Renegotiation and the Impossibility of Optimal Investment

John C. Persons
Ohio State University

In a model with asymmetric information and external equity financing, it is impossible to achieve socially optimal investment because of renegotiation possibilities. The contractual solution suggested by Dybvig and Zender (1991) is not dynamic&y consistent-the manager's contract would be renegotiates resulting in inefficient investment. Moreover, no other compensation contract that would induce the manager to invest efficiently survives renegotiation. Contracts that pay t&e manager based on the stockprice, while producing suboptimal investment as in Myers and Majluf (1984), are robust to renegotiation.

In an influential article, Myers and Majluf (1984) show that a manager acting in the interest of current shareholders may pass up a positive net present value (NPV) project if the firm must finance it by issuing new shares. The key assumption is that the manager has superior information about the firm's future cash flows. When the firm's shares are underpriced, issuing new shares transfers wealth from current shareholders to new investors, reducing the benefits of the new project; if the underpricing is severe enough, current shareholders are better off if the firm rejects the project and avoids the equity issue.

I wish to thank P. Dybvig, R. Green (editor), C. Leach, F. Longstaff. D. Mayers, J. Paul, C. Spatt (executive editor). R. Stulz, V. Warther. R. Young, J. Zender. and an anonymous referee for their comments. I am grateful for financial support from the Charles A. Dice Center for Research in Financial Economics. Address correspondence to John C. Persons. Ohio State University. Fisher College of Business, 1775 College Road, Columbus, OH 43210.

Dybvig and Zender (1991) argue that this underinvestment problem, if it exists, results from offering the manager a suboptimal contract. They present a simple profit-sharing contract that induces the manager to invest efficiently (i.e., to follow the NPV rule). They question the relevance of many recent corporate finance models because the models "impose by fiat a suboptimal contract."[1]

I argue that the problem of suboptimal investment is more stubborn than they suggest. The setting is as in Dybvig and Zender (1991), but the manager and the board of directors are free to privately renegotiate the manager's contract. This makes it *impossible* to achieve efficient investment-any contract that would have induced optimal investment will be renegotiated, and suboptimal investment results. The manager has private information about the firm's profits, and the contract is renegotiated to exploit this information to the mutual benefit of the manager and shareholders.

The incentives to renegotiate and invest inefficiently arise from mispriced equity issues, as in Myers and Majluf (1984). Under any contract that induces efficient investment, the mispricing of equity issues produces cases where the manager's investment decision is contrary to shareholder interests *at the time the decision is made.* For example, the manager accepts slightly profitable projects even though the firm's shares are badly underpriced, or he rejects slightly unprofitable projects even though the firm's shares are severely overpriced. Shareholders would like the manager to change investment policy, but the only way to persuade the manager is to increase his compensation. I allow the board of directors (which acts in the interest of current shareholders) to offer the manager a new contract, which he is free to reject. The question is whether there is some new compensation contract where shareholder gains from changing investment policy exceed shareholder losses from increasing the manager's pay. I show that such a contract always exists-any initial contract that promotes efficient investment will be renegotiated and investment will be suboptimal. Any contract that survives renegotiation-that is, that would not be discarded to exploit the manager's private information-produces suboptimal investment.[2]

There are no explicit costs of renegotiation in the model. If such costs were large enough, they could provide a significant barrier to renegotiation, thus making efficient investment possible. Shareholders do bear an implicit cost when the manager's contract is renego-

[1] Dybvig and Zender (1991, p. 201). In addition to Myers and Majluf (1984), they mention specifically Bhattachatya (1980). Miller and Rock (1985). Harris and Raviv (1985), and Ross (1977) as models to which their criticism applies.

[2] This conclusion is valid, given the space of contracts considered in the model. In particular, see the caveats discussed in note 7 and in Section 4.

tiated, because the manager captures some rents from his "raise." The analysis shows that these implicit costs are not large enough to prevent renegotiation of contracts that would otherwise produce efficient investment.

An important assumption is that the board and the manager cannot commit ex ante not to act opportunistically ex post by renegotiating the contract. There are incentives to make such a commitment, but there are also incentives to violate the commitment once it has been made. If commitment is feasible, the first-best outcome is achievable because contracts need not be dynamically consistent. But when the parties to a contract are free to change the contract, time consistency becomes important, and every dynamically consistent contract produces socially inefficient investment.

Many corporate finance models assume a firm's manager maximizes some increasing function of the stock price. For example, the manager may be given a fixed number of shares or call options, and perhaps a salary. Such "equity-based" contracts produce inefficient investment because of the problems analyzed by Myers and Majluf (1984); Dybvig and Zender (1991) criticize them as suboptimal contracts the modeler has imposed by fiat. However, equity-based contracts are robust to renegotiation-once in place, they survive when agents are free to renegotiate. This "staying power" of equity-based contracts stands in contrast to any contract that induces efficient investment decisions. The nature of the *optimal* contract that survives renegotiation is an open question.[3,4]

The article proceeds as follows. Section 1 outlines the model without renegotiation. Section 2 introduces renegotiation and presents the main results. Section 3 analyzes an example that shows what goes wrong with a profit-sharing contract. Section 4 discusses some issues that arise in the model regarding the board of directors, commitment, and capital structure. Section 5 concludes. Proofs of the propositions are in Appendix A.

1. The Model without Renegotiation

The model presented in this section is virtually identical to the model in Dybvig and Zender (1991)-the next section introduces the pos-

[3] One can construct examples with a finite number of "types" where an equity-based contract is optimal, as well as examples where no equity-based contract is optimal. The present model has a continuum of types, which makes it nontrivial to find the optimal robust contract even for specific examples.

[4] Paul (1992) shows how equity-based compensation can lead to inefficiencies in the allocation of managerial effort among projects. There is no moral hazard in the present model, so these issues do not arise.

sibility of renegotiation. The players are the manager of an all-equity firm and the firm's board of directors. The board chooses a compensation contract to offer the manager, and the manager sets the firm's investment policy. All participants are risk neutral, and the riskless interest rate is zero. There are three periods, labeled 0, 1, and 2. Period 0 represents the date when the manager is hired by the firm. In period 1, the manager decides whether to invest in a new project. Period 2 is the terminal date when the firm's cash flows are realized, the manager is paid, and shareholders receive any residual cash.

When the manager is hired in period 0, the firm has assets in place that will produce an uncertain terminal cash flow $\tilde{a}$ in period 2. Viewing past revenues and costs as sunk, I will speak of $\tilde{a}$ as the profit from existing assets. In period 1, a new project becomes available. The new project requires a period-1 investment I and produces a period-2 cash flow $I + \tilde{b}$, where $\tilde{b}$ is the profit or net cash flow from the project. The random vector $(\tilde{a}, \tilde{b})$ has a continuous positive probability density on $[0, \bar{a}] \times [-I, \bar{b}]$, where $\bar{b}$ is positive (the new project is sometimes profitable). This distributional information is common knowledge.[5,6]

Unlike everyone else, the manager knows the profits a and b when the project becomes available in period 1, so the manager has an informational advantage when he decides whether to invest in the new project. The manager's choice is denoted $d = 1$ if the firm accepts the new project and $d = 0$ if not. This choice d is the first bit of new information received by the public, and the price of the firm's shares adjusts to reflect the new information. If the manager accepts the project, the required investment I is raised through an equity issue. These funds must be invested in the project-that is, the manager cannot issue shares and then decide not to invest. When the cash flows are realized in period 2, the public learns its second bit of new information, the firm's total profit $a + bd$. As in Dybvig and Zender (1991), they do not learn the separate realizations a and b, which

[5] These distributional assumptions are consistent with, but more restrictive than, the assumptions of Dybvig and Zender (1991). (What I have called a is $I^* + a$ in their notation, where I^* is the initial investment in the firm.) They assumed only that $\tilde{a}$ and $\tilde{b}$ have compact support with $\Pr[b > 0] > 0$, $\Pr[b < 0] > 0$, and $\Pr[b = 0) = 0$.

[6] Given that the support of $(\tilde{a}, \tilde{b})$ is $[0, \bar{a}] \times [-I, \bar{b}]$, it may be possible for the public to ascertain ex post that the manager invested in a good or a bad project. If the manager invests and the terminal cash flow $a + I + b$ is smaller than I, then the project must have been bad; if the terminal cash flow is bigger than $I + \bar{a}$, it must have been good. However, the results do not depend on this artifact. If we were to take the support of $(\tilde{a}, \tilde{b})$ to be $\{(a, b) \in [0, \bar{a}] \times [-I, \bar{b}] \mid 0 \leq a + b \leq \bar{a}\}$, the results would go through. (In fact, the proofs need not be altered.) With this specification one cannot-tell for certain that b was positive or that it was negative. Because the (conditional) support of b would depend on the realization of $\tilde{a}$, this specification would rule out independence between $\tilde{a}$ and $\tilde{b}$.

precludes contracts directly contingent on 6. The manager receives his compensation and shareholders get the residual cash.'

The manager's contract specifies his compensation as a function of the investment decision d and realized profits $a + bd$; his compensation is denoted $s_0(d, a + bd)$. For each realization (a, b), the manager either accepts the new project ($d = 1$) or rejects it ($d = 0$); this deterministic investment policy is denoted $d_0(a, b)$.[8] I assume the firm has limited liability, and the manager cannot be compelled to pay the firm at the terminal date, so a compensation contract s_0 must satisfy

$$0 \leq s_0(d, a + bd) \leq a + (I + b)d \tag{1}$$

for each $d \in \{0, 1\}$ and every (a, b).[9] The manager accepts the new project only if doing so maximizes his compensation. Let $s_0^*(a, b)$ denote compensation when profits are (a, b); that is,

$$s_0^*(a, b) = \max_{d \in \{0,1\}} s_0(d, a + bd). \tag{2}$$

As in the standard approach to the principal-agent problem, one can think of the board of directors specifying the investment policy $d_0(a, b)$ (even though they do not observe a and b separately), subject to an incentive compatibility condition: the investment decision always maximizes the manager's compensation. Thus, the board can prescribe any investment policy in which $d_0(a, b)$ is a maximizer in Equation (2) for each (a, b). For convenience, I will sometimes refer

---

[7]This information structure is a maintained hypothesis of the model. In period 1, the public knows only the investment decision d; in period 2, it also learns total profits $a + bd$. The manager, on the other hand, knows the realizations a and b when the new project arrives. This is in the tradition of Myers and Majluf (1984) and Dybvig and Zender (1991). Myers and Majluf take the information asymmetry between managers and investors as given and ask about the effect this has on investment policy. Dybvig and Zender (1991) *also* take the information asymmetry as given and investigate contracts that produce efficient investment decisions despite the asymmetric information.

A separate, and interesting, topic is what types of arrangements might alleviate or even eliminate the asymmetry. For example, one might use the compensation process to reduce the manager's informational advantage via a "revelation" mechanism, whereby the manager publicly announces a and b [*Myerson* (1979), Harris and Townsend (1981)]. Of course, if the public knows a and b, new issues are never mispriced, so the problems analyzed here and by Myers and Majluf (1984) cease to exist. If the public learns a and b ex post, then it becomes trivial to write a contract that forces efficient investment. Asymmetric information between the managerand the public is essential for the problem to be interesting, so I do not allow public revelation of a and b by the manager. As a practical matter, a and b might be very complex and hard to communicate [Hart and Moore (1988)], or the firm may not want such information to be public for competitive reasons (suppose the project is a new product the firm plans to introduce unexpectedly).

[8]The subscript zero on the functions s_0 and d_0 anticipates the next section, when renegotiation is added to the modeL. When recontracting is allowed, the initial contract (s_0, d_0) may he renegotiated in period 1 to (s_1, d_1).

[9]Dybvig and Zender assume that shareholders have unlimited liability though, as they point out (note 6, p. 205), their results are not sensitive to this assumption,

to the pair (s_0, d_0) as a contract; legally, the contract is the schedule s_0.

The task of investors (the "market") in the model is to estimate the value of the firm's shares. The aggregate market value of the shares in period 0 is denoted P_0. In period 1, the firm announces its investment decision, and the value of these shares changes to $P_1(d)$, which takes two possible values: $P_1(1)$ when the manager accepts the new project, and $P_1(0)$ when the project is rejected. Note that when the manager accepts the new project, $P_1(1)$ represents the market value of the *initial* shares-that is, the claim of the firm's current owners. When new shares are issued to raise the amount I needed for the project, the firm's market value will increase to $P_1 + I$, and the initial shareholders will own the fraction $P_1/(P_1 + I)$ of the firm.[10]

Given the price $P_1(1)$ one can determine the final payoff to shareholders; this payoff depends on whether the manager accepts the new project, and on realized profits $a + bd$. If the manager accepts the project, the terminal cash flow is $a + I + b$ and the manager gets $s_0(1, a + b)$, leaving $a + I + b - s_0(1, a + b)$ for shareholders. Of this total, the initial shareholders get the fraction $P_1/(P_1 + I)$ and the new investors get $I/(P_1 + I)$. If the manager rejects the project, no new shares are issued, so the initial shareholders get the entire residual $a - s_0(0, a)$. Therefore, letting P_2 denote the terminal payoff to the initial shareholders, we have

$$P_2(d, a + bd) = \frac{P_1(1)}{P_1(1) + Id}[a + (I + b)d - s_0(d, a + bd)]. \quad (3)$$

When the manager follows the investment rule $d_0(\cdot)$, this can be written as a function of the realization (a, b):

$$P_2^*(a, b) = \frac{P_1(1)}{P_1(1) + Id_0(a, b)}[a + (I + b)d_0(a, b) - s_0^*(a, b)]. \quad (4)$$

Equilibrium requires that market prices be rational. Since everyone is risk neutral and the interest rate is zero, this means the market value of the firm in period 1 must be an unbiased estimate (conditional on public information) of cash available for shareholders at the end of the game. When the manager rejects the new project, the market value of the firm is $P_1(0)$; when he accepts the project, it is $P_1(1) + I$. Equilibrium then requires that, for both $d = 0$ and $d = 1$,

$$P_1(d) + Id = E[\tilde{a} + (I + \tilde{b})d - s_0^*(\tilde{a}, \tilde{b}) \mid d_0(\tilde{a}, \tilde{b}) = d].$$

[10] P_1 must be positive for the firm to raise funds, so any equilibrium must have $P_1(1) > 0$. To see this, suppose the firm initially has N_0 shares outstanding and issues N new shares worth I. Then the initial shareholders' claim is worth $P_1 - N_0(I/N) > 0$, as claimed.

Subtracting *Id* from each side produces the first *equilibrium pricing condition,*

$$P_1(d) = E[\tilde{a} + \tilde{b}d - s_0^*(\tilde{a}, \tilde{b}) \mid d_0(\tilde{a}, \tilde{b}) = d], \tag{5}$$

which says the period-1 wealth of the initial shareholders is the expected difference between profits and compensation, conditional on the investment decision *d*. Stepping back to period 0, rational pricing requires that the shares be priced to earn zero expected return over the next period. This gives the second equilibrium pricing condition:

$$P_0 = EP_1(d_0(\tilde{a}, \tilde{b})) = E[\tilde{a} + \tilde{b}d_0(\tilde{a}, \tilde{b}) - s_0^*(\tilde{a}, \tilde{b})]. \tag{6}$$

Thus, shareholder wealth before the investment decision is announced is the unconditional expected difference between profits and compensation. The final payoff to the initial stockholders is $P_2^*(\tilde{a}, \tilde{b})$, and P_0 is the average payoff over all realizations (a, b).

Note that rational equilibrium pricing does not require that investors know the compensation function $s_0(\cdot)$, but only that they make unbiased estimates of profits, net of compensation. I assume that the details of the manager's contract are known only to the manager and the board of directors, which represents a widely dispersed group of shareholders. The private nature of the compensation scheme will be important when renegotiation is introduced in the next section. It is intended to capture the notion that the process a board of directors will use to evaluate management cannot be made public ex ante, though investors can form expectations about future compensation (e.g., based on past compensation). This assumption is discussed furthur in Section 4 2.

Since P_0 is the expected payoff of the initial shareholders, it is clear from Equation *(6)* that they would like to minimize the manager's average compensation $Es_0^*(\tilde{a}, \tilde{b})$ and maximize $E[\tilde{b}d_0(\tilde{a}, \tilde{b})]$ the average profit reaped from the new project. $E[\tilde{b}d_0(\tilde{a}, \tilde{b})]$ is maximized if the manager invests when *b* is positive but not when it is negative-that is, if the manager follows the NPV rule. The manager's pay cannot be made directly contingent on *b* because only total profits $a + bd$ are observed. However, because the manager-knows *b,* he will invest efficiently if his pay is an increasing function of total profits $a + bd$.

The simplest such contract pays the manager a positive fraction *b* of $a + bd$; I call this a profit-sharing contract. The manager invests efficiently, yielding the largest possible precompensation profits $E[\tilde{a} + \tilde{b}d_0(\tilde{a}, \tilde{b})] = E[\tilde{a} + \tilde{b}^+]$.[11] One can choose β so the manager's expected compensation is his reservation wage, denoted $U^* > 0$.

[11] The notation $\tilde{b}^+$ represents the positive part of $\tilde{b}$, that is, $[\tilde{b}, 0]$.

Dybvig and Zender (1991) show the optimality of such a contract in the absence of renegotiation; the equilibrium outcome is first-best despite asymmetric information. Formally, this profit-sharing contract is

$$s_0(d, a + bd) = \beta(a + bd)^+ = (U^*/E[\tilde{a} + \tilde{b}^+])(a + bd)^+,$$

where setting $\beta = U^*/E[\tilde{a} + \tilde{b}^+]$ ensures that the manager's expected pay is pushed down to its reservation level.[12]

We will see that a profit-sharing contract (or any other compensation schedule that induces efficient investment) causes the manager to make investment decisions in period 1 that are, *at that time,* harmful to the firm's shareholders. Because of this, there are incentives for the manager and the board to renegotiate the contract in a mutually beneficial way. I now add the possibility of renegotiation to the model.

2. Renegotiation

2.1 Extending the model

I assume the parties to a contract (in this case, the firm and the manager) are free to replace their existing agreement with a new one, if they wish. I allow the board of directors to offer the manager a new contract in period 1. Following much of the renegotiation literature, it is the uninformed player-the board of directors-that proposes the new contract.[13] In designing its offer, the board acts in the interest of the firm's current shareholders by maximizing their expected cash flow-the board is a perfect agent of the shareholders. This assumption is discussed in Section 4.1. The manager is free to reject the offer, and the firm is then bound by the existing agreement s_0. Because the manager knows a and b, he will reject any contract that would pay him less than $s_0^*(a, b)$, so renegotiating the contract can only increase the manager's pay. The board may nevertheless wish to change the contract to persuade the manager to alter investment policy.

Recall that the compensation contract is the private information of

[12] I take the positive part of $a + bd$ because the manager's compensation cannot be negative [condition (1)]. This is a minor point because the manager's investment decisions ensure that a + bd will be nonnegative: a is nonnegative and the manager chooses d- 0 whenever 6 is negative. Nevertheless, the function $s_0(d, a + bd)$ specifies what compensation would be if the manager were to choose d and realized profits were $a + bd$. Taking the positive pan of $a + bd$ *ensues* that s_0 is defined properly even for actions that are not taken in equilibrium.

[13] Hart and Tirole (1988), Dewatripont (1989), Fudenberg and Tirole (1990), and Mont and Tirole (1990) are examples of models where the uninformed player proposes any renegotiation. Note also that the board is allowed to make a single offer. This rules out multiple-offer strategies by which the board might extract some information from the manager about the realization *(a, b),* and use this information in devising the next offer.

the manager and the board, though investors make unbiased estimates of net cash flows in equilibrium. In the same vein, I assume any renegotiation and any new contract are also private. Because of this, renegotiating the contract does not affect the pricing of the firm's shares in period 1. An issue of new equity will be priced to value the existing shares at $P_1(1)$, whether or not the contract is renegotiated.

So suppose we have arrived at period 1 with some incumbent contract s_0 and investment rule d_0 in place. The board's period-l contract offer is denoted (s_1, d_1). Just like the initial contract, the new offer s_1 must satisfy limited liability [see Equation (1)], and d_1 must be incentive compatible with s,. Since the manager would reject the new contract when $s_1^*(a, b) < s_0^*(a, b)$ we can restrict attention to contracts s_1 that have $s_1^*(a, b) \geq s_0^*(a, b)$ for all (a, b).[14] Of course, the board may choose to leave the existing contract in place, rather than renegotiate, by setting $(s_1, d_1) = (s_0, d_0)$. If this is an optimal choice, the contract is dynamically *consistent*-(s_0, d_0) is an equilibrium of the subgame that starts in period 1.

The basic question is, what contracts, once in place, can survive in equilibrium, and what contracts would be discarded in favor of a new contract? So let us posit an equilibrium in which it is optimal for the board to leave the contract unchanged in period 1, so the initial contract (s_0, d_o) survives. Since this is an equilibrium, the prices P_0 and $P_1(d)$ must satisfy the equilibrium pricing conditions (5) and (6). Furthermore, renegotiating the contract in period 1 cannot make shareholders better off, else the board would renegotiate. If the manager's contract were renegotiated to (s_1, d_1), the payoff to the initial shareholders would change from $P_2^*(a, b)$ [given in Equation (4)] to

$$P_2^*(a, b \mid s_1, d_1) = \frac{P_1(1)}{P_1(1) + I d_1(a, b)} [a + b d_1(a, b) - s_1^*(a, b)].$$

I call the contract (s_0, d_0) robust to renegotiation if $EP_2^*(\tilde{a}, \tilde{b} \mid s_1, d_1) \leq EP_2^*(\tilde{a}, \tilde{b})$ for every possible renegotiation (s_1, d_1). In this situation, it is indeed in the shareholders' interest for the board to leave the

[14] Let me state this more carefully. Consider any contract offer $(\hat{s}_1, \hat{d}_1)$, and let A be the set of (a, b) where $\hat{s}_1^*(a, b) \geq s_0^*(a, b)$-that is, where the manager will accept the new contract. Then for realization (a, b), the manager's compensation and the investment decision are

$$s_1^*(a, b) = I_A(a, b)\hat{s}_1^*(a, b) + I_{A'}(a, b) s_0^*(a, b),$$

$$d_1(a, b) = I_A(a, b)\hat{d}_1(a, b) + I_{A'}(a, b) d_0(a, b),$$

where I is the indicator function and A' is the complement of A. We obviously have $s_1^*(a, b) \geq s_0^*(a, b)$ for every (a, b). One can define a compensation schedule $s_1(d, a + bd)$ that is incentive compatible with $d_1(a, b)$ and yields compensation $s_1^*(a, b)$, thus producing the *same state-by-state* outcome as the offer $(\hat{s}_1, \hat{d}_1)$. Therefore, there is no loss of generality if, from the outset, one considers only contracts (s_1, d_1) that have $s_1^*(a, b) \geq s_0^*(a, b)$ for all (a, b).

contract (s_0, d_0) in place. On the other hand, if there is some renegotiation (s_1, d_1) that increases expected shareholder wealth, the posited equilibrium crumbles because the contract would be renegotiated.

Definition 1. *The contract (s_0, d_0) is robust to renegotiation if there is no contract (s_1, d_1) that meets the following conditions.*

1. It is incentive compatible and satisfies limited liability: $d_1(a, b) \in \arg\max_d s_1(d, a + bd)$ for all (a, b), and $0 \leq s_1(d, a + bd) \leq a + (1 + b)d$ for all (a, b, d).

2. It is acceptable to the manager: $s_1^*(a, b) \geq s_0^*(a, b)$ for all (a, b).

3. It benefis shareholders: $EP_2^*(\tilde{a}, \tilde{b} \mid s_1, d_1) > EP_2^*(\tilde{a}, \tilde{b})$ when $P_1(1)$ satisfies the equilibrium pricing condition (5).

Strictly speaking, robustness is a characteristic of the pair (s_0, d_0); when there is no ambiguity, I sometimes refer to the robustness of the contract s_0.

2.2 Results

There are two types of equilibria when renegotiation is allowed. The first possibility (equilibrium without renegotiation) is that the manager is offered an initial contract that is robust to renegotiation, and this contract remains in place. Renegotiation is *allowed* but is not *observed* in equilibrium. Since the initial contract survives until the end of the game, the equilibrium pricing conditions (5) and (6) must hold, and the contract must be robust to renegotiation. The second possibility (equilibrium with renegotiation) is that the manager is offered an initial contract which is then renegotiated *in equilibrium* in period 1. In this type of equilibrium, rational pricing requires that the stock prices P_0 and P_1 reflect the renegotiated contract, since it is the renegotiated contract that determines the terminal cash flows. Thus, the renegotiated compensation schedule and investment policy would replace s_0 and d_0 in (5) and (6).

I analyze contracts that are robust to renegotiation, thereby restricting attention to the first type of equilibrium. It is important to verify that we are not forfeiting any generality by ignoring equilibria in which the initial contract is renegotiated. In some models, there are outcomes that can be achieved only by offering an initial contract that is later renegotiated [e.g., Aghion and Bolton (1992), Green and Laffont (1992)]. If that were the case here, it would be foolhardy to focus only on contracts that are robust to renegotiation. The first proposition shows that there is no loss of generality in restricting attention to robust contracts.

Proposition 1. *Consider any equilibrium with renegotiation. There exists an equivalent equilibrium without renegotiation. in which the initial contract is robust and investmentpolicy, compensation, and security prices are identical to the given equilibrium for every realization (a, b).*

For every equilibrium with renegotiation, there is an equilibrium without renegotiation that is identical state by state. A proof of the proposition is in Appendix A, but the reasoning is very simple. Consider an equilibrium in which the contract is renegotiated. If the manager is instead offered the final contract up front, it is easy to show that this contract is robust to renegotiation-there is no profitable way to change the contract. For every state (a, b), the outcome is identical to the equilibrium we started with.

The main result of the paper is

Proposition 2. *There is no contract that is robust to renegotiation and induces efficient investment.*

Given Proposition 1, the obvious corollary is that there is no equilibrium in which investment is socially optimal. Any initial contract with efficient investment is not dynamically consistent-it will be renegotiated in period 1, and the new contract will have suboptimal investment. Given the market pricing of new equity issues, shareholders and the manager can both benefit from renegotiating the compensation contract. In a world where renegotiation can be avoided (it is prohibited or is too costly), the distortions that arise from asymmetric information can be overcome with simple contracts. When renegotiation cannot be prevented, these distortions cannot be overcome.[15]

One might hope that expanding the set of allowable contracts to include contracts that depend on the realized stock prices P_1 and P_2 would make efficient investment achievable. It does not. The impossibility result continues to hold if we consider contracts that depend

[15]One especially simple approach in the absence of renegotiation would be to pay the manager a fixed wage. (In the current setting, the contract would have to be a "truncated" fixed wage contract, because there would not be enough cash to pay the manager in the worst states.) A fixed wage would make the manager indifferent about investment policy, hence willing to invest efficiently. Dybvig and Zender (1991) avoid this trivial solution by requiring that the contract yield a unique optimal investment choice almost everywhere. Once renegotiation is allowed, there is no need to rule out fixed-wage contracts by requiring uniqueness almost everywhere, because a fixed-wage contract would not survive renegotiation. A fixed-wage contract is the easiest contract of all to renegotiate because shareholders do not have to give any rents to the manager. The board can leave the existing compensation schedule in place and have the manager change investment policy so it conforms with shareholders' ex post preferences, thus producing socially inefficient investment. There is no need to "bribe" the manager by changing the compensation schedule, so the manager neither gains nor loses in the renegotiation.

on P_1 and P_2 because these prices are themselves functions of d and $a + bd$.[16] Therefore, a contract $s_0(d, a + bd, P_1, P_2)$ can be rewritten as a function of only d and $a + bd$. If the contract induces optimal investment, it is not dynamically consistent, by Proposition 2.

Proposition 2 is illustrated in the next section by an example that shows what goes wrong with a profit-sharing contract. In the absence of renegotiation, a profit-sharing contract produces the first-best outcome. But if we posit an equilibrium in which a profit-sharing contract survives, it turns out to be in the interest of both shareholders and the manager to renegotiate the contract, destroying the supposed equilibrium. While the example uses a profit-sharing contract and cash flows that are independent and uniform, I stress that Proposition 2 is much more general. For *any* distribution of $(\tilde{a}, \tilde{b})$ with a continuous positive density, any contract with efficient investment will be renegotiated, producing inefficient investment. The proof of the proposition relies on a renegotiation strategy similar to the one presented for this example in Section 3.2.

3. An Example

This example illustrates that profit-sharing contracts do not survive when renegotiation is allowed; the details of the calculations are in Appendix B. Assume that the firm's existing assets will produce a terminal cash flow $\tilde{a}$ uniformly distributed on [0, 600], and the-new project requires an investment of $I = 75$ and produces profits b uniformly distributed on [-75, 150]. The cash flows of the two projects are independent, and the manager's reservation wage is $U^* = 7$. Consider the profit-sharing contract $s_0(d, a + bd) = 0.02(a + bd)^+$ that pays the manager 2 percent of profits, leaving 98 percent for shareholders. In the absence of renegotiation, this contract gives the manager his reservation wage and induces him to invest efficiently.

Since investment is efficient and the manager is paid his reservation wage, the contract produces the first-best outcome when renegotiation is impossible. Using the equilibrium pricing condition (6), the initial shareholders get an average payoff of

$$P_0 = E[\tilde{a} + \tilde{b}d_0(\tilde{a}, \tilde{b}) - s_0^*(\tilde{a}, \tilde{b})] = E[\tilde{a} + \tilde{b}^+] - U^*$$
$$= 300 + 50 - 7 = 343.$$

From the other equilibrium pricing condition (5), the period-l stock price is $P_1(1) = 367.5$ when the firm accepts the new project and $P_1(0) = 294$ when it does not. The stock price increases from 343 to

[16] Dybvig and Zender (1991) emphasize the point that including market prices in the contract is redundant because these market prices depend on public information.

367.5 when the firm announces it is issuing new shares because the announcement signals the good news that *b* is positive, and signals nothing about a. When the manager chooses to invest, the initial shareholders retain an ownership interest of 367.5/(367.5 + 75) ≈ 83 percent and the new investors get 17 percent.

Now consider the possibility of renegotiation. Let us posit an equilibrium in which this profit-sharing contract survives renegotiation; then the equilibrium prices are those given above. Thus, shareholders must give up 17 percent ownership in the firm to fund the new project. The question is now whether, given this pricing of equity issues, the board can devise a new contract the manager will accept $[s_1^*(a, b) \geq s_0^*(a, b)$ for all $(a, b)]$ that makes shareholders better off $[EP_2^*(\tilde{a}, \tilde{b} \mid s_1, d_1) > EP_2^*(\tilde{a}, \tilde{b})]$ If so, the profit-sharing contract is not robust to renegotiation-we have contradicted the supposed equilibrium.

To show that this contract is not robust, I present two renegotiation strategies. The first one increases the manager's compensation when he rejects the new project and *a* turns out to be large. This induces the manager to reject the project when a is large and *b* is not too large, which helps current shareholders-despite the higher compensation-because the firm avoids issuing shares when they are underpriced. The second renegotiation strategy increases the manager's compensation when he accepts the new project and *a* + *b* turns out to be small but positive. This induces the manager to accept the project in these circumstances. Current shareholders benefit because the firm issues overpriced shares in some cases where it would otherwise have rejected the project. Either of these renegotiation strategies is sufficient to destroy the profit-sharing contract.

3.1 Renegotiation produces underinvestment

When a is close to $\bar{a}$ = 600 and *b* is slightly positive, the manager accepts the new project under the profit-sharing contract because investing increases his compensation by 0.026 ≈ 0. Total profits *a* + *b* are approximately 600; after the manager's 2 percent payment, roughly (0.98)(600) = 588 of the profits remain. New investors contribute 75 in period 1 for a 17 percent interest in the firm, and the initial shareholders wind up with (0.83)(75 + 588) ≈ 550 in period 2. The new investors end up with (0.17)(75 + 588) ≈ 113, a capital gain of 38. If the manager were to reject the project, there would be no equity infusion, but the initial shareholders would get all of the residual and end up with 0.98a ≈ 588 > 550, the difference being the foregone wealth transfer to the new investors. Because of this, the board would like to persuade the manager to stop investing when a is large and *b* is slightly positive. The only way to do so is to offer

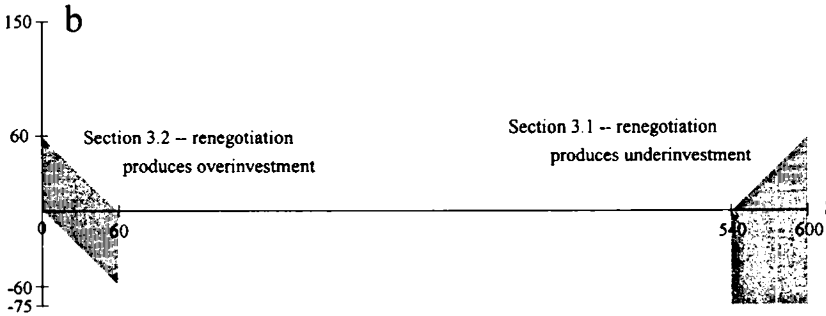

Figure 1
Renegotiating a profit-sharing contract
Two renegotiation strategies are presented in Section 3, either of which destroys a profit-sharing contract. The first strategy gives the manager a raise on the shaded set at the right to induce him to reject the new project (on this set). The second strategy gives him a raise on the shaded set at the left to induce him to accept the new project (on this set). Although a profit sharing contract induces optimal investment when renegotiation is impossible, these sorts of renegotiation strategies destroy the contract and result in suboptimal investment.

the manager more money for rejecting the project-that is, to set $s_1(0, a) > s_0(0, a)$ for a large. This induces the manager to stop investing when b is slightly positive, which helps shareholders. Unfortunately, it also gives the manager a raise when b is *negative,* and shareholders get no benefit in this case because investment policy does not change; even under the initial contract, the manager would have rejected the project when $b < 0$. So the renegotiation strategy must be chosen so the benefits shareholders reap when b is positive exceed the costs they bear when b is negative.

Consider a contract that gives the manager some extra compensation if $d = 0$ and a turns out to be greater than 540-his pay is 0.02a + 0.02(a - 540) rather than just 0.02a - and otherwise leaves the contract s_0 unchanged. When a is greater than 540, the manager will reject the new project if

$$s_1(0, a) = 0.02a + 0.02(a - 540) > s_1(1, a + b) = 0.02(a + b),$$

that is, if $b < a - 540$. This is the shaded set at the right in Figure 1, and the new contract increases the manager's compensation everywhere on this set. On the triangle where b is positive, the manager rejects the project even though its NPV is positive; shareholders benefit because the firm avoids issuing underpriced shares. Shareholders suffer on the rectangle where b is negative because the manager's compensation increases even though investment policy is unchanged. Calculations in Appendix B show that the average payoff of the initial shareholders on the upper triangle increases by 16.97, while on the lower rectangle it decreases by 0.6. Given the conditional probabilities of the two subsets (2/7 and 5/7), shareholders' average payoff on the shaded set increases by 4.42. Since payoffs are unchanged outside this set, shareholders benefit from the renegotiation. The initial profit-sharing contract does not survive, and investment is not socially optimal.

3.2 Renegotiation produces overinvestment

An alternative renegotiation strategy that destroys the profit-sharing contract is to offer the manager a contract that increases his compensation when he accepts the new project and a + 6 is slightly positive-that is, to set $s_1(1, a + b) > s_0(1, a + b)$ for a + b slightly positive. The goal is to get the manager to invest when a is small and b is slightly negative, because the firm's shares are overpriced in these circumstances. To see how this can benefit the initial stockholders, consider $a \approx 0$ and 6 just slightly negative. Under the profit-sharing contract, the manager's compensation is virtually zero regardless of his investment decision, because both a and 6 are close to 0. If the manager rejects the new project (as he will under the profit-sharing contract), the initial shareholders get 0.98a ≈ 0. If instead the manager were to accept the project, new investors would contribute 75 of equity to the firm. The initial shareholders would end up with about 83 percent of this, or 62, rather than 0; they gain because the firm issues overpriced shares. However, changing the contract will also increase the manager's compensation in some cases where investment policy is unchanged-when 6 is positive, the manager would have invested even under the initial contract. The renegotiation strategy must be chosen so that shareholder gains when 6 < 0 exceed shareholder losses when 6 > 0.

Consider a contract that pays the manager 1.2 when $\boldsymbol{d} = 1$ and a + 6 turns out to be between 0 and 60, and otherwise leaves the initial contract intact. This contract is acceptable to the manager because, when $d = 1$ and $a + b < 60$, the initial contract pays 0.02(a + b) < 0.02(60) = 1.2. The shaded area at the left of Figure 1 is the set where the manager's compensation changes-all points (a, b) with a < 60 and $0 < a + b < 60$. The manager accepts the new project everywhere on this set to get the payment 1.2; rejecting the project would yield the lower compensation 0.02a < (0.02)(60) = 1.2. On the lower half of the shaded set, where 6 < 0, the manager would have rejected the project under the initial contract; shareholders benefit on this lower portion because the firm now issues overpriced shares to finance the new project. Types in the upper half, where 6 > 0, would have accepted the project even under the initial contract. The manager would have been paid less than 1.2 under the initial contract, so the new contract gives these types a raise even though their investment behavior is unchanged. Renegotiating the contract is profitable for the initial shareholders if their gain on the lower half of the renegotiation set exceeds their loss on the upper half.[17]

Appendix B shows that shareholders' average payoff on the lower half of the renegotiation set increases by 38.7, whereas on the upper half it decreases by 0.33. The two subsets are equiprobable, so shareholders' average payoff on the renegotiation set increases by about 19, and their payoff does not change outside this set. Renegotiating the contract makes both the manager and the shareholders better off, and the profit-sharing contract does not survive. The renegotiation produces inefficient investment because the firm invests in some unprofitable projects.[18]

The proof of Proposition 2 utilizes a renegotiation strategy similar to this. Under any contract that induces efficient investment, the firm's shares are overpriced when a is small and b is close to zero [for any distribution of $(\tilde{a}, \tilde{b})$] Because of this, one can construct a renegotiation strategy that benefits both shareholders and the manager by inducing overinvestment.

Either of the two renegotiation strategies presented here is enough to show that the profit-sharing contract is not robust. Of course, combining the two strategies would make shareholders (and the manager) better off than either strategy separately. These are not optimal renegotiation strategies, but the point is that the initial contract would not survive-it would be renegotiated to take advantage of the manager's private information. Once renegotiation is allowed, there is no equilibrium in which managers are paid according to a profit-sharing contract, because such a contract does not induce an equilibrium in the subgame starting in period 1. The renegotiation strategies presented in this example are not descriptions of equilibrium; rather they demonstrate that the profit-sharing contract does not describe equilibrium.

3.3 Equity-based contracts

Contracts that simply give the manager some shares of stock or, more generally, provide compensation that is an increasing function of the

[17] The form of the renegotiation in this example was chosen for ease of exposition, An unpleasant feature of this contract is that the manager's compensation $s_1^*(a, b)$ is discontinuous along the lower boundary of the renegotiation set (where $a + b = 0$), dropping from 1.2 to 0.02a. The proof of Proposition 2 uses a similar renegotiation strategy, but the new contract is chosen so that compensation is continuous.

[18] One might be concerned about lawsuits from the investors who buy the new equity issue when the shares are overpriced. The firm and/or the manager might be liable if the plaintiffs can prove the contract was renegotiated in order to take advantage of them. This is less of a concern under the first renegotiation strategy because, in those cases where the manager's compensation is different under the new contract, the firm does not issue shares. Thus, in cases where compensation changes, there is no damaged party to file suit.

terminal stock price are not susceptible to renegotiation. The manager accepts or rejects the new project according to which choice maximizes the stock price P_2. This eliminates the incentives to renegotiate, because the manager accepts the new project when it is in the shareholders' interest *at the time the decision is made.* Of course, these contracts have the drawback pointed out by Myers and Majluf (1984)-the manager is not inclined to invest optimally in an ex ante sense.

The simplest equity-based contract is a linear contract that pays the manager a fixed fraction of the terminal stock price. In the example, suppose the manager is given a contract that pays him $\beta P_2 \approx 0.02063P_2$.[19] With this contract in place, the manager accepts the new project when $b > -75 + 0.232797a$, as illustrated in Figure 2. The firm accepts bad projects when a is low because the firm can issue overpriced shares, and rejects good projects when a is high because an equity issue would be underpriced. As shown in Appendix B, the manager receives his reservation wage, and the equilibrium stock prices are $P_0 = 339.33$, $P_1(1) = 315.66$, and $P_1(0) = 391.91$. Shareholder wealth is lower than the unattainable first-best by 343 - 339.33 = 3.67 because investment is suboptimal. The announcement of an equity issue is bad news about a and good news about 6; because there is more uncertainty about *a* than *b*, the first effect dominates and the stock price falls from 339.33 to 315.66. With $\tilde{a}$ and $\tilde{b}$ independent, one would expect a stock issue to be good news if optimal investment were possible, since it would mean that expected profits are $E[\tilde{a}] + E[\tilde{b} \mid \tilde{b} > 0]$ rather than just $E[\tilde{a}]$. This presumption is even stronger if $\tilde{a}$ and $\tilde{b}$ are positively correlated.

4. Discussion

4.1 Shareholder representation by the board of directors

The board of directors in the model acts to maximize the expected payoff of the current owners of the firm-there is no conflict of interest between the board and shareholders. In this sense, the board is a perfect representative of the firm's (current) shareholders. In period 1, if shareholders would benefit from renegotiating the manager's contract, the board renegotiates; if not, they leave the existing contract

[19] Writing this as a function of *d* and *a + bd,* the manager's contract is

$$s_0(d, a + bd) = 0.02063\left[\frac{\theta(d)(Id + a + bd)}{1 + 0.02063\theta(d)}\right],$$

with $\theta(0) = 1$ and $\theta(1) = 0.808016$ being the portion of the terminal cash flow that belongs to the initial stockholders. The expression in brackets is the equilibrium stock price in period 2.

[20] Recall that the first best has $P_0 = E[\tilde{a} + \tilde{b}^+] - U^* = 300 + 50 - 7 = 343$.

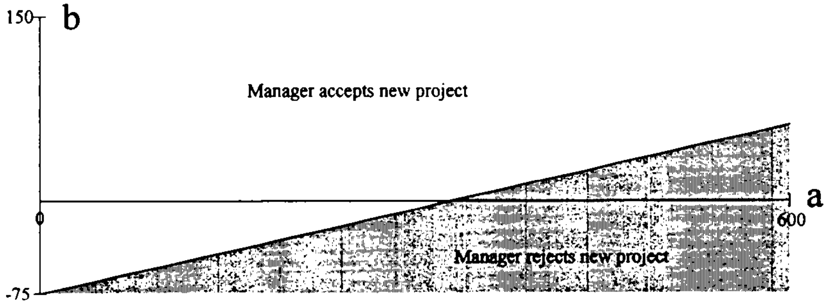

Figure 2
Investment behavior under an equity-sharing contract
The figure shows the manager's investment behavior in the example if he is given an equity-sharing contract (he is just given some of the firm's shares) that pays him his reservation compensation, in expectation. Such a contract results in suboptimal investment, but it is robust to renegotiation-it survives even when the manager and shareholders are free to renegotiate the manager's contract.

in place. Thus, the board is nothing more than an instrument of shareholders.

This is probably a reasonable first-order approximation; after all, it is the shareholders who elect board members for the vast majority of firms. But as a practical matter, there are agency problems between shareholders and board members just as there are between shareholders and managers. Shareholders would like to motivate the board to act in their interest, but incentives are likely misaligned to some degree. This has been evident in recent years as large institutional investors have become more involved in corporate governance when they believe the board is ignoring shareholder interests. I make no attempt here to model these agency problems, but concentrate on the agency problems between shareholders and managers. The board behavior assumed in the model is probably a better approximation for firms where the board is dominated by major shareholders than for firms where shareholder representation is indirect. One beneficial effect of agency problems between shareholders and the board is that such conflicts probably reduce opportunistic behavior by shareholders (like renegotiation in this model); I suspect the deleterious effects of these agency problems are much more important.

A more complete model would include self-interested board members who must be motivated to behave appropriately; this would add another layer of contracts to the problem. When the firm is started, the entrepreneur would design these contracts in a way that maximizes value by encouraging efficient investment and limiting the cost of the governance structure. Considerations of time consistency would also arise at this layer of contracting, since these contracts may also be subject to renegotiation.

The legal environment is another important factor that affects board behavior. For example, in some states the board of directors' fiduciary duty is to the "corporation" rather than to shareholders.[21] Statutes that impose broader fiduciary obligations on the board may impede renegotiation and help restrain shareholder opportunism. In the simple setting of this model, inefficient investment would disappear if the state could mandate that the board act to maximize (precompensation) profits, and could enforce such a statute.

4.2 Commitment and private contracting

A fundamental assumption of this work has been that the board and the manager cannot credibly commit to leave the manager's compensation scheme unchanged. Related to this is the assumption that the compensation scheme is private; presumably, a public contract would facilitate commitment. The inability to forswear renegotiation leads to inefficient investment, and shareholders bear the social cost of this inability to commit. In equilibrium, the value of their shares is lower because the public recognizes that investment policy is inefficient. Ex ante, shareholders would like to commit to refrain from renegotiating the manager's contract; ex post, they would like to break any such commitment.

Within the model, the assumptions of private contracting and lack of commitment may seem strained-why not just make the contract public and require large penalties if the contract is changed? In reality, there are several factors that, in my view, make these assumptions reasonable. They include competitive considerations, nonpecuniary and unobservable compensation, the limited length of employment contracts, and the complexity of the environment in which firms operate. First, a manager's compensation plan may reflect strategic considerations; considerations the firm does not want its competitors to know. This argues against a public contract. Second, one should view a manager's compensation broadly. In addition to a periodic paycheck, compensation can be nonpecuniary (plush office, corporate jet, directing corporate donations as the manager desires) and even unobservable (autonomy, cooperativeness from the board). This makes public commitment to a particular level of compensation very difficult-if the board wants to increase the manager's "pay," it can do so in ways other than cutting a check. Third, employees seldom have employment contracts that cover their remaining working lives. Again taking a broad view of compensation, a manager can be rewarded for

[21] I thank Philip Dybvig and Jaime Zender for pointing out the importance of this feature of corporate law.

actions taken in the current period by a better contract at renewal time. This kind of implicit renegotiation again makes commitment difficult. Writing very-long-term contracts might avoid this problem. However, writing an immutable long-term contract would preclude using future information to improve incentives and risk sharing during the life of the contract. Finally, the model hardly captures the complexity of the environment in which firms operate. The reason for renegotiating the manager's contract is very clear in the model. In reality, there are many plausible explanations for changing the manager's contract, and ferreting out the authentic from the specious can be difficult. Good reasons for changing compensation may arise, and this makes commitment to a given scheme problematical.

Despite these considerations-which I argue make it difficult or impossible to publicly commit to a compensation scheme-there may be factors that facilitate commitment. This would not be surprising since barriers to renegotiation may create social gains, and shareholders have an ex ante interest in erecting such barriers (but an ex post interest in circumventing them). For example, the SEC's compensation disclosure requirements may make renegotiation more difficult. The SEC recently mandated increased management compensation disclosure and has also changed its position to allow shareholder votes on management compensation. (Such votes are not binding, only advisory.) Press reports regarding the new SEC disclosure requirements often reflect the concerns about privacy and competition described above.[22] Long-term management contracts will also, ceteris paribus, make renegotiation more difficult. Another factor that may help restrict renegotiation is the threat of shareholder lawsuits, mentioned in note 18. Of course, all these factors that restrict renegotiation carry costs as well as benefits-it is surely much too costly to completely eliminate opportunistic renegotiation.

A final caveat regarding commitment is in order. The model presented here is sequential but not repeated. We know from the folk theorems [Abreu (1988)) Benoit and Krishna (1985)) Fudenberg and

[22]Here is an excerpt from the *Wall Street Journal,* 9/21/92, regarding the SEC's proposed disclosure rules [Lublin (1992)]:

> Some executives fear the [SEC's proposed compensation] report may help competitors by disclosing links between, say, a senior officer's annual bonus and a business unit's goals, such as added market share, overseas expansion or disposal of a failing operation.
>
> "You are tipping your hand" about future strategy, argues Ray McGovern, general counsel for Omnicom Group Inc., a New York advertising concern. "It just is something we prefer not to do," and shareholders don't need to know it.
>
> Other executives fret that a detailed compensation committee report may impede their boards' effectiveness. The report could inhibit "the free give and take that goes on in the boardroom" by disclosing "what goes on in the minds of members of the board," contends Thomas Ashford, assistant general counsel for American Electric Power Service Corp., a major electric utility in Columbus, Ohio.

Maskin (1986)] that repetition may allow socially desirable allocations that are not achievable in a one-shot game, so repetition could potentially facilitate efficient investment.

4.3 Debt

The firm in the model is financed entirely with equity. One way to view these results is that they provide a role for capital structure, even in the absence of considerations like taxes and financial distress. One role is familiar from Myers and Majluf (1984). If the firm can finance the project with securities that are less sensitive than common stock to firm value, the new securities will be priced closer to true value than equity would be; this diminishes the incentives to renegotiate and invest inefficiently. For example, the firm could issue riskless debt and eliminate the problem completely.[23]

Even when the new financing is through equity, an *existing* capital structure that includes debt might help alleviate the problem of inefficient investment. For example, current shareholders have incentives to overinvest when the existing assets are very unprofitable, because the firm can issue overpriced equity. This could be mitigated by having a senior security, say debt, in the firm's existing capital structure. When cash flows from existing assets are very low, most or all of the incremental cash flows from a new investment will go to the debtholders, and this makes current shareholders less inclined to accept unprofitable projects. "Debt overhang" [Myers (1977)] may be helpful in limiting renegotiation.

More complicated capital structures might also impose broader fiduciary obligations on the board of directors. As discussed in Section 4.1, this could reduce pressures to renegotiate. Having diverse claimants involved in the firm's governance could also make the renegotiation process more costly, thereby making more efficient investment feasible.

5. Collclusion

Myers and Majluf (1984) point out that when a firm raises equity externally, inefficient investment decisions can result from managers having superior information about firm value. The basic point of this article that this problem is a stubborn one. Dybvig and Zender (1991) present a model where giving the manager a simple profit-sharing contract solves the problem when there is one-shot contracting. This

[23]See Nachman and Noe (1993) for a rigorous analysis of the conditions under which debt minimizes mispricing errors due to asymmetric information.

article requires that any contract be dynamically consistent, because the manager and the board of directors are free to privately renegotiate the manager's contract. In this setting, it is impossible to achieve efficient investment because any contract that induces efficient investment will be renegotiated. Contracts that pay the manager an increasing function of the terminal stock price (often assumed in corporate finance models) can survive-they are robust to renegotiation.

Appendix A: Proofs

A.1 Proof of Proposition 1

Consider any equilibrium where an initial contract (s_0, d_0) is renegotiated to (s_1, d_1) in period 1, which requires $s_1^*(a, b) \geq s_0^*(a, b)$ for all (a, b). Because security prices are unbiased in equilibrium, they reflect the contract (s_1, d_1); that is, s_1 and d_1 replace s_0 and d_0 in Equations (3)-(6). Because this is an equilibrium, the period-l offer (s_1, d_1) by the board must be an optimal offer-any other renegotiation offer $(\hat{s}_1, \hat{d}_1)$ with $\hat{s}_1^*(a, b) \geq s_0^*(a, b)$ [for all (a, b)] would produce $EP_2^*(\tilde{a}, \tilde{b} \mid \hat{s}_1, \hat{d}_1) \leq EP_2^*(\tilde{a}, \tilde{b})$.

Now suppose the contract (s_1, d_1) were offered as the *initial* contract. Any renegotiation offer $(\hat{s}_1, \hat{d}_1)$ with $\hat{s}_1^*(a, b) \geq s_1^*(a, b)$ [for all (a, b)] also satisfies $\hat{s}_1^*(a, b) \geq s_0^*(a, b)$. Therefore, as shown in the previous paragraph, any such offer would produce $EP_2^*(\tilde{a}, \tilde{b} \mid \hat{s}_1, \hat{d}_1) \leq EP_2^*(\tilde{a}, \tilde{b})$, which means the contract is robust to renegotiation. The manager's investment decisions and the payoffs to all players under this initial contract are identical to the equilibrium we started with.

A.2 Proof of Proposition 2

Take any employment contract (s_0, d_0) that has $d_0(a, b) = 1$ when $b > 0$ and $d_0(a, b) = 0$ when $b < 0$. As always, this contract must satisfy limited liability and d_0, must be incentive compatible with s_0. The task is to show that the contract is not robust to renegotiation.

Fix some positive δ, and define the set R by

$$R = \{(a, b) \mid a < \delta, -a/2 < b < \delta - a\}.$$

The lower bound on b can be set at any $-a/k$ with $k > 1$; the choice $k = 2$ is arbitrary. Consider the following renegotiation strategy:

$$s_1(d, a + bd) = \begin{cases} \sup\{s_0^*(\hat{a}, \hat{b}) \mid (\hat{a}, \hat{b}) \in R, \hat{a} + \hat{b} = a + bd\} \\ \qquad\qquad \text{if } d = 1 \text{ and } 0 < a + bd < \delta, \\ s_0(d, a + bd) \\ \qquad\qquad \text{otherwise,} \end{cases}$$

$$d_1(a, b) = \begin{cases} 1 & \text{if } (a, b) \in R, \\ d_0(a, b) & \text{otherwise.} \end{cases}$$

Note that $(a, b) \in R$ requires $0 < a + b < d$, so the first part of the definition of s_1 applies if these types accept the project.

The new contract is acceptable to the manager because it gives him at least as much compensation as s_0 for each (a, b). For $(a, b) \notin R$,

$$s_1^*(a, b) \geq s_1(d_0(a, b), a + bd_0(a, b)) = s_0(d_0(a, b), a + bd_0(a, b)) = s_0^*(a, b),$$

where the first equality uses the fact that all $(a, b) \notin R$ with $d_0(a, b) = 1$ have $a + b \approx \delta$. For $(a, b) \notin R$,

$$s_1^*(a, b) \geq s_1(1, a + b) = \sup\{s_0^*(\hat{a}, \hat{b}) \mid (\hat{a}, \hat{b}) \in R, \hat{a} + \hat{b} = a + b\} \geq s_0^*(a, b),$$

the last inequality because (a, b) is in the set over which the supremum is taken.

To verify incentive compatibility, first notice that when $(a, b) \in R$,

$$s_1(1, a + bd) = \sup\{s_0^*(\hat{a}, \hat{b}) \mid (\hat{a}, \hat{b}) \in R, \hat{a} + \hat{b} = a + b\} \geq s_0^*(a, b) \geq s_0(0, a + bd) = s_1(0, a + bd).$$

When $(a, b) \notin R$ and $a + b \notin (0, \delta)$, s_1 is equal to s_0, so setting $d_1(a, b) = d_0(a, b)$ is optimal. Finally, consider $(a, b) \notin R$ *with* $0 < a + b < \delta$, which requires $b < 0$. I must show $s_1(0, a + bd)$ is at least as large as $s_1(1, a + bd)$. Because s_0 and d_0 are incentive compatible and b is negative, $s_0(0, a + bd)$ ³ $s_0(1, a + bd)$. Take any $(\hat{a}, \hat{b}) \in R$ that has $\hat{a} + \hat{b} = a + b$. If $d_0(\hat{a}, \hat{b}) = 1$, then $s_0(0, a + bd) \geq s_0^*(\hat{a}, b)$ because

$$s_0(0, a + bd) \geq s_0(1, a + bd) = s_0(1, \hat{a} + \hat{b}d) = s_0^*(\hat{a}, \hat{b}). \quad \text{(A1)}$$

If $d_0(\hat{a}, \hat{b}) = 0$, we must have $0 \geq \hat{b} > b$, so we can choose a positive $\epsilon < \min(\hat{b} - b, \bar{b})$. We again have $s_0(0, a + bd) \geq s_0^*(\hat{a}, \hat{b})$, using the relations among the points $(\hat{a}, \hat{b})$, $(\hat{a}, \epsilon)$, (a, b), and $(a, b + \epsilon - b)$:

$$\begin{aligned} + bd) &= s_0(0, a) = s_0^*(a, b, + \epsilon - \hat{b}) \\ &\geq s_0(1, a + b + \epsilon - \hat{b}) \\ &= s_0(1, \hat{a} + \epsilon) = s_0^*(\hat{a}, \epsilon) \geq s_0(0, \hat{a}) = s_0^*(\hat{a}, \hat{b}). \quad \text{(A2)} \end{aligned}$$

The second equality is because $\epsilon < \hat{b} -$ implies $d_0(a, b + \epsilon - \hat{b}) = 0$ and the next-to-last equality is because $\epsilon > 0$. Using inequalities (A1) and (A2), we have

$$s_0(0, a + bd) \geq \sup\{s_0^*(\hat{a}, \hat{b}) \mid (\hat{a}, \hat{b}) \in R, \hat{a} + \hat{b} = a + b\}.$$

Recalling the definition of s_1, this means $s_1(0, a + bd) \geq s_1(1, a + bd)$, so it is in the manager's interest to reject the project, as prescribed by d_1 when $(a, b) \notin R$ and $b < 0$.

The renegotiated contract also satisfies the limited liability condition (1). This is obvious for $d = 0$ and when $a + b \notin (0, \delta)$; in these cases, $s_1 = s_0$ and we know that s_0, satisfies limited liability. To check the case $d = 1$ and $0 < a + b < \delta$, notice that the limited liability of s_0 means

$$s_0^*(\hat{a}, \hat{b}) \leq \hat{a} + (I + \hat{b})d_0(\hat{a}, \hat{b}) \leq \hat{a} + I + \hat{b}$$

for any $(\hat{a}, \hat{b})$. Thus, for any $(\hat{a}, \hat{b})$ having $\hat{a} + \hat{b} = a + b$, we have $s_0^*(\hat{a}, \hat{b}) \leq \hat{a} + I + \hat{b} = a + I + b$. Taking the supremum over all such $(\hat{a}, \hat{b}) \in R$ shows that $s_1(1, a + bd) \leq a + I + b$.

The remaining task is to prove that shareholders benefit from the renegotiation when δ is chosen small enough-that is, to show that the average value of P_2 is higher under the renegotiated contract than under the original contract: $EP_2^*(\tilde{a}, \tilde{b} \mid s_1, d_1) > EP_2^*(\tilde{a}, \tilde{b})$ for d small. Since shareholder payoffs do not change outside R, this requires finding a positive d that yields

$$E[P_2^*(\tilde{a}, \tilde{b} \mid s_1, d_1) \mid (\tilde{a}, \tilde{b}) \in R] > E[P_2^*(\tilde{a}, \tilde{b}) \mid (\tilde{a}, \tilde{b}) \in R].$$

If such a d exists, not only does the manager prefer the renegotiated contract, but shareholders do as well. Let R_+ be the subset of R where $b > 0$ and let R_- be the subset where $b < 0$, and consider the limit of shareholder payoffs as δ approaches 0.

First take (a, b) in R_+. The change in average payoff on R_+ is

$$\begin{aligned}
E[P_2^*(\tilde{a}, \tilde{b} \mid s_1, d_1) &- P_2^*(\tilde{a}, \tilde{b}) \mid (\tilde{a}, \tilde{b}) \in R_+] \\
&= \left(\frac{P_1(1)}{P_1(1) + I}\right) E[\tilde{a} + I + \tilde{b} - s_1^*(\tilde{a}, \tilde{b}) \\
&\qquad - (\tilde{a} + I + \tilde{b} - s_0^*(\tilde{a}, \tilde{b})) \mid (\tilde{a}, \tilde{b}) \in R_+] \\
&= \left(\frac{P_1(1)}{P_1(1) + I}\right) E[s_0^*(\tilde{a}, \tilde{b}) - s_1^*(\tilde{a}, \tilde{b}) \mid (\tilde{a}, \tilde{b}) \in R_+]. \qquad \text{(A3)}
\end{aligned}$$

For every $(\hat{a}, \hat{b}) \in R$ with $\hat{a} + \hat{b} = a + b$, $s_0^*(\hat{a}, \hat{b}) \leq s_0^*(a, b) + \delta$ because

$$s_0(0, \hat{a} + \hat{b}d) \leq \hat{a} < \delta \leq s_0^*(a, b) + \delta$$

(the first inequality by limited liability and the second from the definition of R), and

$$s_0(1, \hat{a} + \hat{b}d) = s_0(1, a + bd) \leq s_0^*(a, b) < s_0^*(a, b) + \delta.$$

Since $s_1^*(a, b)$ is the supremum of $s_0^*(\hat{a}, \hat{b})$ over all such $(\hat{a}, \hat{b})$,

$s_1^*(a, b) \le s_0^*(a, b) + \delta$. We therefore have $-\delta \le s_0^*(a, b) - s_1^*(a, b) \le$ ' for every $(a, b) \in R_+$. Applying this to Equation (A3) yields

$$-\delta\left(\frac{P_1(1)}{P_1(1) + I}\right) \le E[P_2^*(\tilde{a}, \tilde{b} \mid s_1, d_1) - P_2^*(\tilde{a}, \tilde{b}) \mid (\tilde{a}, \tilde{b}) \in R_+] \le 0;$$

letting δ approach 0 yields

$$\lim_{\delta \to 0} E[P_2^*(\tilde{a}, \tilde{b} \mid s_1, d_1) - P_2^*(\tilde{a}, \tilde{b}) \mid (\tilde{a}, \tilde{b}) \in R_+] = 0. \quad \text{(A4)}$$

Now consider $(a, b) \in R_-$ Since $d_0(a, b) = 0$, limited liability means that

$$0 \le P_2^*(a, b) = a - s_0^*(a, b) \le a < \delta,$$

which yields

$$\lim_{\delta \to 0} E[P_2^*(\tilde{a}, \tilde{b}) \mid (\tilde{a}, \tilde{b}) \in R_-] = 0. \quad \text{(A5)}$$

For any $(\hat{a}, \hat{b}) \in R$ with $\hat{a} + \hat{b} = a, b, s_0^*(\hat{a}, \hat{b}) < \delta$ because

$$s_0(1, \hat{a} + \hat{b}d) = s_0(1, a + bd) \le s_0(0, a + bd) = s_0(0, a) \le a < \delta$$

(the first inequality because $d_0(a, b) = 0$ and the second by limited liability), and

Taking the supremum of $s_0^*(\hat{a}, \hat{b})$ over all such $(\hat{a}, \hat{b})$ gives $s_1^*(a, b) \le \delta$. Using this, we get

$$\begin{aligned} &E[P_2^*(\tilde{a}, \tilde{b} \mid s_1, d_1) \mid (\tilde{a}, \tilde{b}) \in R_-] \\ &\ge \left(\frac{P_1(1)}{P_1(1) + I}\right) E[\tilde{a} + I + \tilde{b} - \delta \mid (\tilde{a}, \tilde{b}) \in R_-] \\ &> \left(\frac{P_1(1)}{P_1(1) + I}\right) (I + E[\tilde{b} \mid (\tilde{a}, \tilde{b}) \in R_-] - \delta) \\ &\to \left(\frac{P_1(1)}{P_1(1) + I}\right) I \end{aligned} \quad \text{(A6)}$$

as $\delta \to 0$. Since there is a lower bound $B > 0$ on the conditional probability that $(\tilde{a}, \tilde{b}) \in R_-$, given that $(\tilde{a}, \tilde{b}) \in R$,[24] we can use con-

[24] For example, take B = min $f(a, b)$/(min $f(a, b)$ + 2 max $f(a, b)$). (The minimum and maximum exist because /is a continuous function defined on a compact set. The minimum is positive because f was assumed to be positive.) Because the area of R, is $\delta^2/2$ and the area of R_- is $\delta^2/4$, the conditional probability must satisfy

ditions (A4), (A5), and (A6) to get

$$\liminf_{\delta \to 0} E[P_2^*(\tilde{a}, \tilde{b} \mid s_1, d_1) - P_2^*(\tilde{a}, \tilde{b}) \mid (\tilde{a}, \tilde{b}) \in R]$$

$$\geq \liminf_{\delta \to 0} \Pr[(\tilde{a}, \tilde{b}) \in R_- \mid (\tilde{a}, \tilde{b}) \in R]$$

$$\cdot E[P_2^*(\tilde{a}, \tilde{b} \mid s_1, d_1) \mid (\tilde{a}, \tilde{b}) \in R]$$

$$\geq B\left(\frac{P_1(1)}{P_1(1) + I}\right) I > 0.$$

Therefore, shareholders benefit from the renegotiation when δ is small enough, and the proposition is proved: (s_0, d_0) is not robust, and optimal investment is impossible.

Appendix B: Calculations for the example

The example in Section 3 has $I = 75$, $U^* = 7$, $\tilde{a}$ uniform on [0, 600], $\tilde{b}$ uniform on [-75, 150], and $\tilde{a}$ and $\tilde{b}$ i independent. The initial contract is $s_0(d, a + bd) = 0.02(a + bd)^+$, which induces efficient investment. Expected gross profits are therefore $E[\tilde{a} + \tilde{b}^+] = 300 + 50 = 350$, and expected compensation is (0.02) (350) = 7; these give $P_0 = 343$. When the manager rejects the new project in period 1, the stock price becomes

$$P_1(0) = E[\tilde{a} - 0.02\tilde{a} \mid d_0(\tilde{a}, \tilde{b}) = 0]$$
$$= 0.98E[\tilde{a} \mid \tilde{b} < 0]$$
$$= 0.98(300) = 294.$$

When the manager accepts the new project, we have

$$P_1(1) = E[\tilde{a} + \tilde{b} - 0.02(\tilde{a} + \tilde{b}) \mid d_0(\tilde{a}, \tilde{b}) = 1]$$
$$= 0.98E[\tilde{a} + \tilde{b} \mid \tilde{b} > 0] = 0.98(300 + 75) = 367.5.$$

Consider the renegotiation strategy of Section 3.1:

$$s_1(d, a + bd) = \begin{cases} 0.02(a + bd) + 0.02(a + bd - 540) \\ \qquad \text{if } d = 0 \text{ and } a + bd > 540, \\ s_0(d, a + bd) \\ \qquad \text{otherwise,} \end{cases}$$

$$d_1(a, b) = \begin{cases} 0 & \text{if } a > 540 \text{ and } b < a - 540, \\ d_0(a, b) & \text{otherwise.} \end{cases}$$

This contract induces the manager to stop investing on the set $R_+ = \{(a, b) \mid a > 540 \text{ and } 0 < b < a - 540\}$. On the set $R_- = \{(a, b) \mid a$

> 540 and $b < 0\}$, the manager's investment decision is unchanged, but his compensation increases by $0.02\,(a - 540)$. On R_+, the expected value of $\tilde{a}$ is 580 and the expected value of $\tilde{b}$ is 20. The average payoff on R_+ for the initial shareholders under the incumbent contract is therefore

$$\left(\frac{P_1(1)}{P_1(1) + I}\right)E[\tilde{a} + I + \tilde{b} - 0.02(\tilde{a} + \tilde{b}) \mid (\tilde{a}, \tilde{b}) \in R_+]$$
$$= \left(\frac{367.5}{367.5 + 75}\right)[580 + 75 + 20 - 0.02(580 + 20)]$$
$$= \left(\frac{367.5}{442.5}\right)(663) = 550.63.$$

Under the renegotiated contract, the average payoff in R_+ is

$$E[\tilde{a} - 0.02\tilde{a} - 0.02(\tilde{a} - 540) \mid (\tilde{a}, \tilde{b}) \in R_+]$$
$$= 580 - 0.02(580) - 0.02(40) = 567.6,$$

an increase of 16.97. On R_-, the expected value of $\tilde{a}$ is 570. The average shareholder payoff on R_- decreases due to the additional compensation by

$$E[0.02(\tilde{a} - 540) \mid (\tilde{a}, \tilde{b}) \in R_-] = 0.02(30) = 0.6.$$

The distribution of $(\tilde{a}, \tilde{b})$ is uniform, and the areas of R_+ and R_- are 1800 and 4500, respectively. Therefore, the conditional probabilities of R_+ and R_- are $1800/6300 = 2/7$ and $4500/6300 = 5/7$, giving a change in average shareholder payoff on R of $(2/7)(16.97) + (5/7)(-0.6) = 4.42$. Payoffs are unchanged outside R, so the renegotiation strategy of Section 3.2,

$$s_1(d, a + bd) = \begin{cases} 1.2 & \text{if } d = 1 \text{ and } 0 < a + bd < 60, \\ s_0(d, a + bd) & \text{otherwise,} \end{cases}$$
$$d_1(a, b) = \begin{cases} 1 & \text{if } a < 60 \text{ and } 0 < a + b < 60, \\ d_0(a, b) & \text{otherwise.} \end{cases}$$

This contract induces the manager to start investing on the set $R_- = \{(a, b) \mid a < 60 \text{ and } -a < b < 0\}$. On the set $R_+ = \{(a, b) \mid a < 60$ and $0 < b < 60 - a\}$, the manager's investment decision is unchanged, but his compensation increases from $0.02\,(a + b)$ to 1.2. On R_-, the expected value of $\tilde{a}$ is 40 and the expected value of b is -20. The average payoff on R_- for the initial shareholders under the incumbent contract is $E[\tilde{a} - 0.02\tilde{a} \mid (\tilde{a}, \tilde{b}) \in R_-] = 40 - (0.02)(40) = 39.2$. Under the renegotiated contract, the average payoff on R_- is

$$\left(\frac{P_1(1)}{P_1(1) + I}\right)E[\tilde{a} + I + \tilde{b} - 1.2 \mid (\tilde{a}, \tilde{b}) \in R_-]$$

$$= \left(\frac{367.5}{367.5 + 75}\right)[40 + 75 - 20 - 1.2] = \left(\frac{367.5}{442.5}\right)(93.8) = 77.90,$$

an increase of 38.70. On R_+, the expected values of $\tilde{a}$ and $\tilde{b}$ are both 20. The average shareholder payoff on R_+ decreases due to the additional compensation by

$$\left(\frac{367.5}{442.5}\right)(1.2 - 0.02E[\tilde{a} + \tilde{b} \mid (\tilde{a}, \tilde{b}) \in R_+])$$

$$= \left(\frac{367.5}{442.5}\right)(1.2 - 0.02(20 + 20)) = 0.33.$$

The areas of R_+ and R_- are equal, so the change in average shareholder payoff on R is (0.5)(38.70) + (0.5)(–0.33) = 19.19. Payoffs are unchanged outside R, so the renegotiation strategy is profitable for shareholders.

Finally, consider the equity-sharing contract discussed in Section 3.3. Simplifying the expression in note 19, the manager's compensation is

$$s_0(0, a) = 0.02063\left(\frac{a}{1.02063}\right) \quad \text{or}$$

$$s_0(1, a + b) = 0.02063\left[\frac{0.808016(75 + a + b)}{1 + (0.02063)(0.808016)}\right]. \qquad \text{(A7)}$$

The payment $s_0(1, a + b)$ is greater than $s_0(0, a)$ if and only if $b > -75 + 0.232797a$, so this inequality defines the set where the manager accepts the new project. The acceptance set has area $\int_0^{600}\int_{-75+0.232797a}^{150} db\, da = 93{,}096.5$. Since $\tilde{a}$ and $\tilde{b}$ are uniform and independent, one can calculate $P_1(1)$ as

$$P_1(1) = (93{,}096.5)^{-1} \int_0^{600} \int_{-75+0.232797a}^{150} a + b - s_0(1, a + b)\, db\, da$$

$$= (93{,}096.5)^{-1}$$

$$\cdot \int_0^{600} \int_{-75+0.232797a}^{150} a + b$$

$$- 0.02063\left[\frac{0.808016(75 + a + b)}{1 + (0.02063)(0.808016)}\right] db\, da$$

$$= 315.66.$$

The area of the rejection set is $\int_0^{600}\int_{-75}^{-75+0.232797a} db\, da = 41{,}903.5$, which gives

$$P_1(0) = (41{,}903.5)^{-1}\int_0^{600}\int_{-75}^{-75+0.232797a} a - s_0(0, a)\, db\, da$$

$$= (41{,}903.5)^{-1}\int_0^{600}\int_{-75}^{-75+0.232797a} a - \frac{0.02063a}{1.02063}\, db\, da$$

$$= 391.91$$

These can be used to calculate the period-0 stock price:

$$P_0 = \frac{93{,}096.5}{93{,}096.5 + 41{,}903.5}(315.66) + \frac{41{,}903.5}{93{,}096.5 + 41{,}903.5}(391.91) = 339.33.$$

One can also verify that the contract does in fact pay the manager $0.02063P_2$, a fixed fraction of the terminal stock price. When $d = 0$, the manager's compensation is $0.02063(a/1.02063)$ [see Equation (A7)], and the terminal stock price is

$$\begin{aligned} P_2(0, a + bd) &= a - s_0(0, a) \\ &= a - 0.02063(a/1.02063) \\ &= a/1.02063, \end{aligned}$$

verifying the claim. When $d = 1$, Equation (A7) shows that the manager's compensation is

$$\begin{aligned} &0.02063\left[\frac{0.808016(75 + a + b)}{1 + (0.02063)(0.808016)}\right] \\ &= 0.02063[0.79477(75 + a + b)], \end{aligned}$$

so we must verify that the terminal stock price is $0.79477(75 + a + b)$. This is calculated as

$$\begin{aligned} P_2(1, a + bd) &= \left(\frac{P_1(1)}{P_1(1) + 75}\right)[75 + a + b - s_0(1, a + b)] \\ &= \left(\frac{315.66}{315.66 + 75}\right) \\ &\quad \cdot \left(75 + a + b \right. \\ &\quad \left. - 0.02063\left[\frac{0.808016(75 + a + b)}{1 + (0.02063)(0.808016)}\right]\right) \end{aligned}$$

$$= \left(\frac{315.66}{315.66 + 75}\right)\left(\frac{75 + a + b}{1 + (0.02063)(0.808016)}\right)$$
$$= 0.79477(75 + a + b),$$

so the contract does pay a fixed fraction of the stock price.

References

Abreu D., 1988, "On the Theory of Infinitely Repeated Games with Discounting," *Econometrica,* 56, 303-396.

Aghion, P.. and P. Bolton. 1992, "An Incomplete Contracts Approach to Financial Contracting," *Review of Economic Studies.* 59, 473-494.

Benoit, J. P., and V. Krishna, 1985, "Finitely Repeated Games," *Econometrica,* 53, 905-922.

Bhattachatya, S., 1980, "Nondissipative Signaling Structures and Dividend Policy," *Quarterly Journal of Economics,* 95, 1-24.

Dewatripont, M., 1989, "Renegotiation and Information Revelation over Time: The Case of Optimal Labor Contracts," *Quarterly Journal of Economics,* 104, 589-619.

Dybvig, P. H., and J. F. Zender, 1991, "Capital Structure and Dividend Irrelevance with Asymmetric Information," *Review of Financial Studies,* 4, 201-219.

Fudenberg. D., and E. Maskin, 1986. "The Folk Theorem in Repeated Games with Discounting and with Incomplete Information." *Econometrica,* 54. 533-554.

Fudenberg, D.. and J. Tirole. 1990, "Moral Hazard and Renegotiation in Agency Contracts," *Econometrica,* 58, 1279-1319.

Green, J. R., and J. J. Latfont, 1992, "Renegotiation and the Form of Efficient Contracts," *Annales d 'Economic et de Statistique,* 25/26, 123-150.

Harris, M.. and A. Raviv, 1985. "A Sequential Signalling Model of Convertible Debt Call Policy," *Journal of Finance,* 50, 1263-1281.

Harris, M.. and R. Townsend, 1981, "Resource Allocation under Asymmetric Information," *Econometrica,* 49, 33-64.

Hart, O., and J. Moore, 1988. "Incomplete Contracts and Renegotiation," *Econometrica,* 56, 755-785.

Hart, O., and J. Tirole, 1988, "Contract Renegotiation and Coasian Dynamics," *Review of Economic Studies,* 55, 509-540.

Latfont, J. J., and J. Tirole, 1990, "Adverse Selection and Renegotiation in Procurement," *Review of Economic Studies,* 57, 597-625.

Lublin. J., 1992. "Executives Grumble about SEC Plan to Require More Pay Data," *Wall Street Journal,* Sept. 21. B1.

Miller, M. H., and K. Rock, 1985, "Dividend Policy under Asymmetric Information," *Journal of Finance,* 40, 1031-1051.

Myers, S. C., 1977, "Determinants of Corporate Borrowing," *Journal of Financial Economics,* 5, 147-175.

Myers, S. C., and N. S. Majluf, 1984, "Corporate Financing and Investment Decisions When Firms Have Information That Investors Do Not Have." *Journal of Financial Economics,* 13, 187-221.

Myerson, R., 1979, "Incentive Compatibility and the Bargaining Problem," *Econometrica,* 47, 61-74.

Nachman, D. C.. and T. H. Noe, 1993, “Optimal Design of Securities under Asymmetric Information:” forthcoming in *Review of Financial Studies.*

Paul, J. ht., 1992. “On the Efficiency of Stock-Based Compensation,” *Review of Financial Studies,* 5, 471-502.

Ross, S. A., 1977, “The Determination of Financial Structure: The Incentive Signalling Approach,” *Bell Journal of Economics,* 8, 23-40.