theta) d\theta}{\int_{a_i(N)}^{a_{i+1}(N)} g(\theta) d\theta} \quad \text{if } \hat{\theta}_i \in \hat{\theta}, i=0,1,\dots,N-1$$

$$I^*(\theta) = I(\theta^{AVG}(a_0(N), a_1(N))) \quad \text{if } \theta \notin \hat{\theta}$$

3. If $\theta = \hat{\theta}_i \in \hat{\theta}$ then

$$\sigma(\hat{\theta}_i, y) = 1 \text{ if } \int_{a_i(N)}^{a_{i+1}(N)} L(\theta_i^{AVG} - t) h(t | \hat{\theta}_i, y) dt - c_i \geq 0 \text{ where } h(t | \hat{\theta}_i, y) = \frac{g(t) f(y | t)}{\int_{a_i(N)}^{a_{i+1}(N)} g(s) f(y | s) ds}$$

$$= 0 \text{ if } < 0$$

4. If $\theta \notin \hat{\theta}$ then

$$\sigma(\theta, y) = 1 \text{ if } \int_{a_0(N)}^{a_1(N)} L(\theta^{AVG} - s) h(s | \hat{\theta}_1, y) ds - c_1 \geq 0 \text{ where } h(t | \hat{\theta}_1, y) = \frac{g(t) f(y | t)}{\int_{a_0(N)}^{a_1(N)} g(s) f(y | s) ds}$$

$$= 0 \text{ if } < 0$$

Proof: See Appendix.

Condition 1 in the proposition above states that the bank sends a signal depending on which step of the partition its type lies in. Note that the level of the signal it sends is indeterminate, except for the fact that it is the same for every type in the step.²⁷ This is a direct result of signals per se being costless, for it is the interpretation by the investors of those signals as emanating from a certain average type which endogenously creates costs for the bank. Condition 2 describes the investor's response to signals from the bank. Its response to off-equilibrium path signals is to assume that they were sent by types in the lowest step. Condition 3 describes the investor's litigation response after seeing the realization y . Condition 4 describes its response to an earlier

²⁷ This leads to the possibility that we could have optimistic equilibria where banks always overstate but their signals are appropriately discounted, or pessimistic equilibria where the banks are very conservative and investors push up bank valuations. Of course, small costs of making arbitrary announcements would lead to a close correspondence between the level of the signals and types.

deviation.

The intuition behind the 'coarse' nature of the equilibrium is that small lies are not costly so the bank must be forced to announce large lies in order to change the investor's funding response. The costs of these large lies are sufficient to give the bank incentives to announce the truth. Also note that the noise introduced by these steps make it sequentially rational for the investor to sue. The proof of Proposition 3.3 is of independent technical interest and is by construction, step by step. We develop an iterative algorithm which determines the equilibrium suing response, and then follow work by Crawford and Sobel(1982) to establish the existence of the equilibrium.

Call the partition with the highest number of steps the maximal sized partition. The size (i.e the number of steps) of the maximal partition is important for it describes, in a sense, the maximum amount of information that can be conveyed in any equilibrium. Under a monotonicity assumption, this partition is unique and is the only equilibrium to survive the universal divinity refinement (see Kumar(1989)).

Under a variety of conditions, it can be shown that the maximal partition size decreases as the size of the debt outstanding to the firm increases. In other words, *the information the bank can convey to the market decreases as the size and riskiness of its debt claim, or the extent of its conflict of interest, increase*. For example, if the investor's litigation strategy is constant across steps, the proof in Crawford and Sobel (1982) obtains and the maximal partition size decreases as the conflict of interest (as denoted by the size of debt D) increases. Similarly if there are only two possible realizations of y , and the investor is not allowed to sue unless he suffers a loss in the value of his investment, the investor's suing strategy is constant across every step but the first (he can sue only in one state while by Lemma 3.2, not suing is an option only in the first step). However, the first step is arbitrary in any case and hence the proof in Crawford and Sobel goes through. We now state a sufficient condition for no information to be transmitted and then present an example. Rather than do comparative statics for the general case, we will do it in the example.

The maximum costs of lying are imposed on the bank if the investor always sues,

regardless of the realization of Y . Let U^{Bk} be the bank's preference function in this case. A sufficient condition on the size of the conflict of interest for no information to be revealed, is that the bank not have an incentive to reveal information even in this extreme situation.

Lemma 3.5: *There exist only uninformative equilibria if*

$$U^{Bk}(I(\theta^{AVG}(a, \bar{\theta})), \theta, D) - U^{Bk}(I(\theta^{AVG}(\underline{\theta}, a)), \theta, D) > 0 \text{ for all } a \in (\underline{\theta}, \bar{\theta}) \quad \text{---(B).}$$

Proof: Omitted.

Condition (B) implies that no end-point exists to bound the first step, even when the investor inflicts the most severe penalties for lying. Thus no equilibrium can be informative. Note also that the higher is D , the greater the benefit from declaring a high type and hence easier the sufficient condition to satisfy.

Example 1

Let there be 4 equally likely types for the firms and 4 possible states. The associated probability matrix as well as the required investment and the market response²⁸ I^M is

	y^1	y^2	y^3	y^4	$I(\theta)$	$I^M(\theta)$
$\theta_1=1$	0.3	0.28	0.22	0.2	0.5	0.4
$\theta_2=2$	0.25	0.25	0.25	0.25	0.75	0.46
$\theta_3=3$	0.18	0.26	0.29	0.27	1	0.52
$\theta_4=4$	0.15	0.22	0.31	0.32	1.25	0.58

Let $L(\theta^C - \theta) = -0.005 (\theta_C - \theta + (\theta_4 - \theta_1))^2$ and $c_l = 0.02$. Assume initially that debt is 0.5.

There are only three possible equilibria. This is easily seen. As $L(0) < c_l$, no fully revealing equilibrium exists. Also, this ensures that no equilibrium in which any of θ_2, θ_3 , or θ_4 are perfectly revealed can exist. This is because the investor has no incentive to sue on receiving a signal from any of these types, in which case lower types have an incentive to imitate these types. This reduces

²⁸ We take the market response $I^M(\theta)$ to be different from $I(\theta)$ to show that there is no loss of generality in our earlier assumption.

the possible equilibria to three, which are the partitions $A = \{\theta_1, \theta_2, \theta_3, \theta_4\}$, $B = \{(\theta_1), (\theta_2, \theta_3, \theta_4)\}$ and $C = \{(\theta_1, \theta_2), (\theta_3, \theta_4)\}$. Equilibrium A is the pooling or babbling equilibrium, which always exists, in which signals have no meaning, equilibrium B is a more informative one where the lowest type separates out, and in equilibrium C, the top two and bottom two types form the steps.

As the debt level increases, first equilibrium C vanishes, then equilibrium B leaving only the un-informative equilibrium at high levels of debt (see Fig. 1). It also appears from the figure that as the legal penalties increase, more information is revealed. This however is not monotonic. If penalties are high enough, Assumption 4 no longer holds and banks have an incentive to pool in understating in order to avoid legal penalties. The equilibrium again becomes un-informative. Therefore higher penalties do not necessarily result in more information revelation if there is a possibility of errors.²⁹

So far we have relied on a costly external correction mechanism to give the bank incentives to signal appropriately. This imposes dead-weight costs of litigation in addition to the costs of noisy certification. One way to reduce the social costs is to improve the bank's certification ability, for example, by permitting them to buy risky positions in the firm at the time of underwriting so as to substantiate their certification. The advantage that is signaling is now costless or non-dissipative. We now explore this.

Section 4: Costless Signalling

A number of models have explored costless signaling where the signaler is the owner or management acting in the interest of old equity (Heinkel (1982), Brennan and Kraus (1987), Constantinides and Grundy (1989)). The basic idea behind these models is that, in equilibrium, the cost to the firm of newly issued claims is locally convex in the firm quality so that management

²⁹ This contrasts with the mechanism design literature, where a small probability of high penalties leads to the first best. A key difference in our model is that the possibility of errors decreases in the type that is conveyed to the market.

signals the true quality. For example, if management wants to issue a junior security like equity, it should simultaneously exchange a more senior security like debt for it. This exchange, if large enough, credibly commits the management to declaring the true value of the firm because it loses on repurchasing debt any gains of overstating value on the equity issue. What is less satisfactory is that the management has to repurchase inordinate amounts of debt (and issue high amounts of equity) in order to credibly signal the true value of a small equity financed investment. The reason is that management is acting in the interest of old equity which has the highest incentive to overstate firm value.

Suppose, however, the housebank is allowed to purchase equity at the time of the issue. Assume contracts requiring insiders to hold their stake for a specified period of time are credible.³⁰ The bank has a more senior claim than equity. Further, it can use cash to purchase firm equity. Both factors improve the bank's signaling ability over management. In what follows, we find and characterize a fully revealing signaling equilibrium in which the bank purchases small amounts of firm equity in order to signal firm value.

Non-Dissipative Signaling Equilibria

Let the bank announce that it will underwrite the firm's stock issue and it will buy and hold $n(\theta)$ shares for its own account. Investors form average beliefs $\hat{\theta}(n(\theta))$ and respond with $I(\hat{\theta}[n(\theta)])$ of funds. Suppressing the argument of $\hat{\theta}$, the share price, given their beliefs is $P^E(\hat{\theta}, D) = \frac{V^E(\hat{\theta}, D) - I(\hat{\theta})}{n_{old}}$ and they get new shares numbering $n_{new}(\hat{\theta}) = \frac{I(\hat{\theta})}{P^E(\hat{\theta}, D)}$ in return. As the true state is θ , the full information expected value of the shares is $P^E(\theta, D^*) = \frac{V^E(\theta, D^*)}{n_{old} + n_{new}}$ where $D^* = D + I(\theta) - I(\hat{\theta})$. Therefore the value of the bank's position if it announces $n(\theta)$ when the true firm quality is θ is

³⁰ Such contracts are normally written before IPO's. In certain countries like Germany and the United States, laws also exist, prohibiting the undisclosed sale of an insider stake for a certain period after a public issue.

$$[I(\hat{\theta}) - I(\theta) + V^D(\theta, D^*)] + n(\theta)[P^E(\theta, D^*) - P^E(\hat{\theta}, D)] \quad (3.5)$$

The first bracketed term is the change in the bank's debt and cash position while the second term is the gain (or loss) on the equity it buys at market price. Note that in a fully revealing equilibrium, by Proposition 3.2, investors have no incentive to sue. The non-dissipative equity purchase takes the place of legal penalties in providing incentives to not overstate value.

In a fully revealing equilibrium, outsiders must not be fooled. Therefore $\hat{\theta}(n(\theta)) = \theta$. As we assume no re-bargaining takes place amongst the insiders, the face value of their claims do not change. The value of the bank's claim must be its full information value. The equilibrium condition is that

$$[I(\hat{\theta}) - I(\theta) + V^D(\theta, D^*)] + n(\theta)[P^E(\theta, D^*) - P^E(\hat{\theta}, D)] - V^D(\theta, D) = 0 \text{ at } \theta = \hat{\theta}(n(\theta)) \quad (3.6)$$

where the term on the right is the full information value of the bank's claim. The bank chooses $n(\theta)$ to maximize (3.5), the F.O.C is

$$I'(\hat{\theta}) - V_2^D I'(\hat{\theta}) - [P^E(\theta, D^*) - P^E(\hat{\theta}, D)] - n(\theta)[-P_2^E(\theta, D^*) I'(\hat{\theta}) - P_1^E(\hat{\theta}, D)] = 0 \quad (3.7)$$

Totally differentiating the equilibrium condition (3.6), and substituting the F.O.C, we get

$$n(\theta) = \frac{I'(\theta)[1 - V_2^D]}{P_1^E + P_2^E I'(\theta)} \quad (3.8)$$

The denominator is the rate of change of the share price with θ , keeping the announcement $n(\theta)$ constant. As incremental investment is positive NPV, the denominator must be positive if the debt overhang is not too high. The numerator is the benefit of getting risky debt paid back by incrementally overstating θ . Note that the more sensitive the share price to θ , the lower the equilibrium equity purchase required, while the more sensitive the required investment or the

higher the debt level, the greater the required stake.

In order for this to be fully revealing, it must be that $n(\theta)$ is monotonic in θ . As θ increases, $(1-V_2^D)$ decreases because the incremental value of a unit of debt increases as the quality of the firm goes up. If $I'(\theta)$ changes little or is non-increasing, the numerator as a whole decreases in θ . The denominator, must increase with θ , because the debt overhang $D-I(\hat{\theta})$ remains constant, while the incremental investment is positive NPV. Therefore, under these conditions the equilibrium equity stake $n(\theta)$ the bank takes in the firm is decreasing in θ (see example 2).

Now, totally differentiate the F.O.C. Then totally differentiate (3.8) and substitute it in the differentiated F.O.C. In order for the S.O.C of the bank's maximization problem to be satisfied,

$$\begin{aligned} & -I''(\theta)[1 - V_2^D] + (I'(\theta))^2 V_{22}^D + 2I'(\theta) V_{12}^D \\ & + n(\theta) \left[P_{11}^E(\theta, D) + I''(\theta) P_2^E(\theta, D) + (I'(\theta))^2 P_{22}^E(\theta, D) + 2I'(\theta) P_{12}^E(\theta, D) \right] \leq 0 \end{aligned} \quad (3.9)$$

The conditions (3.8) and (3.9) are easily interpreted. They are merely the First and Second order conditions obtained by maximizing the equilibrium condition with respect to θ . The intuition is that outsiders will attribute any announced quality $\hat{\theta}$ to the firm that has the maximum incentive to make that announcement. In a fully revealing equilibrium, the announced quality and the attributed quality must be the same, i.e the equilibrium condition must attain its unique maximum with respect to θ at $\theta=\hat{\theta}$.

We can simplify (3.9) by recognizing that the sum of equity and debt claims identically equal the value of the firm. Therefore, $V^D(\theta, D) + N P^E(\theta, D) = V(\theta)$ where $N=(n_{\text{old}} + n_{\text{new}})$. Hence $V_2^D = -NP_2^E$, $V_{22}^D = -NP_{22}^E$ and $V_{12}^D = -N P_{12}^E$. Substituting in (3.9), we require that

$$-I''(\theta) \left[1 - V_2^D [1 - n/N] \right] + I'(\theta)^2 \left[V_{22}^D [1 - n/N] \right] + 2I'(\theta) \left[V_{12}^D [1 - n/N] \right] + nP_{11}^E < 0 \quad (3.10)$$

We present an example.

Example 2

Let $Y \sim U[X-b\theta, X+a\theta]$ and $I(\theta)=c\theta$. Then

$$\begin{aligned} V(\theta) &= X + \frac{(a-b)\theta}{2}; \quad V_2^D = \frac{X+a\theta-D}{(a+b)\theta}; \quad V_{12}^D = \frac{D-X}{(a+b)\theta^2}; \quad V_{22}^D = \frac{-1}{(a+b)\theta} \\ P_1^E &= \frac{a^2 - (D-X)^2/\theta^2}{2(a+b)N}; \quad P_2^E = \frac{D-(X+\theta a)}{\theta(a+b)N}; \quad P_{11}^E = \frac{2(D-X)^2}{2(a+b)\theta^3 N} \end{aligned}$$

Substitute $D=2.1$, $a=2$, $b=0.8$, $c=0.5$, $X=2$, $\Theta=[0.55,0.75]$, $n_{\text{old}}=1$.

The share purchase schedule is in Fig 2. and is decreasing in quality. The relative gains for each quality type at an announcement of $n=2.50$ is seen in Fig 3. Note that the maximum gain is zero and occurs for type $\theta=0.65$.

We have assumed that the bank holds no equity prior to the issue. It is easily shown that the size of equity required to be purchased is increasing in the previous holding. In the limit of course, no credible issue will be possible if the bank holds too large a prior stake. This is one reason, in addition to diversification and regulatory reasons why banks could be asked to limit their stake in a firm. A bank selling holdings when it is over the limit will then convey no information.

Section 5: Conclusion

Empirical Evidence and Implications

We have shown that banks are handicapped because of the presence of conflict of interest, in their ability to certify firms to the market. Yet, despite this ex-post inefficiency, banks may be

able to underwrite firms because of the bank's ability to monopolize the firm.³¹ An act like the Glass Steagall in the U.S and Article 65 in Japan prevents this ex-post inefficiency from getting entrenched, by forcing the firm to choose an independent underwriter. A partial solution, if such regulation is done away with, is to deregulate further and permit banks to buy small amounts of junior securities in the firm when underwriting it. This is currently permitted in Japan but only indirectly allowed in the United States (see Table 1).³²

There is much casual evidence that the conflict of interest problem is pervasive in merchant banking - where investment banks also make bridge loans to the firms they advise. The woes of First Boston are well documented. In 1988, First Boston withdrew a \$1.15 billion offering of Federated Department Stores junk bonds, because of poor demand. The bonds were later re-issued after the size was reduced to \$750 million and the coupon enhanced. In 1989, it announced a junk bond issue of \$475 million for Ohio Mattress to pay down a \$457 million bridge loan. The issue was later withdrawn because of poor demand. Finally, First Boston had to sell its parent \$1.1 billion of bridge loans that firms could not re-finance. There is a strong suggestion that firms had trouble refinancing bridge loans because of problems of the credibility of the underwriter.

Unfortunately, there is no recent empirical study we know of that compares the relative efficiency of banks and independent investment banks in underwriting issues.³³ Moore (1933)

³¹ One other source of monopoly that we briefly touched on stems from the bank's inside information. For example, in section II, if the bank knows the costs to underwrite a firm but the investment bank only learns it after the due-diligence, the bank can extract rents because of the Winner's curse effect. These rents increase in the variance of the costs. If expected legal penalties are a significant component of costs, increasing the size of legal penalties may simply increase the lock-in to the bank. This is yet another reason why raising penalties may not be the best way of resolving this problem.

³² Bank Holding Companies are allowed to hold some amounts of equity in a firm.

³³ Part of the problem is to define efficiency in underwriting. In terms of our model, the variance of realized returns should be higher for bank underwritten issues. There are two problems with any such analysis, however. First, the issues the bank brings to the market does not include those which preferred to continue borrowing because of the high expected cost of inefficiency. Second, banks lend to, and have a stronger monopoly over, less well known firms. The first effect would tend to bias tests against accepting the hypothesis that banks are less efficient, while the second would bias the test towards acceptance.

compares firms underwritten by banks to those underwritten by investment banks. He concludes that

"...banks, despite their closer association with the corporations whose securities were being floated, have decidedly not performed the security origination function any better than the private investment banks."

There is some evidence to support our conjecture that rational investors are not systematically defrauded in the absence of legal penalties, but that the introduction of legal penalties improves the ability of the underwriter to transmit information to the market. Simon (1989) finds no long term abnormal expected returns for a sample of initial public stock offerings before and after the Securities Act of 1933 for NYSE securities. However, she finds the variance of abnormal returns decreased considerably after the Securities Act. This suggests that more information was transmitted. Our analysis indicates that the improvement need not have come only from a significant change in the quantity and quality of the information gathered³⁴, but may also have been due to an increase in credibility of the underwriting. The Securities Act would have been beneficial even if it did not change disclosure or information gathering practices.

Policy Implications

The strongest argument for repealing Glass-Steagall has been efficiency. There is a belief that the information banks acquire from lending should be transferable to underwriting. The resultant economies of scope should improve welfare. At any rate, the argument goes, increased competition in the currently oligopolistic investment banking industry should be welfare improving.

However, our analysis shows that any efficiency gains from economies of scope may be dissipated in inefficient underwriting. Also, competition in this industry, characterized by

³⁴ Some economists suggest that the Securities Act did not change practices. For example, "the actual mechanism of Investment Banking, except for slight changes in form, has not been materially affected by the Securities Act of 1933. Examination of most of the apparent changes discloses that they are no more than a continuation of the trend commencing prior to 1933 or that they are adequately explained otherwise than by the Securities Act." Bates(1937)

relationships, increasing returns to scale and sunk costs may not increase and the old efficient oligopolists may be replaced by new inefficient ones.

An implicit assumption so far, is that it is impossible to write a law forbidding a bank to underwrite a firm that it has 'significant interests' in. Given the proliferation of banking services, it may be hard to define and police 'significant interests'. Moreover, there are no economies of scope under such a law, thus obviating the need to repeal the Glass-Steagall act. 'Chinese Walls' between the investment subsidiary and the lending subsidiary suffer from the same problem. Moreover, if the two subsidiaries share a common parent capital base, they have common interests and the conflict of interest problem surfaces again.

We are not suggesting that there are no gains to removing the separation of commercial and investment banking. On the basis of the theory discussed earlier, this paper unlike previous research, maintains that there is ambiguity about the size of efficiency gains (if any) from doing so. The scope for further research, especially empirical, is obvious.

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Tables

Table 1

Country	Market Capitalization (% of GNP) Dec 1987 ^a	Permissible activities for deposit taking banks ^c
Belgium	30	Banks may hold equity in connection with their underwriting activity.
France	20	Underwriting allowed. Banks may hold 20% of shares in a non-bank company (and 100% if financed by long-term deposits).
Federal Republic of Germany	20	Universal Banking
Italy	16	Underwriting allowed. Banks cannot hold more than 2% in non-bank company shares.
Japan	105	Banks not allowed to underwrite corporate securities. 5% limit on holdings in any firm
Netherlands	48	Underwriting allowed. Equity participation greater than 5% subject to approval.
U.K	92	No specific controls. By tradition, a separation between deposit-taking banks (accepting houses) and merchant banks (issuing houses).
U.S	60	Banks not allowed to underwrite corporate securities. Some equity participation now allowed to holding companies.

a Source: European Banking in the 1990's. Jean Dermine ed.

b Source: World Development Report 1989

c Source: Richard Levich in "Deregulating Wall Street" Ingo Walter ed.

Table 2

The detailed sequence of events is

Housebank invests information gathering costs of C^{PRE} .	Investment bank may invest these costs. They both submit proposals.	Firm chooses underwriter	Underwriter completes due diligence, at cost C_D and announces $\hat{\theta}$.	Market Investor updates priors and amount I is raised.	Investment $I(\theta)$ takes place with bank making up shortfall or getting repaid with excess funds.	Value of firm realized. Claims paid out.
Date -2	Date -1	Date 0			Date 1	
----- ----- ----- ----- ----- -----						

Fig 1. NUMBER OF EQUILIBRIA FOR DIFFERENT DEBT LEVELS AND LEGAL PENALTIES

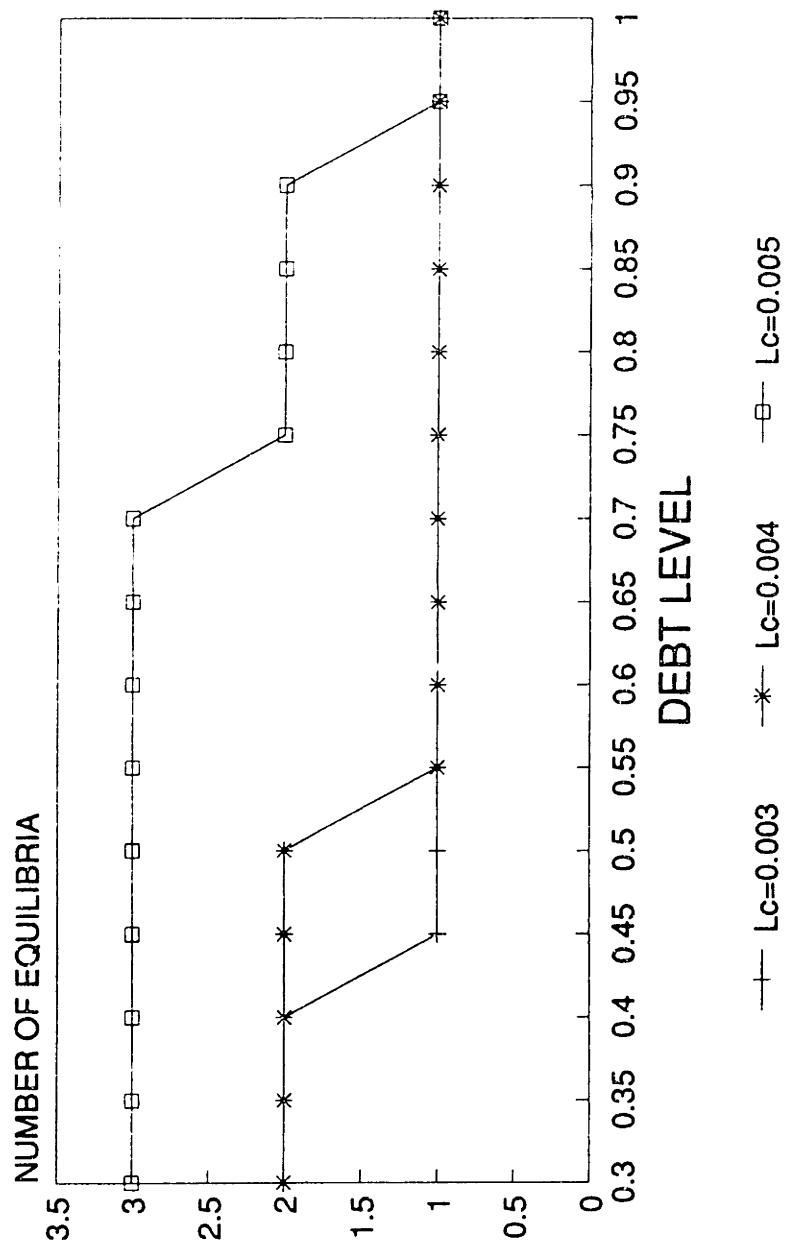


Fig 2. NUMBER OF SHARES BOUGHT BY BANK
IN FULLY REVEALING EQUILIBRIUM

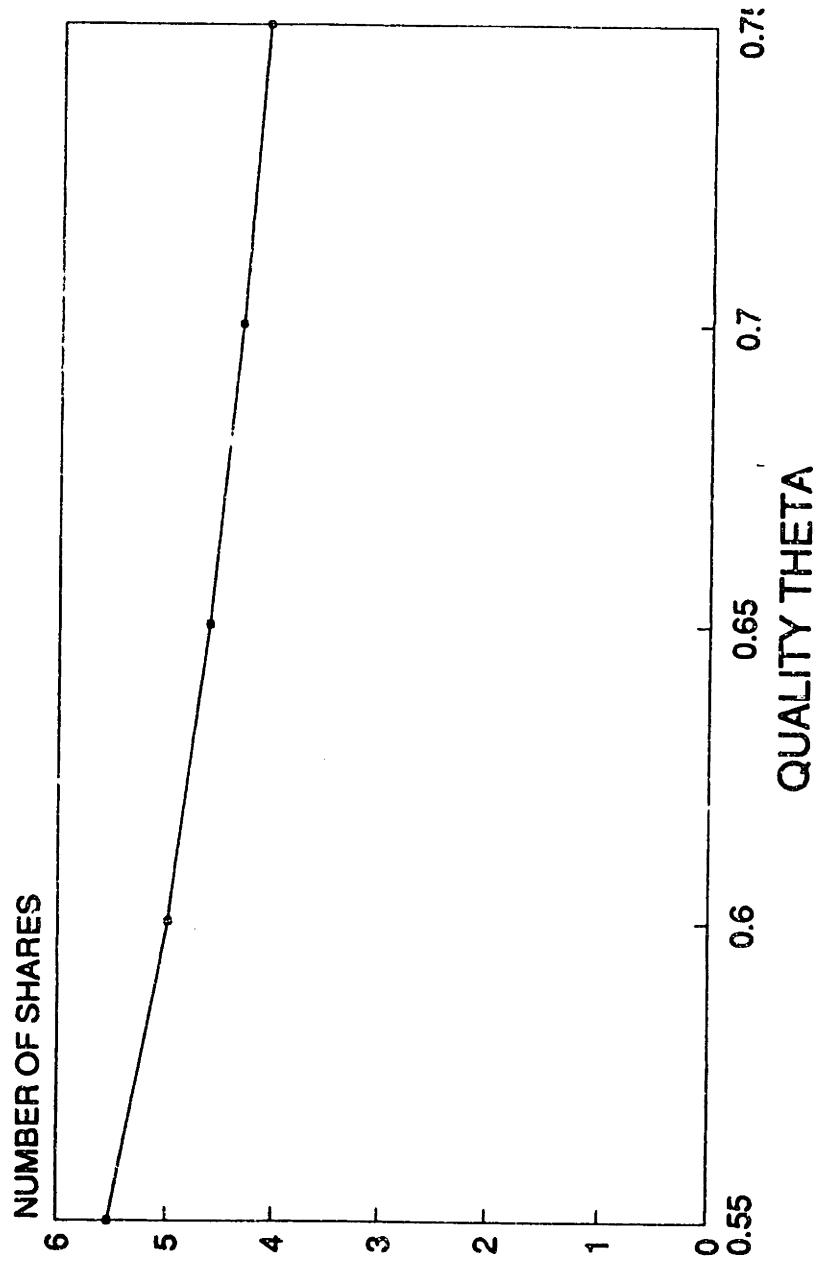
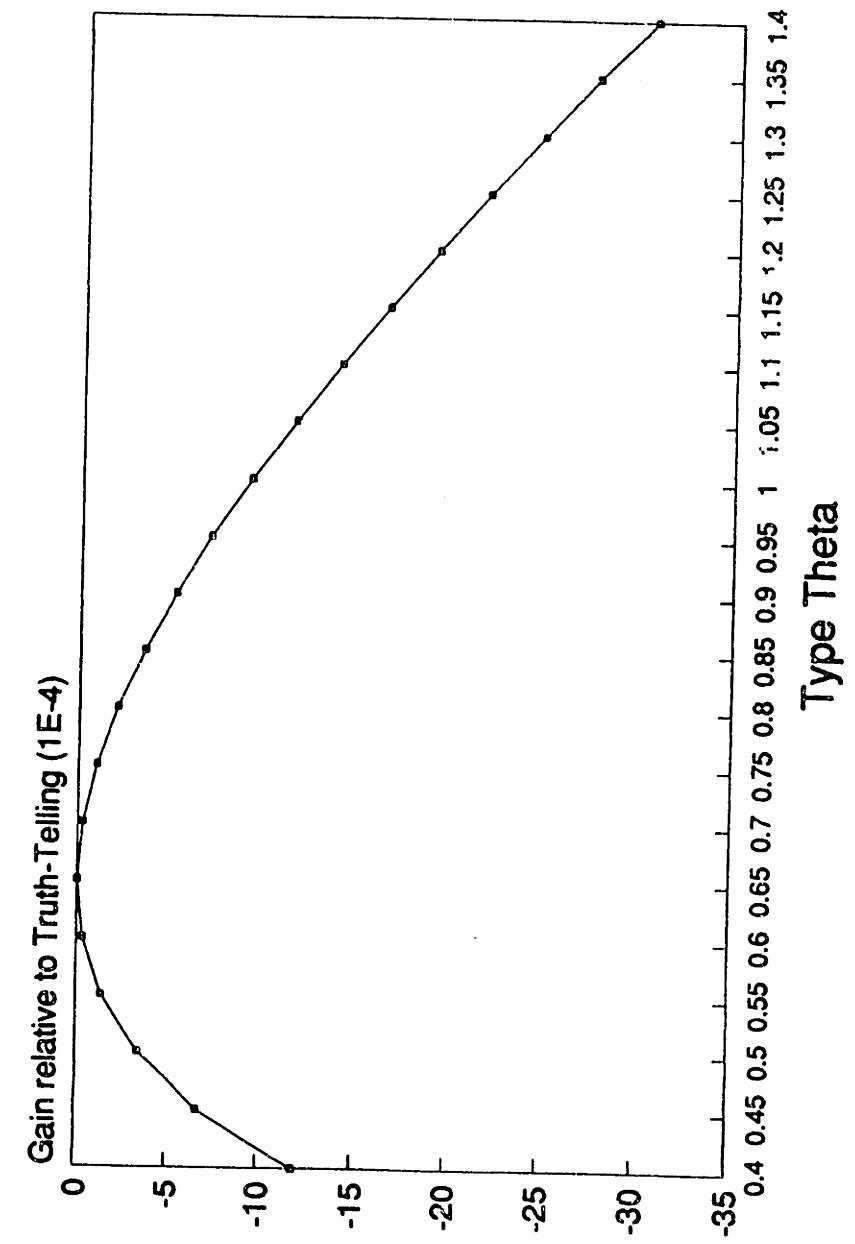


Fig 3. Gains for different types when bank announces $\Theta=0.65$



Appendix

Proof of Proposition 3.3

(A) We first define an arbitrary initial step by picking a_1 . Now we have to find $y^0 \in \Psi$ such³⁵ that it is incentive compatible for the investor to sue if he knows that $\theta \in [\underline{\theta}, a_1]$ and only if he observes a realization $y \leq y_0$. i.e substituting parameters in (3) of Proposition (3.3), it must be that $\sigma(\theta^{AVG}(\underline{\theta}, a_1), y) = 1$ iff $y \leq y_0$. We start by conjecturing $y_0 = y^k$ and check the condition. If it holds, by Lemma 3.1, $y_0 = y^k$. If it does not hold we check for y^{k+1} and so on. If no such y_0 exists, the investor does not sue when he encounters a signal from this step. Now $U^B_0(I(\theta^{AVG}(\underline{\theta}, a_1)), \theta, D)$ is well defined in step 0.

A suing strategy is completely determined by a tuple consisting of a signal and a corresponding level of y at and below which the investor sues. Now, suppose we have determined upto step $i-1$ the step end-points $(\underline{\theta}, a_1, \dots, a_i)$ as well as y_0, \dots, y_{i-1} such that on seeing signal $\hat{\theta}_j$ at date 0, the investor sues at date 1 for all $y \leq y_j$. Now consider the bank of type a_i . Assume the investor sues after seeing signal θ_i and realizations $y \leq y_i^*$. Let a_{i+1}^* solve

$$U^B_{i+1}(I(\theta^{AVG}(a_{i+1}, a_i)), \theta, D) = U^B_i(I(\theta^{AVG}(a_i, a_{i+1})), \theta, D) \quad \text{---(AC)}$$

By strict concavity of U^B_i for a given y_i^* , and as $I(\theta^{AVG}(a_i, a_{i+1}))$ is increasing in both arguments a_{i+1}^* is unique. We can easily show

Lemma 3.3: If $a_{i+1}^* = a'$ solves (AC) when $y_i^* = y'$, then $a_{i+1}^* = a'' > a'$ solves (AC) when $y_i^* = y'' < y'$.

Proof: Omitted.

Lemma 3.4: If it is incentive compatible for the investor to sue for all $y \leq y_i^*$, in a step $[a_i, a')$ then

³⁵ We can easily incorporate constraints on litigation - for example that the investor can sue only if he has incurred a loss. We do this in the example.

it is incentive compatible for him to sue for all $y \leq y^*$, in a step $[a_i, a'']$ where $a'' > a'$.

Proof: Omitted.

The rest of the construction is simple using these Lemmas. Assume we have solved till step i-1.

Let $y_i = y^k$.

(B) Find a_{i+1}^* which solves (AC).

B.1) If $a_{i+1}^* > \bar{\theta}$, then start again at (A) with another value of a_i . Lemma 3.3 permits us to conclude that no solution exists as the solution with any other suing strategy would also exceed $\bar{\theta}$.

B.2) If $a_{i+1}^* \leq \bar{\theta}$,

then check if it is incentive compatible to sue for all $y \leq y^i$.

B.2.1) If yes then check if incentive compatible to sue for the next higher y to y_i .

B.2.1.1) If yes, then no solution exists for this value of a_i . Start with a different value at step (A).

B.2.1.2) If no, then (B.2.1.2.1) if $a_{i+1}^* = \bar{\theta}$, we have a partition equilibrium with i steps.

(B.2.1.2.2) if $a_{i+1}^* < \bar{\theta}$, we have solved for the i^{th} step. Go to (B) with $i = i + 1$.

B.2.2) If no, set y_i to the next lower y and go to (B). If no such y exists, start again at (A).

Note that by this algorithm, varying a_i up from $\underline{\theta}$, we can trace out all the partition equilibria in one pass. By applying Lemma 3.3 and Lemma 3.4 after step B.2.1.2, we can assure ourselves that for every initial point a_i , the equilibrium suing response determined by this algorithm is unique (if a solution exists) and hence the equilibrium is unique. The pooling or babbling equilibrium trivially shows that an equilibrium exists.

Having generated the partition, we know the conjectured strategies are best responses for the investor. It remains to be shown that a signal $\hat{\theta}_i$ is a best response for a bank of type $\theta \in [a_i, a_{i+1}]$ to $I(\theta^{\text{AVG}}(a_i, a_{i+1}))$.

i.e that $U_i^B I(\theta^{\text{AVG}}(a_i, a_{i+1})) , \theta , D) = \max_j U_i^B I^M(\theta^{\text{AVG}}(a_j, a_{j+1}), \theta, D) -(AB)$.

But because $U_{12}^B > 0$ (Assumption 6), and $\theta \in [a_i, a_{i+1}]$ it follows that

$$\begin{aligned}
& U^B(I(\theta^{IVG}(a_i, a_{i+1})), \theta, D) - U^B(I(\theta^{IVG}(a_j, a_{j+1})), \theta, D) \\
& \geq U^B(I(\theta^{IVG}(a_i, a_{i+1})), a_i, D) - U^B(I(\theta^{IVG}(a_j, a_{j+1})), a_i, D) \geq 0 \quad (i) \quad \text{and} \\
& U^B(I(\theta^{IVG}(a_i, a_{i+1})), \theta, D) - U^B(I(\theta^{IVG}(a_k, a_{k+1})), \theta, D) \\
& \geq U^B(I(\theta^{IVG}(a_i, a_{i+1})), a_{i+1}, D) - U^B(I(\theta^{IVG}(a_k, a_{k+1})), a_{i+1}, D) \geq 0 \quad (ii)
\end{aligned}$$

where (i) and (ii) hold for any $0 \leq j \leq i \leq k \leq N$ and the second inequality in each expression is by concavity. Hence (AB) is proved. Q.E.D

Chapter 4 A Note on Indexation in the Presence of Debt

ABSTRACT

In response to the L.D.C debt crisis, several economists have suggested indexing a country's debt to some measure of its ability to pay like exports. Indexation reduces the states in which the country defaults and hence the costs associated with potential default. Yet indexation has only been marginally used in debt reduction plans. This note shows why the conversion of outstanding straight debt to indexed debt is more difficult than other forms of debt reduction. If creditors each hold small fractions of outstanding debt, substantial default risk has to exist after conversion in order to give them incentives to convert. However, if the fraction each creditor holds is large, the country can credibly threaten to not invest and get conversion to default free indexed debt. This suggests that a country facing a debt overhang has an incentive to delay till small creditors sell out before it offers an acceptable indexation plan.

Introduction

In response to the L.D.C. debt crisis, several economists (for example Lessard and Williamson 1985, Lessard 1987, Fischer 1987) have suggested indexing a country's debt to some measure of its ability to pay, like exports or G.N.P. If the ability to pay is also correlated with the ability of creditors to inflict penalties, indexation leads to better collateralization of the debt. This is beneficial to the country as it improves the country's ex-ante ability to borrow (Eaton, Gersovitz and Stiglitz (1986)). Indexation also reduces costly renegotiation and improves investment incentives by making the debt write-down in states of default explicit. In addition, Lessard (1987) suggests that countries which are dependant on a single commodity can diversify price risk by issuing bonds which pay a rate varying directly with the commodity price. Finally, Froot, Scharfstein and Stein (1989) show that indexing debt payment to revenues helps separate the countries that truly need debt relief from those that do not.

Despite these potential advantages, indexation has seldom been a part of L.D.C. debt reduction plans. Even if offered it has only been partial in the following sense; First, it has been offered as only one in a menu of options to old debt holders. The other options usually involve exchanging old bonds for new fixed debt obligations which are lower in face value but better collateralized than the old fixed claims. Second, the indexation has taken the form of linking the interest rate *above a fixed floor rate*¹ to some measure of the ability to pay. To the extent that there is a significant fixed portion of debt after the debt has been converted, a substantial amount of default risk is retained. Indexation, so far, appears to be less a means of risk sharing or reducing the probability of default than a means of giving the converting creditor some of the upside as an 'equity kicker'.

Similarly, indexed bonds have not been widely used to restructure debt in the corporate

¹ Priovolos (1988) finds that 95% of corporate issues of indexed debt are commodity linked bonds (with a floor value) rather than commodity convertible bonds which have no floor value but are completely contingent on the value of the commodity.

sector in the United States, though income bonds² were issued in the railroad reorganizations and commodity swaps are gaining favor.

It is clear that a country has a disincentive to issue equity-like instruments, like indexed debt, when it already has a substantial amount of risky debt outstanding. The reason, familiar from the corporate finance literature, is that such an issue results in a transfer from the residual claimants (the country) to old fixed claim holders (the creditor banks). The issue of equity-like instruments reduces default risk thus increasing the value of old risky fixed claims. As the new claimholders break even, the increase in value is paid by the old residual claimants - in this case the country.

But in a debt conversion or reduction plan, all the existing debt is sought to be converted. If so, what accounts for the rarity of indexed schemes?

This note shows why the conversion of outstanding fixed claims³ to indexed debt is more difficult than other forms of debt reduction or conversion. Unlike a debt reduction plan where creditors (henceforth called banks) write down a portion of the outstanding straight debt to a lower face value, (henceforth called a *write-down*), indexation can improve investment incentives without requiring a decrease in the expected value of the outstanding claims. However, the familiar hold-out or free-rider problem still occurs; a bank that 'holds-out' and does not convert its claim from straight debt to indexed debt gains, if other banks convert.

The hold-out problem here *differs* from that in a straight debt write-down in important ways. First, if each bank accounts for a small fraction of the loan, its incentive to hold out is much higher than in a write-down. Second, the incentive of the hold-out banks to convert need not be improved by making the converted debt senior. In a write-down, however, banks always convert when faced with such a rule. Third, the firm or country will end up paying more in expectation,

²The payment on income bonds increases in the profits of the firm up to a point, after which the payment becomes fixed. Schlarbaum and McConnell (1981) test - and reject - the hypothesis that the unpopularity of these bonds stems from an irrational mental association of these bonds with bankruptcy.

³ By fixed, we mean fixed in real terms. Most country debt is linked to the Prime rate or LIBOR.

as a result of hold-outs, than it expects to pay if no indexation takes place.

If each bank holds a small fraction of the debt, substantial default risk has to exist after conversion in order to give banks an incentive to convert. This, in a sense, nullifies many of the above reasons for converting to indexed debt, hence the use of indexation only as some kind of equity participation. However, when the fraction held by each bank is large, the country can credibly threaten to not invest and get conversion without retaining default risk ex-post. If small holders tend to sell out over time because of high fixed costs of monitoring and renegotiation, the country has an incentive to drag on debt renegotiation, while letting the size of the debt mount. While this makes ex-post renegotiation efficient, it gives perverse ex-ante incentives. We end by discussing other possible reasons for the rarity of indexed debt.

Section 1: The Model

We consider a risk-neutral world where a country has foreign exchange reserves and assets worth L , at date 0. It also has the opportunity to invest I in a mine, which will produce output X of ore at date 1. The country produces only this commodity for export, and all the ore is exported for consumption goods. The price of ore at date 1 is p , which is uncertain at date 0 and publicly verifiable at date 1. Its distribution $F(p)$ and density $f(p)$ are common knowledge and have support $[p, \bar{p}]$. Let $E(p)X > I$ where E is the expectations operator, so that the investment improves welfare.

The country has debt outstanding to the banks of face value D at date 0. Let fraction a mature at date 0, while fraction $(1-a)$ matures at date 1. We assume initially that all capital goods for the investment have to be bought in foreign exchange. At present, we also assume the country's ability to pay and the banks' ability to levy penalties are the same; The banks can credibly commit to levying penalties up to $pX + L$, that is, they can seize all the exports and the country's foreign assets if the country does not pay. As set up so far, the situation is identical to that faced by a firm with cash and current assets worth L .

The country cannot pay off all its debt, i.e $L < D$. Also $pX + (L-I) < D$, so that there is some chance of default, even after investment. The country suffers costs of financial distress if

it defaults at date 1. An example of these costs are those dissipated in building up bargaining position before renegotiating the debt. Finally, the interest rate is zero and everyone is risk neutral.

We consider first the case when the country has enough money to pay off currently maturing debt and invest i.e $L \geq aD + I$. The country wants to minimize the probability of default at date 1 by recontracting debt claims. The sequence is as follows; the country first makes a take it or leave it offer to the banks. The banks then individually and simultaneously decide to accept or reject the offer. The country invests if it can, the state is realized and the existing or recontracted claims paid out. We focus only on pure strategy equilibria of this game.

We consider fixed claims and price contingent claims.⁴ Let the country offer to convert each dollar of face value of existing straight debt into price indexed debt, which pays $G(p)$ when the price is p . Sufficient conditions for an indexing scheme to minimize the costs of default are

$$0 \leq D \frac{dG(p)/dp}{X} < 1 \quad \text{--(A.1)}$$

$$G(0) = 0 \quad \text{--(A.2)}$$

(A.1) requires that the debt payment increase with price at a slower rate than revenues. (A.2) requires that there be no fixed component to debt.

Assume at first that existing debt is held by many symmetric banks. Let fraction α of the banks agree to convert. As the indexation scheme is monotonic in p , for every α there is a unique default price p_d below which the country defaults. This is implicitly defined by

$$G(p_d)\alpha D + (1-\alpha)(1-\alpha)D - p_d X - [L-I-\alpha(1-\alpha)D] = 0 \quad \text{(4.1)}$$

The first term in (4.1) is the payment at date 1 to indexed debt, the second is that to straight debt maturing at date 1, the third is the revenue from the project and the term in square brackets is the amount carried over from date 0. Totally differentiating, then substituting (4.1),

⁴ Allowing equity claims will not change the analysis- price contingent claims are simply equity claims.

$$\frac{dp_d}{d\alpha} = \frac{G(p_d)D - p_d X - (L-I)}{(1-\alpha)(X - \alpha G'(p_d)D)} \leq 0 \quad (4.2)$$

Indexed debt requires a lower payment in states of low price and hence lowers the default price. This reduction in states of default is the main benefit of indexation. Note that as $\alpha \rightarrow 1$, $p_d \rightarrow 0$, which is a consequence of assumptions (A.1) and (A.2).

Consider now a bank possessing old debt with face value of one dollar. Let the value when converted to indexed debt be V_I , while the value when the bank holds out, i.e. rejects the offer and does not convert, be V_H . Assuming first that indexed debt ranks pari-passu with old debt,

$$V_I(\alpha) = \int_E^{P_d(\alpha)} \frac{G(p)\alpha}{(1-a)(1-\alpha) + G(p)\alpha} \frac{pX + (L-I) - a(1-\alpha)D}{\alpha D} f(p) dp + \int_{P_d(\alpha)}^{\bar{p}} G(p)f(p) dp \quad (4.3)$$

$$V_H(\alpha) = a + \int_E^{P_d(\alpha)} \frac{(1-a)(1-\alpha)}{(1-a)(1-\alpha) + G(p)\alpha} \frac{pX + (L-I) - a(1-\alpha)D}{(1-\alpha)D} f(p) dp + \int_{P_d(\alpha)}^{\bar{p}} (1-a)f(p) dp \quad (4.4)$$

$V_H(0)$ is the expected value, per dollar of face value of existing debt, when no indexation takes place. It is easily shown that $\frac{dV_H}{d\alpha} \geq 0$ --(4.5).

The intuition is; First, as the amount paid out at date 0 is lower, there is more cash carried over and shared at date 1. Second, as indexed debt is of a lower face value in default states, each dollar of hold out debt becomes relatively more senior and gets a larger share of the amount distributed in the default states. Finally, the states in which the hold-out debt is fully paid off, increase from (4.2).

$$\text{In equilibrium, } V_I(\alpha) = V_H(\alpha) \quad --(4.6)$$

i.e the marginal bank must be indifferent between indexing and holding out. From (4.5) and (4.6), $V_I(\alpha) \geq V_H(0)$ i.e the country makes a higher expected payment, in order to get banks to convert to the indexed loan, than with no indexation. Further, in order to get all banks to index, it has to give them an expected value equal to the face value of the existing debt. The intuition is that each one of the converting banks expects a payment equal to the value of holding out. In the limit as bank holdings become infinitesimal, the hold-out's claim is safe as the default point falls to zero.

i.e As $\alpha \rightarrow 1$, $V_H \rightarrow 1$, i.e the hold out debt is fully paid off. In order to get everyone to convert, the country has to offer a premium exactly equal to the discount on the existing debt.

Section 2: Seniority, hold-out and hold-in

One way suggested to get around this free-riding is to make the hold-out debt junior to debt that converts (Dooley (1989), Gertner and Scharfstein (1990)).⁵ A seniority rule affects the value of claims in states of default. Comparing the value of holding out under this seniority rule, with the value under indexation,

$$V_H(\alpha) - V_f(\alpha) = a + \int_2^{p_d(\alpha)} \left[\frac{pX + (L-I) - a(1-\alpha)D - G(p)\alpha D}{(1-\alpha)D} - G(p) \right] f(p) dp + \int_{p_d(\alpha)}^{\bar{p}} ((1-a) - G(p)) f(p) dp \quad (4.7)$$

When debt is only partially indexed, default occurs between price states p and $p_d(\alpha)$. The first integral in (4.7) is the difference between the amount obtained by hold-out debt and that obtained by indexed debt in states where default occurs, while the second integral is the difference when default does not occur. Again note that as more banks convert, the second term dominates the first. It is not possible to freeze the free-riders out because the seniority of converted debt in states of default, is offset by the reduction in the face value of these indexed claims. In the limit as $\alpha \rightarrow 1$, regardless of seniority, the hold-out always gets the face value of its claim. Contrast this with a simple debt write-down where the marginal bank always converts to avoid being frozen out in the default states. Thus in a simple debt write-down, a seniority clause causes a 'hold-in' effect (Gertner and Scharfstein (1990)), where everyone rushes to convert. This effect is absent in a default-free indexation scheme, because the probability of default has been reduced to zero and seniority has no bite.

In summary, if the purpose of debt conversion is to reduce the probability of default, it is optimal to convert fixed claims to claims which vary with the ability to pay. The problem is that

⁵ For example by issuing bearer bonds which are less easily negotiated, in place of existing bank loans.

such claims are prone to costly free-rider problems. We have shown that when banks are small, *no default free indexed scheme is possible*.

An immediate solution is to offer senior claims structured such that they default for low price realizations. Some probability of default is retained after conversion so as to provide incentives for conversion. We solve for such a contract in the Appendix. This resembles the actual debt restructuring plans seen.

A new claim structured with zero default probability is possible if the country can make a credible threat to not invest if the bank holds-out. This requires restructuring claims so that a single hold-out imposes such high costs on the country that it cannot invest. Obviously, this is possible only if each bank's fractional holding is sizeable. We explore this next.

Section 3: Indexation with the ability to under-invest

Suppose now that investment I cannot be made under the existing conditions. This occurs if, first, the country does not have enough cash to invest and pay off currently maturing debt and second, the existing debt overhang does not permit enough borrowing to finance the investment. More formally, these conditions are

$$I + aD - L > 0 \quad (4.8)$$

$$I + aD - L > \int_{p_A(0)}^{\bar{p}} (pX - (1-a)D) f(p) dp \quad (4.9)$$

(4.8) is a cash constraint while (4.9) indicates the inability to borrow enough to invest without a debt reduction or conversion. We assume that the country first offers to index existing debt after which it raises new funds. The offer must give existing banks more than what they get by refusing to lend new money and only levying penalties today,

$$L \leq \int_0^P G(p) D f(p) dp \quad (4.10)$$

In order that the country be able to borrow to invest, it must be that

$$\text{Free Income Stream} = \int_0^P (pX - D G(p)) f(p) dp \geq I - L \quad (4.11)$$

Of course, this is conditional on each bank converting. If the hold-out by the marginal bank does not change country's ability to invest, then this offer will not be accepted; from (4.9) and (4.10) it is easily seen that banks must accept $V_I < V_H(0)$, which by (4.5) and (4.6) is not possible in equilibrium.

The interesting case is when the country's investment decision changes conditional on the bank holding out. Let there be n symmetric banks who hold existing debt. If one bank holds out, $\alpha = 1 - 1/n$. The gain from holding-out = $\Delta(\alpha, D) := (1-\alpha)D [V_H(\alpha) - V_I(0)]$

If the bank holds-out, the country has to pay the current maturity of existing hold-out debt $(1-\alpha)aD$. Also, the future amount the country can promise new banks is reduced by the amount of the future transfer to the hold-out. This reduces the amount the country can borrow to finance investment. The country can credibly threaten not to invest if:

$$\text{Free Income Stream} - \Delta(\alpha, D) < I - L \quad (4.12)$$

Higher the gain from holding out $\Delta(\alpha, D)$, higher the ability of the country to credibly threaten to not invest. The comparative statics for Δ are;

$$\Delta_1(\alpha, D) = -D [V_H'(\alpha) - V_I(0)] + (1-\alpha)D V_H'(\alpha) ; \Delta_2(\alpha, D) = (1-\alpha)[V_H(\alpha) - V_I(0)]$$

$$\Delta_{11}(\alpha, D) = -2D V_H'(\alpha) + (1-\alpha)D V_H''(\alpha)$$

Note that as n decreases, α decreases, the individual bank's holdings become larger, while its marginal gain per dollar decreases. If V_H'' is small, the former effect dominates when α is small. The gain from holding out, conditional on investment taking place, increases as the individual bank holdings increase. Therefore the cost that each bank inflicts if it does not index

grows.

Once the cost of holding out grows to the point where (4.12) is satisfied, the country can make an offer that no individual bank can refuse, for the bank knows that holding out will prevent the country investing. Paradoxically, increasing the priority and magnitude of the bank's claims beyond a point improves the ability of the country to force conversion through a credible threat to not invest. Also, if the fraction of each bank's holdings is small, the country has an incentive to delay meaningful renegotiation till such time as monitoring and renegotiation costs force small creditors to sell out to the larger creditors.

Ex-post, this ability to force conversion through financial distress may be good as it improves efficiency, but ex-ante it may reduce the incentives of the country to avoid financial distress. A more subtle feature is that the country has an incentive to pay out or waste its cash at date 0, so as to increase the amount it has to borrow. If the country has good investment opportunities, it can then credibly threaten to forego them unless given debt relief. Of course, this threat would never work if banks were small and dispersed. This again reflects the idea that though having dispersed investors is not ex-post efficient, it can be ex-ante more efficient in that it provides the country a 'hard' budget constraint.

We re-examine our analysis differ under the assumption that the ability of the country to pay and the ability of banks to inflict penalties differ.

Section 4: Difference between ability and willingness to pay

Our entire analysis carries through unchanged if the actual fungible current wealth that the country possesses (liquid assets and reserves) L_C is more than that the banks can extract through threat of sanctions, L . This matters only in terms of the country's ability to make credible threats to not invest. But as the country can be thought of as having a reservation value $L_C - L$, the credibility constraint (4.12) transforms to:

$$\text{Free Income Stream} - \Delta(\alpha, D) - (L_C - L) < I - L_C \quad \text{which reduces back to (4.12).}$$

If pX represents only what the banks can seize of the revenues from the mine, our entire

analysis carries through unchanged. However, if in addition $L_c > L$, the credibility constraint changes. The country has a greater private ability to invest because some of its cash reserves are not extractable. It also has a greater private incentive to invest as some of the revenues from the project cannot be extracted by the banks. It is now less credible for countries to threaten to not invest in projects if the individual bank holds out. In fact, if the country has excess reserves compared to the ability of banks to inflict penalties at date 0, the component of investment⁶ directed to projects producing for domestic consumption rises, first, to reduce current reserves⁷ and second, because the country's incentives here are higher.

Finally, if the ability of banks to inflict penalties does not cumulate, then the analysis is substantially different. Any debt rescheduling is tantamount to forgiveness unless the country invests all the current extractable cash in assets which produce revenues which can be seized from the country. Banks will be reluctant to forgive current maturities of debt as they have no ability to extract it in the future. The country's borrowing capacity is restricted to the future ability of banks to inflict penalties. There is underinvestment for two reasons; First, the country has a lower incentive to invest because of the Myers' underinvestment problem and second, the country has a lower ability to borrow because of the inability to commit to pay.

So far, we have only discussed why countries faced with financial distress may not be able to convert their straight debt to indexed debt easily. It is not necessary that the existing fixed claim be explicit as in debt claims. A country or a firm has outstanding implicit fixed claims. For example, the implicit contracts that the firm has with its employees, the government and other stakeholders could be viewed as risky fixed claims. Thus this reluctance to index could extend to cases where firms have no debt outstanding. We now suggest other reasons why indexed debt may have costs.

⁶ This could be consumed rather than invested.

⁷ The incentive to run down cash reserves is counterbalanced by an incentive to build cash so as to be able to credibly threaten to go it alone if banks pull the plug.

Section 5: Other costs of Indexed Debt

First, the most appropriate variable to index to, may partially be within the control of the country. For example, indexation to revenues diminishes the incentives of the country to produce those revenues. Indexation for a firm can also be detrimental to the extent that financing influences strategy in product market competition. In an oligopolistic market, a firm with debt indexed to price is susceptible to predation by competitors. By reducing production, competitors can drive the price high and force the firm into bankruptcy. Of course this works only if the firm has capacity constraints and shallow pockets. On the other hand, if all firms have deep pockets or flexible capacities, price indexation by one firm would be copied by other firms. This increases competition in the industry and pushes profits below the Cournot level. In order to avoid this 'bad' equilibrium, firms would not index in the first place.

Even if the firm or country does not act strategically with respect to the indexing variable, problems can arise. For example, indexing to price is useful only if the commodity does not suffer from large quantity variations. It would be inappropriate for a major coffee producer to have its debt indexed to coffee prices. If the coffee crop fails, the ability to pay is low, precisely when the world price is high. This explains why agricultural commodities may not be good candidates for indexing.

Finally the rationale behind indexing may not always hold. In theory, payments by an agent in bad states are costly either because of risk aversion or because of costs of financial distress. Yet the high payments in good states, needed to offset low payments in bad states, can also be costly. For example, it is natural to think that a firm would like to invest when the price is expected to be high. If the price today is the best expectation of the price in the future, the firm wants to invest precisely when its payments are high. In so far as the ability to borrow is leveraged up by wealth, price indexation reduces its ability to borrow and invest, precisely when its competitors are doing so. An indexed contract which involves an actual outflow of wealth may then be dominated by an equity contract (or foreign direct investment in the case of a country), which allows creditors to participate in the up-side without requiring an immediate actual outflow from the firm.

Section 6: Conclusion

We have discussed why conversion of fixed claim contracts to contracts which insure completely against default may not be possible. Our analysis suggests why it has been so difficult for countries with a debt overhang to index their debt completely. This implies a role for contract design in making indexed contracts more popular and attractive.

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Appendix

As the analysis in the text is for a country, the analysis we perform here is for a firm. Let the costs if default occurs be $C(p_d)$ where p_d is the price below which default occurs. Much recent research has argued that the costs of financial distress increase as expectations of financial distress increase (Brealey and Myers (1988), Titman(1984)). It is natural to think that the costs of default $C(p_d)$ increase in p_d , which is what we assume. We now want to determine the optimal contract the firm should offer if banks are infinitesimal. Let the firm offer a new contract in which hold-outs are subordinated to those who convert.

The firm wants to find $G(p)$ to minimize

$$\begin{aligned}
 & F(p_d) \cdot C(p_d) + \int_{p_d}^{p_s} p X f(p) dp + \int_{p_s}^{\bar{p}} D G(p) f(p) dp \\
 \text{s.t. } & \int_{p_d}^{p_s} \frac{p X}{D} f(p) dp + \int_{p_s}^{\bar{p}} G(p) f(p) dp \geq (1 - F(p_d)) \quad (\text{i}) \\
 & \text{and } \int_{p_d}^{p_s} \frac{p X}{D} f(p) dp + \int_{p_s}^{\bar{p}} G(p) f(p) dp \geq \frac{L}{D} \quad (\text{ii})
 \end{aligned}$$

The objective function is the sum of the costs of financial distress and the payments on the recontracted claims. The new borrowing will have an NPV of zero and can be omitted. Constraint (i) requires that the (infinitesimal) bank prefer to index rather than to hold-out. Constraint (ii) requires the bank to prefer to index rather than liquidate. If the costs of default are high, the second constraint will not bind, while the first will. The problem can then be re-written as

$$\min_{p_d} F(p_d) \cdot C(p_d) + D(1 - F(p_d))$$

An implicit constraint is that the indexation scheme be such that there be no default at a price higher than p_d . We omit this constraint now but will construct a solution to the unconstrained problem that satisfies this. The F.O.C is $F'(p_d) [C(p_d) - D] + F(p_d) C'(p_d) = 0$

An optimal indexing scheme should satisfy the individual rationality conditions and the condition that default only at a prices (weakly) below p_d . We calculate the optimal linear scheme for a uniform distribution: Consider $p \sim U[p, \bar{p}]$ and $C(p_d) = Cp_d + d$. It follows that $p_d = \frac{D-d}{2C}$.

An optimal scheme which achieves this is

$$\begin{aligned}
 G(p) &= p_d X/D && \text{for } p \leq p_d \\
 &= b(p - p_d) + p_d X/D && \text{for } p > p_d
 \end{aligned}$$

It is easily shown that a constant b can be found such that all the rationality and default conditions are satisfied if $X/D > \frac{2(\bar{p}-p_d)}{(\bar{p}^2-p^2)}$. The optimal scheme has positive default probability if $\frac{D-d}{2C} > p_d$.