Managerial Incentives and Corporate Control

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Para Miriam, com amor e carinho.
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Chapter 1

Sale of Information as a Cost of Auctioning Public Companies

Abstract

Auctions of public companies may be costly for shareholders. This happens because the incumbent management team may sell information to one of the bidders. This agency cost may explain why debtholders are reluctant to push for an auction of a company in default. The sale of information also explains why, in a takeover battle, investment banks and LBO artists may give a share of the company to the incumbent managers, even if the latter do not have any comparative advantage with respect to outside managers. The share should be seen as the price of information. The takeover of RJR-Nabisco by KKR is used as a motivation for this chapter.
On January 17, 1991 Eastern Airlines ceased its operations after losing $3.0 billion under bankruptcy court supervision. Jensen (1991) used this case to argue that judges do not have the correct incentives and skills to make decisions on a business reorganization plan. He suggested that the role of the bankruptcy court should be limited to supervise an auction of the company, and to distribute the proceeds among the claimholders according to the seniority of the claims. His main argument was that an auction would allocate the company’s assets to their best use. Moreover, competition among the bidders would allow the claimholders to receive the company’s value under its most efficient alternative use.

According to the above reasoning, creditors should strictly prefer auctioning a company under default, rather than betting on a reorganization plan. However, as Easterbrook (1990) pointed out “...when creditors draft legislation to present the Congress, their agenda does not include a demand that judges put corporate debtors on the block.” The fact that they do not push for auctions suggests that they foresee some cost in this strategy.

In this chapter we argue that auctions are costly because the incumbent management team can sell private information on the firm’s value to one of the bidders. The sale of information reduces the expected revenue of the auction, implying a cost to the claimholders. This explains why debtholders may prefer to try a reorganization plan rather than putting the firm on the block.

We can give the main intuition through a simple example. Consider a firm that will be sold through a first price auction to one of two symmetric risk-neutral bidders.² Suppose also that the value of the firm is uniformly distributed over the interval [0, 1]. Then the only Nash Equilibrium of this auction has both bidders bidding \( \frac{1}{2} \). The auction delivers the firm’s value to the shareholders.

Now suppose that the Chief Executive Officer (CEO) knows the true value of the company, and that he is willing to sell this information to one of the bidders. We claim that a competitive auction will fail to deliver the company’s value to the shareholders.

To see this, suppose that the manager actually sells the information to one of the bidders. In this case the auction will be played under asymmetric information. One of the bidders knows the firm’s value, while the other stays with the uniform distribution. Engelbrech-Wiggans, Milgrom and Weber (1983) showed that the unique equilibrium bidding strategies

²In a first price auction the object is sold to the bidder that placed the highest bid. The winner pays the bid and the losers pay nothing.
of this auction are given by

- Informed bid: \( b^i(v) = \frac{v}{2} \)
- Uninformed bid: \( b^u = \) randomizes uniformly over \([0, \frac{1}{2}]\).

Note that the informed bid is contingent on the firm's value, \( v \). More importantly, the informed bidder bids less than his true valuation. The intuition for this result comes from the greater cautiousness of the uninformed bidder. The latter knows that his rival will bid low when the value is low. Therefore, the uninformed bid will win more frequently when the firm's value is low. It follows that a bidder should revise his bidding strategy (downwards), if he finds out that his rival obtained private information on the firm's value. On the other hand, the informed bidder takes advantage of his rival's greater cautiousness to reduce his own bid, increasing his payoff in case he wins. In short, private information gives a strategic advantage to the informed bidder, and reduces the auction's expected revenue.

Indeed, the equilibrium strategies imply that the expected revenue of the auction is \( \frac{1}{3} < \frac{1}{2} \). Contrary to the symmetric case, the competitive auction fails to deliver the firm's value to the shareholders. The difference is absorbed by the informed bidder, who has an expected payoff of \( \frac{1}{3} \) in the auction. Actually, the difference is split between the CEO and the bidder. The former can exploit competition between the bidders to extract part of (or all) the expected payoffs due to the informational advantage.

The example is not the end of story for, at least, two reasons. First, most likely the information cannot be verified by a court. Therefore, it is not obvious that the CEO can sell it. Second, the example does not consider any reaction from the board of directors. For instance, the board could hire external auditors to publicly reveal the information. Moreover, the threat of an auditor could be enough to make the CEO release the information under some incentive scheme.

The nonverifiability of the information is not a problem. We shall show in section 1.2 that the CEO can overcome it by selling the information under an incentive scheme. On the other hand, the second point is more subtle. If the cost of gathering information is too high

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2 This is known in the auction literature as the "winner's curse".
3 The expected payoff of the uninformed bidder is zero.
4 For instance, a bidder may fear that the CEO will also sell the information to the opponent. In such case there would not be any informational advantage in the firm's auction. Hence, the bidder would not pay a positive price for the information.
the threat is not credible, and the CEO cannot be stopped from selling the information. However, the threat could be useful when the cost is low. In principle the board could obtain the information (cheaper than hiring an auditor) by offering an incentive contract to the CEO, sweetened by the threat of hiring the auditor.

In this chapter we assume that the board cannot pay the manager to reveal the information. An incentive contract to induce the CEO to release information on the company’s operations would be considered an undue compensation. The board of directors would be threatened by a legal suit for breach of fiduciary duty in case they try to implement it.

However, there is an alternative mechanism that does not require transfers to the CEO, but allows the board to extract part of the information rent. The board of directors can sell its right of hiring an auditor to the CEO. The latter could be interested in such contract because it assures that the board would not block the sale of information by releasing it through an auditor. Moreover, this mechanism is very easy to implement. For instance, by scheduling the auction to an early date the board commits not to gather all information. On the other hand, the CEO could give up his severance payment in exchange for the board’s cooperation.

Nevertheless, we shall show that the board cannot fully eliminate the expected loss due to the CEO’s private information, even using this alternative mechanism. The same asymmetry of information that is the root of the agency problem precludes the above mechanism to deliver the company’s value to the shareholders.

Now we can translate the example to our two main applications. First consider the case of a bankrupted firm. As Myers (1977) pointed out, the possibility of bankruptcy may lead to a sub-optimal investment plan. If the company is sold, without debt, the new owners can implement the value maximizing investment plan. However, at the time of the auction the CEO may be the only one to know the value maximizing plan.

Second, consider the case of a takeover. Auctions are strongly present in the market for corporate control, being used to end most takeover battles. Moreover, takeovers are usually

\[8\text{It is common practice in public companies to pay a “bonus” (called severance payment) for CEOs that are forced to retire. Nevertheless, we shall prove in section 1.2 that a severance payment does not induce truthful revelation of the information. An incentive compatible contract requires a payment contingent on the value of the firm after the auction.}\]

\[9\text{One way to formalize these arguments is to consider that the initial entrepreneurs preclude some side payments to the CEO to avoid collusion between the latter and the board of directors.}\]

\[7\text{The basic idea is that the investment may impose an initial cost on the equityholders, which cannot be recovered because the returns will be captured by the debtholders.}\]
followed by internal reorganization, and/or an increase of market power (Baghat, Shleifer, and Vishny, 1990). Therefore, the bidders need to estimate the value of the firm under the new ownership. As before, it is likely that the CEO will have private information to help such assessment.

Is the loss caused by the sale of information relevant? This is an empirical question which is beyond the scope of this chapter. Nevertheless, we shall argue that the takeover battle for RJR Nabisco gives some evidence that the potential loss may be quite high.

RJR Nabisco was acquired by KKR in 1988, through an auction where the management group run with another bidder (Shearson Lehman). The management of RJR Nabisco was known in the market as a profligate spender, without any clear comparative advantage with respect to outside managers. Nevertheless, both bidders tried to bring them to their side. The management group eventually joined Shearson in a management buyout, after this investment bank agreed with a package that promised $2 billion for seven RJR executives including the CEO. These figures suggest that the strategic advantage of being the most informed bidder may be quite relevant.

This example is also useful to highlight another insight provided by the model. The sale of information explains why bidders may offer the incumbent management a partnership in the new company, even when the latter lack any comparative advantage with respect to outside managers. The stake offered to the management should be seen as the price paid to his private information.

We should note that there is already a paper that explains costs of selling financially distressed firms. Shleifer and Vishny (1991) argue that the bidder with the highest valuation is likely to be a company in the same industry. However, this company could be credit constrained for the same reasons that led the auctioned one into distress. In this case, the auction would be won by some “deep pocket” who does not value the company so much. Nevertheless, Shleifer and Vishny cannot explain why auctions are not used when the company is small, or it is bankrupted for idiosyncratic reasons. In both cases credit constraint should not be a problem for companies in the same industry.

Finally, Lowenstein (1985) argues that shareholders lose in takeovers led by the incumbent management because the latter choose a moment of underpricing in the stock market to launch the tender offer. Besides relying in the inefficiency of the stock market, Lowen-
stein does not explain why competition does not eliminate the underpricing.\textsuperscript{8} This chapter provides such explanation, and shows that the assumption of inefficient stock market is not necessary.

The chapter proceeds as follows. In Section 1.1 we present the general framework. We opted for a more abstract model to make clear that the results are not affected by the reason of the company’s auction, i.e., a takeover battle or bankruptcy. In Section 1.2 we prove that the sale of information is costly to the shareholders. The proofs not presented in the text can be found in the Appendix. In Section 1.3 we describe the takeover battle for RJR-Nabisco, and Section 1.4 concludes the chapter.

1.1 General Framework

We consider a public corporation run by a self interested risk neutral manager, who is monitored by a board of directors. The firm’s stock is currently traded at price $p^0$. Without loss of generality we set $p^0 = 0$.

At time 0, $T^0$, a new technology is made available to two risk-neutral outsiders, whom we call the bidders.\textsuperscript{9} However, there is uncertainty about the true value of the firm, $V$, under this new technology.

We have in mind two main cases: bankruptcy and disciplinary takeovers. In the case of bankruptcy the improvement after the change in control is due to the new capital structure. We assume that the existing debt will be paid (not necessarily at the face value) with the proceeds obtained from the firm’s sale. Free of the debt, the new company would have the correct incentives to pursue a value maximizing investment plan.\textsuperscript{10} There is uncertainty on $V$ because the bidders and the board do not know the value maximizing plan at $T^0$. In the case of disciplinary takeovers the bidders will implement a new incentive scheme that aligns the interests of the manager with the shareholders. Nevertheless, at $T^0$ the outsiders do not know the potential of the firm under this new incentive scheme.

\textsuperscript{8}As shown by Kaplan (1989), managers face tough competition in management buyouts. In his sample, the incumbent managers lost the firm’s control in 34 occasions (28%).

\textsuperscript{9}They are outsiders because we do not allow them to be the manager neither to participate in the board of directors. The number of bidders is unessential. We can generalize it at the cost of some notation, without adding any insight.

\textsuperscript{10}As Myers (1977) pointed out, a highly indebted company may pass positive NPV projects. This happens if the the project requires an initial investment from the shareholders, which cannot be fully recovered because the debtholders will capture the project’s returns.
From now on we will not characterize the reason for the potential increase in the firm’s value. We will consider that the firm’s value under the new technology is distributed according to a cumulative distribution function (CDF), $F(v)$, as in Assumption 1 below.

**Assumption 1** $F(v)$ is absolutely continuous with density $f(v)$. It is common knowledge to the board and the bidders, and it has support on the interval $[0, V]$, where $0 < V < \infty$.

We assume that the board of directors will implement the change in control according to the best interest of the shareholders. Surely this is not a trivial assumption. Nevertheless, in the cases that we want to address (bankruptcy, and disciplinary takeovers) there are clear external reasons pushing the board to the sale. Moreover, in both cases the board’s performance is closely monitored by a court. Finally, this assumption is useful to show that the auction can be costly even in the best case scenario where the outside directors act in the best interest of the shareholders. We summarize the board’s incentives, and the mechanism used to sell the firm in the following assumption.

**Assumption 2** The company will be sold as an indivisible object through a sealed second price auction. The board of directors will maximize the expected revenue of the auction net of any costs.

We are using second price auctions to simplify the model’s solution.\(^{11}\) Nevertheless, our results are valid for any sale mechanism that gives an advantage to the most informed bidder.\(^ {12}\) Solving our model for a first price auction would be closer to our main intuition, i.e., the sale of information is costly to the shareholders because of the winner’s curse. Unfortunately, the outcome of a first price auction depends on the bidders’ prior on the firm’s value. The updating of these priors would make the solution too messy. By using a second price auction we can bypass the updating.\(^ {13}\)

We want to use the simplest possible information structure that allows the incumbent

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\(^{11}\)In a sealed second price auction of an indivisible object, the bidder that places the highest bid wins, he gets the object and pays a price equal to the second highest bid. The losers pay nothing. We also assume that in case of a tie the winner is chosen according to the toss of a fair coin.

\(^{12}\)Therefore, we rule out mechanisms such as the one proposed in Cremer and Mclean (1985). They show that a seller can extract all buyers’ surplus (even under asymmetric information) by imposing harsh punishments in the buyer that falsifies his valuation. However, this mechanism relies on unlimited liability on the buyer, which is not a realistic assumption in the market for corporate control.

\(^{13}\)As a drawback, second price auctions have multiple equilibria that cannot be ruled out by the usual refinements.
manager to sell information. Therefore, we assume that at $T^0$ he is the only one that knows the realization of $V$.

**Assumption 3** *The manager knows the realization of $V$ at time 0.*

Assumption 3 captures the idea that the act of running the firm gives private information to the manager.\(^{14}\)

We do not endow the manager with any special skill. His sole advantage with respect to outside managers is the knowledge of the firm’s value at $T^0$. In particular, we allow the incumbent manager’s replacement without affecting $V$.

Being a self interested agent, the manager will try to exploit his informational advantage by selling it to the bidders. The crudest way to implement the sale of information has the manager publicly announcing his willingness. In a more realistic scenario he would negotiate with a bidder a stake in the deal, or a more aggressive compensation package, in exchange for his help in the planning of the bidding strategy.

We take the toughest stand for the manager. The value $V$ at $T^0$ cannot be verified by a court (ex-post). Therefore he must impose on himself an incentive scheme that assures truthful revelation of $V$ under the agreed conditions.

**Assumption 4** *$V$ is not verifiable.*

The board of directors anticipate that the manager will try to sell the information.\(^{15}\) In principle the board could offer the manager an incentive contract to obtain the information. However we don’t allow a contract that pays the manager to release information on his own company. This contract would be seen as an undue compensation to the manager. More importantly, a court could consider it as a self dealing transaction, obtained by collusion between the board and the manager. However, we endow a non-empty action space to the board. They can obtain the information through a third party at a cost $C$.

**Assumption 5** *The board can learn the realization of $V$ at a cost $C > 0$.*

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\(^{14}\)We could also assume that the manager knows some characteristic of the firm that is correlated with $V$. In this setup, the private information would be represented by a random variable $X$. The pair $(V, X)$ would form a random vector with joint distribution $F(V, X)$. However, because all agents are risk neutral, $X$ would be important only through the first conditional moment $E[V|X]$. Under mild conditions on $F(V, X)$, all results follow if we substitute $E[V|X]$ for $E[V]$. Therefore, $X = V$ turns to be a harmless simplification.

\(^{15}\)Recall that the uncertainty on $V$ is common knowledge at $T^0$. 


Assumption 5 allows the board to gather the information without the manager's cooperation. We will interpret $C$ as the cost of hiring an auditor to gather the information, and we will assume that reputation ensures a truthful auditor's report. An alternative interpretation would have the board hiring financial advisors to be in charge of the gathering and distribution of information. The cost $C$ would be related to the hiring costs, the delay in the auction due to the time needed to collect information, and the risk of leaking strategic information to competitors.

After acquiring the information through an auditor, the board can decide if it is in the company's interest to release it to the bidders, and how to release it. Note that, contrary to the manager, the board can release a noisy signal to the bidders. They can do this because they rely on the auditor's reputation to commit a honest report. For instance, the board can preclude the auditor from gathering further information at the cost of a qualifying note in the auditor's report. On the other hand, there is no reputation consideration to guarantee that the manager will not choose a convenient realization of the random variable. It is worth noting that Admati and Pfleiderer (1986) showed that it may be optimal to add noise to the information, if the seller can commit truth-telling. Nevertheless, they did not provide a mechanism where incentives assure that the noise is honestly added.

The board's action space is not limited to gathering and releasing information. The board can threaten the manager to hire the auditor, and release the information for the bidders, unless the manager pays something to the company. This might extract the manager's gain from the sale of information without spending $C$.

Surely this mechanism seems quite unrealistic. One can hardly imagine a side payment from the incumbent manager to a company that will be auctioned. Nevertheless, one can imagine the incumbent manager as a partner of an investment bank in a buy-out proposal, where the manager agrees to give up his severance payment if the board accepts the offer. In this case, the partnership is the price paid by the investment bank for the information, and the release of the severance payment is the price paid by the manager to avoid the board fostering competition in the firm's takeover. In short, the mechanism may not be so absurd. The next assumption summarizes the discussion on the sale of information and auditing rights.

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18 The hiring of an investment banker and a law firm to advise the board is a common practice in takeovers, and bankruptcy procedures.
**Assumption 6** The manager cannot credibly commit to add noise to the information. However, the board can do it. Moreover, the board can offer the manager to waive the right of hiring the auditor in exchange for a side payment.

Now we can describe the timing of the game with the correspondent action space. As we said before, it is efficient to change the firm’s control. The bidders can afford to pay a premium over the current stock price to implement the change. We consider the date of the firm’s auction, $T^4$, as given.

- $T^4$: Sale of the firm through a second price auction.

- $T^3$: Last moment to release the information to the bidders, if it is meant to be used by the latter in the auction. You can think of $T^4 - T^3$ as the time that the bidders need to analyze the information. If the information is not fully released by the board at $T^3$, the manager sells the information to the bidders.

- $T^2$: Last moment for the board to hire an auditor, in order to release the information no later than $T^3$. We can think of $T^3 - T^2$ as the time that the auditor needs to learn the information.

- $T^1$: The manager accepts or rejects the board’s proposal to sell the auditing rights.

- $T^0$: The board proposes a contract to the manager that guarantees that an auditor will not be hired.

We have a dynamic game with incomplete information, and we will look for a Perfect Bayesian Equilibrium.

### 1.2 Sale of Information as an Agency Cost

**Solving the Game: Overview**

At $T^0$ it is common knowledge that the company will be auctioned at $T^4$. Moreover, the board knows that the manager can sell information to the bidders, and the manager knows that the board can eliminate his informational advantage by hiring an auditor. We will solve this game backwards. The optimal action at each stage will be found by comparing
the expected payoffs of the continuation game conditioned on the available information. The main steps of the solution are the following:

- **Step 1** ($T^4$): We characterize the equilibrium strategies of the firm's second price auction under different information structures. We show that the expected revenue of the auction is smaller when the bidders have asymmetric information about $V$.

- **Step 2** ($T^3$): The manager sells the information on $V$ to one of the bidders if and only if none of them are fully informed. The optimal sale mechanism is characterized.

- **Step 3** ($T^2$): The board decides if the auditor should be hired. It will be shown that it is optimal for the board to fully release the information at $T^3$, if it was acquired at $T^2$. Therefore, the board chooses between paying the cost $C$ to release the information to both bidders, or having a reduced expected revenue in the firm's auction due to asymmetric information.

- **Step 4** ($T^0$): It is shown that the board's optimal mechanism to sell the auditing rights is a take it or leave it offer.

- **Step 5** ($T^1$): The manager accepts or rejects the contract that sells the auditing rights. Suppose that $C$ is larger than the expected loss due to asymmetric information in the firm's auction. Then the manager knows that the board will not hire an auditor, hence he does not accept the contract. On the other hand, suppose that $C$ is less or equal than the expected loss. Then the board can threaten to release the information. The manager accepts the contract if the expected revenue from the sale of the information is larger than the contract's price.

### 1.2.1 The Firm's Auction at $T^4$

In this subsection we characterize the auction's payoffs under different information structures. We will use these payoffs to analyze optimal decisions in earlier stages of the game.

We will assume that the uninformed bidder(s) and the board reach $T^4$ with the same initial prior $F(v)$ on $V$. This is not necessarily true because they can update their prior at $T^1$ (when the manager responds to the board's proposal to sell the auditing rights), and at $T^3$ (when the manager proposes the sale of information). Nevertheless, Lemma 4 proves that this assumption is harmless. All the equations to be derived here are valid provided
that we replace the unconditional expectations for the updated ones. We opted for not considering the updating only for notational simplicity.\textsuperscript{17}

We start with an auction where one bidder knows the realization of $V$, and the other keeps the prior distribution, $F(v)$, on $V$. Since at $T^0$ the bidders are symmetric we can assume, without loss of generality, that bidder 2 is the fully informed one. Next we show that bidding his true valuation is a weakly dominant strategy for bidder 2 at $T^4$.

**Lemma 1** For any $v \in [0, V]$, bidding the true valuation, $v$, is a weakly dominant strategy for the informed bidder.

**Proof:** Take any bid $b_1$ for bidder 1, any realization $v$, and any bid $b$ of bidder 2. The latter knows the realization of $V$. Therefore, we do not need to update his prior when we consider an outcome of the auction. We have three cases to analyze.

- **$b_1 > v$:** If $b > b_1$, bidder 2 wins for sure, and his expected payoff is $(v - b_1) < 0$. If $b = b_1$, we have a tie and bidder 2 wins with probability $\frac{1}{2}$. His expected payoff is $\frac{1}{2}(v - b_1) < 0$. So, bidding $v$, and loosing, is strictly better than any $b \geq b_1$. For any $b < b_1$, bidder 2 looses. Therefore, any $b$ is weakly dominated by $v$.

- **$b_1 < v$:** If $b < b_1$, bidder 2 loses getting zero. If $b = b_1$, there is a tie. Bidder 2 wins with probability $\frac{1}{2}$, and his expected payoff is $\frac{1}{2}(v - b_1) > 0$. Finally, for any bid $b > b_1$, bidder 2 wins, and his expected payoff is $(v - b_1)$. Therefore $v$ is strictly better than any $b \leq b_1$ and weakly dominates any $b > b_1$.

- **$b_1 = v$:** In this case, the expected payoff of bidder 2 is zero for any bid $b$. \square

Unfortunately, we cannot guarantee that, in equilibrium, bidder 2 will play the weakly dominant strategy. Actually, second price auctions are known to have plenty of equilibria that cannot be ruled out by the usual refinements.\textsuperscript{18} From now on, we restrict our attention to the set of equilibria where the informed bidder plays the weakly dominant strategy, $b_2(v) = v$.

**Lemma 2** For any bid $b_1$ of the uninformed bidder, his expected payoff $E[R_1(b_1)]$ is zero whenever bidder 2 plays the weakly dominant strategy. Therefore, bidder 1 will be willing to randomize over the support of $V$.

\textsuperscript{17}Moreover, not explicitly considering the updating in the expectations does not affect earlier stages because of the Law of Iterated Expectations.

\textsuperscript{18}See Milgrom (1981) for further comments and an insightful example.
Proof: If bidder 1 wins the auction, he knows that he will pay the true value independently of his bid. □

Suppose that J(b) is the CDF according to which bidder 1 (the uninformed one) will randomize. Then bidder's 2 expected payoff (gross of the cost of acquiring the information) conditioned on \( V = v \), and given \( J \) is

\[
E[R_2|V = v]_j = J(v)[v - \int_0^v sdJ(S = s|S < v)].
\]  

(1.1)

The first term is the probability that bidder 1 will bid less than bidder 2.20 The second term is the value of the firm minus the expected bid of bidder 1, given that it is less than \( v \).

Note that \( E[R_2|V]_j \) is a random variable. Then, the expected payoff of bidder 2 before he acquires the information is

\[
E[R_2]_j = E[E[R_2|V]_j].
\]  

(1.2)

Lemma 3 If for some \( \epsilon > 0 \) the interval \([0, \epsilon]\) belongs to the support of \( J \), then \( E[R_2|V = v]_j \) is increasing on \( v \). Moreover, \( E[R_2]_j > 0 \).

Proof: See the appendix.

The condition on \( J \) is a mild one. It requires the uninformed bidder to be willing to bid with positive probability (but that can be very small) in a neighborhood of zero. This condition assures that the informed bidder is better off than the uninformed. It avoids perverse equilibria where the informed bidder is hurt by the indifference of the uninformed one, who gets zero payoff independently of his bid.21

Now we can characterize the board's expected revenue conditioned on \( V \) (\( E[R|V]_j \)):

\[
E[R|V = v]_j = J(v)\int_0^v sdJ(S = s|S < v) + (1 - J(v))v = v - E[R_2|V = v]_j.
\]  

(1.3)

In words, the expected revenue of the seller conditioned on \( V \) is the sum of the expected

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19\( J \) will be added to the notation to emphasize that the expectation depends on the choice of the randomization device.

20Note that by writing \( J(v) \) we used that the informed bidder plays the weakly dominant strategy \( b_2(v) = v \).

21The problem is that the winner's curse does not have a bite in second price auctions when the informed bidder bids the true valuation.
payment given that the informed bidder wins the auction of the firm, and the expected payment given that the uninformed bidder wins.

Taking expectation on equation (1.3):

\[ E[R_j] = E[V] - E[R_{2j}] . \] (1.4)

Note that \( E[R_j] \) is strictly less than \( E[V] \) if and only if the expected advantage of the informed bidder, \( E[R_{2j}] \), is strictly positive. This completes the characterization of the firm's auction when one player knows \( V \), and the other keeps the prior \( F(v) \) on \( V \).

Note that the proofs of Lemmas 1 to 3 do not depend on the uninformed bidder's prior on \( V \). Therefore, the results do not change if the uninformed bidder updates his prior at earlier stages of the game. We state this result as a Lemma for future reference.

**Lemma 4** Suppose that bidder 1 reaches the firm’s auction with a non degenerated prior \( F^*(v) \) on \( V \), and bidder 2 knows the realization of \( V \). Then \( (V, J) \) is still a Bayesian Equilibrium of the auction. It follows that the expected payoff of bidder 2 is \( E[R_{2j}] \), and the expected payoff of bidder 1 is zero.

Now consider the case where both bidders know the true realization of \( V \). Then, the unique Nash Equilibrium of the second price auction will have both bidders bidding \( V \). The expected payoff of the bidders in this auction is zero. The expected payoff of the auction at \( T^2 \) is \( E[V] \).

Finally, consider the case where both bidders are uninformed. Then we have a symmetric second price auction at \( T^4 \). We can treat it as a game with complete information, where both bidders have valuation \( E[V] \) for the firm. The unique Nash-Equilibrium of this game has both bidders bidding \( E[V] \).

Note that the auction’s expected revenue under symmetric information is no less than the expected revenue when the bidders have asymmetric information at \( T^4 \). This result is not new in the takeover literature. Tiemann (1988) showed that a discriminatory release of information may be optimal for the shareholders if the discrimination decreases the asymmetry of information. He suggested that a white knight, i.e. a friendly bidder, may be a way to implement the optimal discrimination.

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22 By equation (1.4), the expected revenue of the auction under asymmetric information is \( E[V] - E[R_{2j}] \). On the other hand, the expected revenue under symmetric information is \( E[V] \).
1.2.2 The Sale of Information at $T^3$

Having characterized the outcome of the auction at $T^4$, we move backwards to the sale of information at $T^3$. In this subsection we show that the bidders will be willing to pay a positive price for the information only if they know that the opponent will not have access to the information. Moreover, we exhibit an optimal mechanism for the manager to sell the information.

As in the previous subsection, we do not consider any updating on the bidders’ expectation due to the manager’s act at $T^1$. The reader can check that the proofs of Lemma 5, and Proposition 1 do not use the bidders’ prior on $V$.

**Lemma 5** If bidder 1 knows that bidder 2 knows $V$, then bidder 1 is not willing to pay a positive price for the information.

**Proof:** Suppose that bidder 1 also acquires the information. Then, there will be a second price auction at $T^4$, where both players have the same valuation $V$. Since $V$ is a weakly dominant strategy for any informed bidder, it follows that the expected payoff of bidder 1, gross of the cost to acquire the information, is zero. □

**Definition:** In an $\alpha$-mechanism the manager sells the information to the bidder that pays the highest percentage, $\alpha$, of his ex-post profit in the firm’s auction.²³

In a management buyout the incumbent management team becomes a partner of outside investors, usually an investment bank, to make a joint offer for the company. The incumbent management team continues running the company under the close monitoring of the outside partners. The latter finance the purchase of the shares retained by the management team and give them an incentive contract based on the profits of the new company. It can be shown that giving a stake in the new company is equivalent to the percentage $\alpha$ that is auctioned in the $\alpha$-mechanism.

**Proposition 1** The $\alpha$-mechanism is optimal for the manager. He can credibly commit not to sell the information twice, and both bidders bid $\bar{\alpha} = 1$. Therefore, the expected payoff of the manager under this mechanism is $E[R_2|V]$, and the expected payoff of the bidders is zero.

²³In case of a tie the information is sold to one of the bidders through the toss of a coin.
Proof: See the appendix.

This mechanism allows the manager to keep both bidders in their participation constraints for any realization of $V$. This is the best that a mechanism can do regarding the bidders. In the proof we argue that the mechanism also extracts as much as possible from the board. The commitment of not selling the information twice is credible because the manager internalizes the expected gain due to the informational advantage. Another important point to be noted is that the proof of Proposition 1 does not depend on the bidders’ prior on $V$.

1.2.3 The Board’s Decision at $T^2$

The optimal choice at $T^2$ will be found by comparing the expected payoff of the auction under the two alternatives available to the board: hiring and not hiring the auditor.\(^{24}\)

The Auditor Is Not Hired at $T^2$

In this case, the manager will sell the information to one of the bidders at $T^3$. Proposition 1 showed that the manager will extract all the surplus provided by the private information. Both bidders will have zero expected payoff at $T^2$, after considering the payment to the manager.

Now we can see that the formula for the expected revenue of the shareholders, equation (1.4), is not surprising. At $T^2$ the bidders, the manager and the board play a constant sum game with total payoff (from the perspective of the board) $E[V]$. In this game the bidders get zero and the manager gets $E[R_2]$. Therefore, the board’s expected payoff is $E[V] - E[R_2]$. For convenience we repeat below the expected payoffs, conditioned on the board not hiring the auditor.

Board: $E[R_2] = E[V] - E[R_2]$ \hspace{1cm} (1.5)

Bidders: $E[R_1] = E[R_2] = 0$ \hspace{1cm} (1.6)

Manager: $E[R_2|V = v]$. \hspace{1cm} (1.7)

\(^{24}\) As before we do not consider any updating on the expectations due to the manager’s act at $T^1$. The arguments below do not depend on this updating.
The Auditor Is Hired at $T^2$

We start studying the board's incentive for disclosing the information at $T^3$ conditioned on having acquired it at $T^2$.

Suppose the board does not disclose any information at $T^3$. Then, the act of not releasing the information may convey some information to the bidders. They can conjecture that the board acquired the information at $T^2$, but they did not release it because it brings bad news for the value of the firm. Proposition 2 below shows that this conjecture is not valid. Indeed, it shows that full disclosure of $V$ dominates any partial disclosure.

**Proposition 2** Assume Assumptions 1 to 6, and that the board acquired the information at $T^2$. Then the expected payoff of the auction cannot decrease if the board fully discloses the information at $T^3$. If we also assume that for some $\epsilon > 0$ the interval $[0, \epsilon]$ belongs to the support of $J$, then the board will strictly prefer to disclose any realization $v > 0$.

**Proof:** See the appendix.

The intuition of Proposition 2 comes from the fact that even if the board does not disclose $V$, one of the bidders will get it through the manager.

Consider any realization $v$ of $V$, and that the information is acquired at $T^2$. As shown in Proposition 2, the board releases it at $T^3$, and the bidders will be equally informed on the firm's auction. At $T^4$ the firm will be sold at price $v$. We have the following expected payoffs at $T^2$:

\[ \text{Board: } E[R] = E[V] - C \quad (1.8) \]

\[ \text{Bidders: } E[R_1] = E[R_2] = 0 \quad (1.9) \]

\[ \text{Manager: } 0. \quad (1.10) \]

A direct comparison of equations (1.8) and (1.5) shows that the board prefers to hire the auditor if and only if

\[ C \leq E[R_2]. \quad (1.11) \]

Equation (1.11) is quite intuitive. The auditor will be hired if and only if the auditing cost is less than the expected loss due to the sale of information. Proposition 3 below
summarizes the board's decision to hire an auditor at $T^2$.

**Proposition 3** Consider any Perfect Bayesian Equilibrium where the informed bidder plays the weakly dominant strategy $V$, and the uninformed bidder plays according to a CDF $J$, such that, for some $\epsilon > 0$, the interval $[0, \epsilon]$ belongs to the support of $J$. Then the board is better off acquiring the information at $T^2$, if and only if, $C \leq E[R_2]j$.

**1.2.4 Contract Proposal at $T^0$**

There are two main lessons from the previous subsections. First, the manager will sell the information on $V$ at a positive price, if the board does not provide it to the bidders. Second, ultimately the price is paid by the shareholders (or debtholders).

Nevertheless, hiring the auditor is an inefficient solution. The board would be contracting with a supplier that has a high cost to produce the information. A priori, one could conjecture that the board could pay the manager to obtain the information. In particular, a severance payment to the manager is usual when the board requires him to quit. In such case it is expected that the former manager provides the incoming one all relevant information. Nevertheless, we shall show in proposition 4 below that such contract does not assure truthful revelation of $V$.

**Proposition 4** Suppose that exists some $\epsilon > 0$, such that the support of $J$ belongs to the interval $[0, \epsilon]$. Then there is no incentive compatible side payment that elicits truthful revelation of $V$ from the manager.

**Proof:** Suppose by contradiction that exists an incentive compatible mechanism $M$, that promises the manager a transfer $t(v)$ if he announces $v$. Proposition 2 implies that the board will reveal any announced $v$ to the bidders. Then the manager's expected utility upon the acceptance of $M$ turns to be $t(v)$. Mooreover, $t(v) = t$ for any $v$. To see this, suppose that $t(v') > t(v)$ for some $v' \neq v$. Then a manager of type $v$ would be better off claiming that he is of type $v'$, contradicting incentive compatibility. But $t(,) \equiv t$ is not incentive compatible. The manager can accept $t$, lie about $v$, and then sell the true $v$ at $T^3$. Understanding that the initial announcement is a fake one, the bidders would be willing to pay for the manager's information at $T^3$. $\Box$

Proposition 4 rules out the board eliciting truthful revelation from the manager through a side payment. Of course, the board could obtain the information by proposing a contract
contingent on the firm's value after the auction as in the $\alpha$-mechanism. We ruled out this possibility on the ground that the court would consider it a self-dealing transaction. However, the board can offer the manager a contract where they waive the right of hiring an auditor in exchange for a side payment.\textsuperscript{25}

Note that the contract proposal at $T^0$ does not convey information because the board has the same information structure of the bidders. On the other hand, the manager's decision at $T^1$ may convey some information. However, the bidders' strategies at $T^2$ and $T^4$, and the optimality of the $\alpha$-mechanism do not depend on the bidders' prior on $V$. Therefore, the optimality condition to hire an auditor, equation (1.11), is still valid, provided that $E[R_2]_j$ is updated to take into account the information conveyed by the manager's response at $T^1$. Of course, we will have to take into account this updating to design the optimal mechanism that sells the auditing rights. To solve the optimal mechanism we add another assumption.

**Assumption 7** For some $\epsilon > 0$ the interval $[0, \epsilon]$ belongs to the support of $J$. Moreover, $E[R_2|V = v]_j$ is differentiable on $v$, and $(\frac{1-F(v)}{f(v)})(\frac{dE[R_2|V = v]}{dv})_j$ is non increasing on $v$.

The first part of Assumption 7 is by now well known. It assures that the informed bidder has an advantage in the firm's auction. The second part is a regularity condition, which is standard in the mechanism design literature except for the derivative.\textsuperscript{26} Note that the first term in brackets is the inverse of the hazard rate. Therefore, the regularity condition is satisfied if the hazard rate is increasing and $E[R_2|V = v]_j$ is concave on $v$.

We now describe the optimal contract.

**Theorem 1** Consider Assumptions 1 to 7, and define $v^*$ and $v'$ as the values of $V$ that solve the following equations:

$$C = \left(\frac{1-F(v^*)}{f(v^*)}\right)(\frac{dE[R_2|V = v^*]}{dv})_j \quad (1.12)$$

$$E[R_2|V < v']_j = C. \quad (1.13)$$

\textsuperscript{25}For instance, the manager could give up of his severance payment in exchange for an early auction. In this case the board would not have time to gather information, even if they were pressured by the other bidders.

\textsuperscript{26}The regularity condition avoids "bunching". Consider that $F$ and $J$ are uniformly distributed over $[0, 1]$. Then Assumption 1 and the first part of Assumption 7 are satisfied, but the regularity condition is not. Nevertheless, it can be shown that the optimal contract takes the form described in Theorem 1 below. Therefore, the regularity condition is sufficient but not necessary.
• $E[R_2]_j < C$: No contract will be accepted by the manager. The auditor will not be hired, and the manager will sell the information at $T^3$. The manager’s expected payoff at $T^0$ is $E[R_2|V = v]_j$, and the board’s payoff is $E[V] - E[R_2]_j$.

• $E[R_2]_j \geq C$: The optimal mechanism to sell the board’s right of hiring an auditor is a take it or leave it offer, at price $t^*$ defined by:

$$t^* = \begin{cases} 
E[R_2|V = v^*]_j & \text{if } E[R_2|V < v^*]_j \geq C \\
E[R_2|V = v']_j & \text{if } E[R_2|V < v^*]_j < C.
\end{cases} \quad (1.14)$$

Proof: See the appendix.

If $E[R_2]_j < C$ the manager knows that the board cannot afford to hire the auditor, unless he provides some information through his response to the contract proposal. However, rejecting the offer does not update the board’s prior on $V$ if the manager’s strategy is to reject for any $v$. This is optimal for the manager because he obtains $E[R_2|V = v]_j$, that is the upper bound of his expected utility.

On the other hand, if $E[R_2]_j \geq C$ there is scope to hire an auditor. Therefore, the manager should consider the board’s proposal. The proof that a take it or leave it offer is optimal is standard except for one detail. The board must have the correct incentives to carry through the threat of hiring the auditor after the manager’s response, i.e., $E[R_2|\text{offer was rejected}]_j \geq C$.

The intuition of the optimal contract is the following. Suppose that the board can commit to hire the auditor if the manager does not buy the contract. Then the optimal selling mechanism is a take it or leave it offer at price $t^* = E[R_2|V = v^*]_j$. If it is optimal to hire the auditor once the manager rejects this contract, then the commitment is not necessary. The take it or leave it offer is indeed optimal. However, if this is not true, then the “optimality” is sustained by the commitment. But since the commitment is not credible, $E[R_2|V = v^*]_j$ is not optimal anymore. Then the optimal contract is still a take it or leave it offer, but the price is increased to $E[R_2|V = v']_j$ to make the commitment “credible”. Actually, this is the lowest price such that $E[R_2|\text{offer was rejected}]_j \geq C$.

The characterization of the optimal contract allows us to do some comparative statics. Suppose the firm has a large cost $C$. Then, most probably $E[R_2]_j < C$, and the firm will be underpriced by $E[R_2]_j$ in the auction. Conversely, with a low $C$ most likely $E[R_2]_j \geq C$, and
the underpricing will be mitigated by the sale of the auditing rights. Note in equation (1.12) that \( C \) converging to 0 makes \( v^* \) converge to \( V \). In this case the price of contract would be \( t^* = E[R_2|V = V] \), which would be rejected by the manager with probability 1 because it is the upper bound of the expected payoff in the sale of the information. Therefore, the auditor will be hired, and the shareholders’ expected payoff will be \( E[V] - C \rightarrow E[V] \). No agency cost!

These arguments suggest that the expected payoff of the board increases upon a reduction of \( C \), while the opposite should hold for the manager’s expected utility. Proposition 5 below shows that the first conjecture is correct, but not the second. When \( E[R_2|V < v^*] < C \), the board must raise the price above the “optimal” level to commit the hiring of the auditor. A reduction in \( C \) relaxes the commitment constraint and the price can be lowered, which is always in the interest of the manager.

**Proposition 5** The expected payoff of the auction is non-increasing on \( C \), and it is strictly decreasing for \( C \) small enough. On the other hand, the expected utility of the manager is non-decreasing on \( C \), unless \( E[R_2|V \leq v^*] < C \) and \( E[R_2] \geq C \).

**Proof:** See the appendix.

We can now state the underpricing result.

**Theorem 2** Under Assumptions 1 to 7, the expected payoff of the auction at \( T^0 \) is less than \( E[V] \).

**Proof:** We have already shown that the expected payoff of the shareholders is \( E[V] \) when \( C = 0 \). By the first part of Proposition 5, the expected payoff is smaller than \( E[V] \) for any \( C > 0 \). \( \Box \)

We can also say something about underpricing and the realization of \( V \). Since the optimal contract is a take it or leave it offer, the higher the expected payoff in the sale of information the higher is the manager’s expected payoff. But the expected payoff of the sale of information increases with \( v \). Therefore, provided that the auditor is not hired, the higher is \( v \) the larger is the underpricing.

What happens if the manager is credit constrained and cannot pay \( t^* \)? Or if legal constraints do not allow the transfer. Then the contract is not offered and the auditor is hired if and only if \( E[R_2] \geq C \). The underpricing result is still valid! Actually, the result is strengthened because the inefficient hiring of the auditor will happen more frequently.
In the next section we illustrate the relevance of the sale of information in the market for corporate control through the takeover battle for RJR-Nabisco.

1.3 A Takeover Case: KKR Acquiring RJR-Nabisco

On November 30, 1988, RJR - Nabisco, the America's 29th largest public company, went private for $25 billion. The largest takeover battle in American history was won by the largest LBO artist, KKR, who defeated the incumbent management in an open auction for the company.

This highly publicized takeover is particularly suitable to highlight our model because of the clear linkage between information flow and bidding strategy. Moreover, RJR incumbent management team was “known as a profligate spender”. It seems that their sole advantage compared to outside managers was their knowledge of the firm, in particular where to cut costs.

Wall Street had long considered RJR a suitable target for a takeover. The strong cash-flow from the second largest tobacco company in USA gives a lot of room for the huge debt that takeovers impose on the targets. Indeed, in 1987 KKR approached RJR’s Chief Executive Officer, Ross Johnson, with a proposal of a management buy-out (MBO). Some members of the incumbent management team and KKR would buy the existing shares borrowing against future revenues of the company. Johnson declined KKR's proposal at the time.

In the end of July 1988, Ross Johnson hired Shearson Lehman to prepare takeover defenses. RJR shares were then traded at the low $50's after a peak of $71 before the stock market crash of 1987. The management team feared that the group was a probable target of a hostile takeover, because of what they considered a huge underprice of the group’s stock. Shearson made an in depth analysis of the group’s businesses to implement the defenses.

By the beginning of September, 1988, Johnson authorized Shearson Lehman to prepare plans for an MBO. In the beginning of October Shearson and the management group reached

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27 RJR Nabisco total sales amounted to $15.8 billion in 1987, mostly from tobacco and food.
28 The main source of this section is Burrough and Helyar (1990).
29 The incumbent management joined Shearson Lehman in the bid. Shearson is an investment bank controlled by the American Express Group.
an agreement. Ross Johnson and six other RJR executives would receive 8.5% of the new company, and an incentive scheme that could rise the stake to 20% in 5 years, an estimated value of $2.0 billion. Moreover, in a unique case in MBO’s, Johnson would retain control of the board, with veto power in the decisions. The management agreement reflected the strong bargaining power of the management team against the LBO artist, Shearson.

On October 19 Johnson presented the proposal at the board’s meeting: $75 per share, amounting to $17 billion. The board of directors assigned a special committee to analyze the proposal. One legal advisor, and two investment banks were hired to advise the special committee. A press release announced the bid on October 20, 1988. RJR’s stock price jumped from $56 to $77.25 upon the announcement. The market expected competition and further bidding.

On October 21 KKR hired its advisory team. In the same day Shearson and KKR met. Shearson tried to convince KKR not to bid using the argument that they had the management team on their side. Indeed, KKR had never tried a takeover without the support of the incumbent management team. Nevertheless, there was no agreement. On October 24 KKR launched a tender offer for RJR Nabisco at $30 per share. On October 25 Shearson offered a 50% partnership on the deal to KKR, that rejected it. However, at the same night Johnson made clear to KKR that he would not leave Shearson. After this conversation KKR returned to Shearson trying an agreement, which had not happened.

KKR realized that they have to obtain information in order to challenge further bids. On October 26 KKR met with former RJR Chief Executive Officer, Tyler Wilson. To their disappointment, they found him too outdated on the company’s businesses. On October 31, RJR executives were briefed by KKR under a schedule prepared by the special committee. The meetings were worthless. Then, KKR tried another agreement with Shearson, now accepting a 50% partnership. The attempt failed once more.

On November 3, the management group announced a tender offer at $92 per share. On November 5 The New York Times released the management agreement. Under great pressure, the special committee announced on November 7 that a sealed first price auction would take place on November 18. On the same day KKR met with Paul Sticht, another former RJR CEO. Despite finding him outdated, KKR retained Sticht as a temporary CEO for RJR Nabisco.

31 Each advisor received $14 million for their services.
On November 9, the management of Del Monte (fruit and juice division of RJR) found out that strategic information had been delivered to their main competitor, Dole. Del Monte believed that one of the bidders, Forstmann Little and Co., provided the information in an attempt to attract Dole to the deal.

As late as November 14, KKR did not have some basic information: cash reserves, total debt, and an estimate of the golden parachutes. They realized that the information was highly concentrated on the upper management levels. The middle management and the investment bankers advising the special committee did not know the company.

On November 16 Johnson agreed to scale down the incentive payments, and to reduce the management's stake from 8.5% to 6.5%. On the other hand, KKR did not feel comfortable in raising their bid. Actually, one of the two main partners, Roberts, suggested to withdraw for lack of information.

On November 18 the management group bid $100 ($23.0 billion), while KKR bid $94 ($21.6 billion). Nevertheless, a third bidder, First Boston, promised something between $105 and $108 based on an unusual tax structure. The special committee decided to give more time to First Boston to present a detailed proposal. All bids were made public and a new auction was scheduled to November 29.

On November 29, First Boston proposal was disconsidered by the special committee. KKR bid $106, and Shearson bid $101. However, a member of the special committee disclosed the bids to Johnson before the official announcement of the winner. Shearson obtained a further reduction of the management agreement from 6.5% to 4.5%, and initiated a sequence of open bids.

The takeover battle ended on November 30, with KKR getting the company for $109 per share ($25 billion). Shearson's final bid had a face value of $112. But the advisors of the special committee considered the offers equivalent, because KKR included protection clauses on the value of the securities used in the payment.

Despite the huge premium obtained in the buy-out, some shareholders sued the board of directors. The plaintiffs argued that the special committee could have obtained a further increase in the bid, had they continued the auction. On January 31, 1989 the claim was

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32Golden parachutes are company’s payments to the managers in case they are forced to retire. Johnson’s golden parachute amounted to $52.5 million, while Ed Horrigan’s, the second executive, amounted to $45.7 million.
33See Burrough and Helyar (1990) page 368.
rejected by the Delaware Court.\textsuperscript{34}

In the spring of 1990, RJR Nabisco passed for difficult moments when its credit rating was downgraded, and its junk bonds were traded at \$ 56 cents on the dollar. This would cause a big loss to the company, since \$ 6.5 billion in junk bonds had the value protection clause. Nevertheless, before the trigger date of the protection clause, KKR retired 85% of these junk bonds. The retirement was possible due to a cash injection of \$ 1.7 billion from KKR's limited partners, and a mix of new commercial bank loans and issuance of preferred stock. In the beginning of 1991, RJR Nabisco stock was back at the NYSE, trading at \$ 6.25 a share. In mid 1991 RJR credit was upgraded, and the financial statements reported strong earnings over the year. On April 3, 1992 RJR stock closed at \$ 9.62 a share.\textsuperscript{35}

How can our model help to understand the takeover battle for RJR - Nabisco? RJR's board had a large cost to acquire information. Apparently, only the top management had a broader picture of the company. Under this scenario, we could conjecture that RJR had a cost $C$ larger than the auction's expected loss due to asymmetric information ($E[R_2|\bar{y}]$). Therefore, the management could sell information without further thoughts on the board's actions. Moreover, the two main bidders offered partnership to the incumbent management in the takeover. This is consistent with competition for information.

The huge premium embedded in the final bid suggests that the realized $V$ was considerably high. The model predicts that the manager's stake should be high. Indeed, the management agreement was considered outrageous by the media.\textsuperscript{36}

There was a constant search for information from the part of the uninformed bidder, KKR. Moreover, at least one of the two main partners was not willing to bid at all because of lack of information.

Finally, the management agreement was downward revised after the public announcement of the bid. The point is that the announcement revealed part of the private information, which was the contribution of RJR management to the deal. Intuitively, the more public the information, the less its value.\textsuperscript{37}

\textsuperscript{34}See RJR Nabisco, Inc. Shareholders Litigation.


\textsuperscript{36}See Time Magazine December 5, 1988 cover story.

\textsuperscript{37}Our model cannot capture this intuition because a partial release of information does not change the equilibrium strategy of the uninformed bidder.
1.4 Conclusions

In this chapter we showed that a self interested manager may take advantage of an auction of his company to sell information to a bidder. The price of the information will be ultimately paid by the claimholders of the company, who will receive, on average, less than the company's value. We have also argued that the reason for the auction is not important. The main point is that the change of control should be preceded by some uncertainty on the new value of the company. Therefore, the model's predictions are valid for auctions driven by bankruptcy or takeover battles.

The takeover battle for RJR Nabisco suggests that the loss due to the sale of information may be quite relevant. This may explain why creditors are reluctant to push for an auction of a financially distressed company. A reorganization under a bankruptcy court supervision may be ex-ante preferred by the creditors even if there are clear costs in this alternative.

We also shed some light on why investment banks and LBO artists may be willing to give a share of the new company to the incumbent management team even when they do not have any comparative advantage with respect to outside managers. The share should be seen as the price paid for the private information.

Finally, this chapter provides a new testable implication on takeovers. The model predicts that the board's cost to acquire information should be positively correlated with the shareholders expected loss in the auction. Suppose that a large shareholder can enforce a better monitoring scheme on the management. It seems natural to assume that a better monitoring scheme should reduce the cost to acquire information. Therefore, the relation between cost and expected loss can be tested by looking at the correlation between the existence of a large shareholder and the takeover premium. To our knowledge this hypothesis has not been tested yet.
1.5 Appendix

Lemma 3

Note that we can write the original hypothesis on $J$, as $J(s) > 0$, for any $s > 0$. We first show that $E[R_2|V = v]_j$ is increasing on $v$. Take any $v' > v > 0$. Then $E[R_2|V = v']_j - E[R_2|V = v]_j = J(v')[v' - \int_0^v sdJ(S = s|S < v')] - J(v)[v - \int_0^v sdJ(S = s|S < v)]$. But, for any $v > 0$, $J(S = s|S < v) = \frac{J(s)}{\int_0^v J(s)ds}$. Therefore, $E[R_2|V = v']_j - E[R_2|V = v]_j = J(v')[v' - \frac{1}{\int_0^v J(s)ds} \int_0^v sdJ(s)] - J(v)[v - \frac{1}{\int_0^v J(s)ds} \int_0^v sdJ(s)] = [J(v')v' - J(v)v] - [\int_0^v sdJ(s) - \int_0^v sdJ(s)] = [J(v')v' - J(v)v] - [\int_0^v sdJ(s)] = \int_0^v J(s)ds > 0$. Where the last equality follows an integration by parts. The strict inequality comes from $J(s) > 0$, for any $s \geq v > 0$. Now suppose that $v' > v = 0$. By inspection of $E[R_2|V = v]_j$, one can see that $E[R_2|V = 0]_j = 0$. Hence, it suffices to show that $E[R_2|V = v]_j > 0$, for any $v > 0$. But this is true because, for any such $v$, $J(v) > 0$, and $v > \int_0^v sdJ(S = s|S < v)$. The second part of Lemma 3 is an immediate corollary of the first part. We showed that $E[R_2|V = v]_j \geq 0$, with strict inequality for any $v > 0$. Since $\{v \in V : v > 0\}$ has positive measure, we have that $E[R_2]_j > 0$. □

Proposition 1

Suppose bidder 2 wins the auction on $\alpha$, with bid $\bar{\alpha} \in [0, 1]$, and $v$ is the value of the firm. Then the manager will receive $\bar{\alpha}(v - s)$ if, in the firm's auction, bidder 1 bids $s < v$. If $s \geq v$, bidder 2 ex-post profit is zero, and the payoff of the manager is also zero. We proved in Lemma 4 that, no matter how bidder 1 updates his prior on $V$, $(V, J)$ is an equilibrium of the firm's auction. Therefore, the expected payoff of the manager is $\bar{\alpha}(J(v)[v - \int_0^v sdJ(S = s|S \leq v)]) = \bar{\alpha}E[R_2|V = v]_j$. Suppose that, after the auction on $\alpha$, the manager threatens to sell the information to bidder 1, unless bidder 2 pays an additional fee. We show that this threat is not credible. If bidder 2 refuses to pay, and the manager provides the information, the firm's auction will be carried under complete information. The unique equilibrium of the second price auction would have both bidders bidding the true value $v$. The ex-post profit of bidder 2 would be zero and the manager would loose $\bar{\alpha}E[R_2|V = v]_j$. Moreover, by Lemma 5, bidder 1 would not willing to pay a positive price for the information. We conclude that the manager will not carry through the threat. Since the argument follows for any $\bar{\alpha}$, the bidders can be sure that there will not be a second sale after the mechanism is played. Then the unique Nash Equilibrium of the auction on $\alpha$ has

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both bidders bidding $\alpha = 1$. It follows that the $\alpha$-mechanism allows the manager to keep both bidders on their participation constraints for any realization of $V$. This is the best that a mechanism can do regarding the bidders. Under Assumption 6, any feasible mechanism determines one of three possible information structures: both bidders are informed, no bidder is informed and one of the bidders is informed. In subsection 1.2.1 we showed that the worst case for the shareholders is when there is only one informed bidder. Therefore, the $\alpha$-mechanism exploits as much as possible any gains that can be extracted from the board. Since it also extracts as much as possible from the bidders, optimality follows. □

**Proposition 2**

We divide the proof in two parts. In the fist part we show that the proposition holds when the comparison is between full disclosure and no disclosure at all. In the second part we compare full disclosure with a partial one.

- **Full Disclosure vs No Disclosure**

Define the indicator function $I$ as follows: $I = 1$ if the information is not released, $I = 0$ otherwise. Then the new valuation of the bidders given $I = 1$ will be written $E[V|I = 1]$. Note that $C$ is a sunk cost at $T^3$. Therefore, it does not affect the board’s decision. Take any realization $v$ of $V$, we have two alternatives:

(i) The board discloses $v$ at $T^3$. Then, the bidders will be equally informed at $T^4$, and they will bid $v$. The board’s expected revenue at $T^3$ is $v$.

(ii) The board does not disclose $v$. In this case the bidders will update their priors. The new valuation is $E[V|I = 1]$. First assume that $F(V|I = 1)$ is degenerated on $v$. Then the act of not releasing the information reveals $v$. At $T^4$ both bidders bid $v$, and nothing is gained by avoiding the disclosure.\(^{38}\) Now assume $F(V|I = 1)$ is not degenerated. Then there is something to be learned from the manager, who will sell the information through the $\alpha$-mechanism.\(^{39}\) One of the bidders will be fully informed, while the other will have valuation $E[V|I = 1]$. By Lemma 4, the bidders keep the same bidding strategies at $T^4$, independently of the uninformed bidder’s prior on $V$. Therefore, the expected revenue of the board at $T^3$ will be given by equation (1.5): $E[R|V = v]_j = v - E[R_2|V = v]_j \leq v$. To

\(^{38}\)Note that the degenerated case may happen for at most one realization of $V$. Therefore, it is a probability zero event. Hence, we will disregard it when we discuss the board being strictly better off releasing the information.

\(^{39}\)The proof of Proposition 1 did not use the bidders’ prior on $V$. Therefore the $\alpha$-mechanism is still optimal for any updating at $T^3$. 

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obtain the strict inequality we need \( v > 0 \). In such case it suffices to find restrictions that obtain \( E[R_i | V = v] > 0 \). But we showed in the proof of Lemma 3 that this is accomplished by the restriction placed on \( J \).

- Full Disclosure versus Partial Disclosure

We interpret partial disclosure as adding noise to the realization \( v \). Call the noisy signal \( Z \), and \( z \) its realization. We will compare the expected payoff of the board under the three ways of releasing \( v \) with noise.

(i) Suppose that the board sells the same noisy signal for both bidders. In this case, the bidders would still be willing to acquire \( V \) through the manager. For any realization \((v, z)\), one of the bidders would acquire \( v \). We can proceed as in the first part, substituting \( E[V | Z = z] \) for \( E[V | I = 1] \) in the uninformed bidder's valuation.

(ii) Consider full release to bidder 2 and a noisy signal, \( Z \), to bidder 1. By Lemma 5, bidder 1 does not have any incentive to acquire \( V \) through the manager. We are back to the previous case, at the stage that one of the bidders acquired \( V \) through the manager. Note that the result does not change if we allow a more active role for the manager. For example, he could say to bidder 2 that he would reveal the information to bidder 1, unless he receives some side payment. But this does not change the expected revenue of the board. The only consequence would be a transfer from bidder 2 to the manager.

(iii) Consider a different noisy signal for each bidder. Then one of them would acquire the information through the third party. We are back to the second case. □
Theorem 1

CASE I: $C \geq E[R_2]$j

Consider any contract that specifies a non negative transfer from the manager to the board. We show that the following strategies form a Bayesian Equilibrium of the subgame that starts at $T^1$.

- Manager: “Reject the offer for any $v$”
- Board: “Does not hire the auditor”

Given the manager’s strategy the board does not update its prior on $V$. Since $C > E[R_2]$j, it is optimal for the board not to hire the auditor. Given the board’s strategy it is clearly optimal for the manager to reject the contract. Note that the equilibrium is also perfect. Out of the equilibrium path the offer is accepted by the manager, but then the board cannot hire the auditor independently of its prior on $V$.

CASE II: $C < E[R_2]$j

As in Myerson (1981), we consider direct mechanisms where the allocation is determined by a pair of functions $(z(\cdot), t(\cdot))$ defined below:

- $z(v)$: probability that the board gives up the right to hire an auditor given announcement $v$.
- $t(v)$: transfer from the manager to the board upon announcement $v$.

We will solve the optimal direct mechanism $(z^*(\cdot), t^*(\cdot))$ under two auxiliary assumptions:

Assumption 8 The board can commit not to reveal the announced $v$ to the bidders if the auditor is not hired.

Assumption 9 The board can commit to hire the auditor when this is not precluded by $(z^*(\cdot), t^*(\cdot))$.

Note that $(z^*(\cdot), t^*(\cdot))$ is not necessarily the optimal mechanism to sell the auditing right. An optimal direct mechanism requires truthful revelation of $V$. However, Proposition 2 showed that it is in the best interest of the board to announce $v$, once they know it. Therefore, Assumption 8 is not a credible commitment.
Nevertheless, an indirect mechanism $y^*$ equivalent to $(x^*(.), t^*(.))$ may be optimal if it is not fully revealing. Actually Lemma 6 below shows that such $y^*$ is optimal if Assumption 9 is satisfied.

**Lemma 6** Suppose that $(x^*(.), t^*(.))$ is the optimal direct mechanism under Assumptions 8 and 9. Then the indirect mechanism $y^*$ that is equivalent to $(x^*(.), t^*(.))$ is an optimal mechanism to sell the auditing right, if $y^*$ is not fully revealing and satisfies Assumption 9.

**Proof:** Suppose, by contradiction, that some contract $M$ that does not fully reveal $V$ dominates $(x^*(.), t^*(.)) \equiv y^*$. By the Revelation Principle, $M$ is equivalent to some direct mechanism, $(x''(.), t''(.))$. Moreover, $M$ cannot satisfy Assumption 9, otherwise its allocation would be feasible for the program that picked $y^*$ as an optimal. Because $M$ does not satisfy Assumption 9, for some $v$ the auditor will not be hired with probability 1, when $x''(v) < 1$. Consider an indirect mechanism $\bar{y}$ equivalent to $(\bar{z}(.), \bar{t}(.))$, which is defined by:

\[
\bar{z}(v) = \begin{cases} 
1 & \text{if } (x''(v), t''(v)) \text{ does not satisfy Assumption 9} \\
 x''(v) & \text{otherwise}
\end{cases}
\]

\[
\bar{t}(v) = t''(v) \quad \forall v.
\]

By construction $\bar{y}$ satisfies Assumption 9, hence it is feasible for the program that picked $y^*$ as an optimal. Furthermore, $\bar{y}$ is equivalent to $M$ in terms of allocation. Therefore, $\bar{y}$ dominates $y^*$. But this contradicts $y^*$ being optimal. □

The strategy to solve the optimal contract is the following. First we solve the optimal $(x^*(.), t^*(.))$ under Assumptions 8 and 9. We show that $(x^*(.), t^*(.))$ is equivalent to a take it or leave it offer, $y^*$. Then we check if it is optimal for the board to follow Assumption 9 under $y^*$. If so, this is indeed the optimal contract (by Lemma 6). Otherwise, we show that the optimal contract is still a take it or leave it offer. However, at a higher price than the one set by $y^*$.

- **The Solution Under Assumptions 8 and 9**

Given an incentive compatible contract $y \equiv (z(.), t(.))$, the expected payoffs of the board and the manager are:
Board: $\int_0^v t(v) + z(v)(v - E[R_2|V = v]) + (1 - z(v)) (v - C) dF(v)$

Manager: $z(v) E[R_2|V = v] - t(v)$.

The board does not know at $T^0$ the realization of $V$. Therefore, the expected payoff of contract $y$ depends on the board’s prior $F(v)$. The integrand is the sum of the transfer paid by the manager and the expected revenue of the firm’s auction given the probability of hiring an auditor, $1 - z(v)$.

The manager’s payoff shows that he gets zero unless the auditor is not hired, that happens with probability $z(v)$. Manipulating the expression for the board’s payoff:

$$E[U_0(y)] = \int_0^v t(v) - z(v)(E[R_2|V = v] - C) dF(v) + E[V] - C$$

(1.15)

$$E[U_1(y, v)] = z(v) E[R_2|V = v] - t(v)$$

(1.16)

The optimal contract $y^*$ is found by solving the following program:

$$\text{Max}_{\{z(.), t(.)\}} E[U_0(y)] \quad \text{s.t.}$$

$$z(v) E[R_2|V = v] - t(v) \geq z(v') E[R_2|V = v] - t(v') \quad \forall v, v'$$

(1.18)

$$z(v) E[R_2|V = v] - t(v) \geq 0 \quad \forall v$$

(1.19)

$$z(v) \in [0, 1] \quad \forall v.$$ 

(1.20)

Equation (1.19) assures that the contract will be accepted, while equation (1.18) is the truth-telling condition. Equation (1.20) makes $z(.)$ a probability measure for any $v$. Note that $U_0$ and $U_1$ are linear on $z(.)$ and $t(.)$. Moreover, Lemma 3 shows that $E[R_2|V = v]$ is increasing on $v$, implying $\frac{\partial U_1}{\partial v} \geq 0$. Finally, it is straightforward to show that the manager’s

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Note that we are using Assumption 9. If the board does not waive his right the auditor will be hired, and the information will be released to the bidders.
utility satisfies the Single-Crossing Condition, and \[ \frac{\partial u_i}{\partial t^i} = E[R_2|V = v]_j \leq \bar{V}. \]

Then by standard arguments (see Fudenberg and Tirole (1991), chapter 7) we can replace the original program by:

\[
Max_{\{z(.)\}} \int_{0}^{v} z(v)[C - (1 - F(v)))(\frac{dE[R_2|V = v]_j}{dv})]f(v)dv
\]  
(1.21)

s.t. \( z(v) \in [0,1] \ \forall v \)  
(1.22)

\[
\frac{dz(v)}{dv} \geq 0 \ \forall v.
\]  
(1.23)

Given a solution \( z^*(\cdot) \), we can recover the optimal \( t^*(\cdot) \) by setting

\[
t^*(v) = z^*(v)E[R_2|V = v]_j - \int_{0}^{v} \frac{\partial E[R_2|V = s]_j}{\partial s} z^*(s)ds.
\]  
(1.24)

To solve program (1.21) we disconsider the monotonicity constraint (equation (1.23)). Later we check if this is satisfied by the solution of the relaxed program.

For any \( v \), the optimal \( z^*(\cdot) \) of the relaxed program must solve:

\[
Max_{\{z(v)\}} z(v)[C - (1 - F(v)))(\frac{dE[R_2|V = v]_j}{dv})]
\]  
(1.25)

s.t. \( z(v) \in [0,1] \)  
(1.26)

But the objective function is linear on \( z(v) \). Therefore:

\[
z^*(v) = \begin{cases} 
1 & \text{if } C \geq (1 - F(v))(\frac{dE[R_2|V = v]_j}{dv}) \\
0 & \text{otherwise}.
\end{cases}
\]  
(1.27)

Because of Assumption 7, the second term in inequality (1.27) is decreasing on \( v \), and it is zero at \( v = \bar{V} \). We have two possibilities:

\bullet C > (1 - F(v))(\frac{dE[R_2|V = v]_j}{dv}) \ \forall v.

Then we have \( z^*(\cdot) \equiv 1 \). The auditor will never be hired. Plugging \( z^* \) in equation (1.24) we find that \( t^*(\cdot) \equiv 0 \). Plugging \( (z^*(\cdot) \equiv 1, t^*(\cdot) \equiv 0) \) in equation (1.15), we find
that \( E[U_0(y)] = E[V] - E[R_2] \). But this contradicts \( z^*(\cdot) \equiv 1 \) being optimal because a take it or leave it offer at price \( E[R_2|V = \bar{V}]_j \) gives the board an expected payoff of \( E[V] - C > E[V] - E[R_2]_j \) when \( C < E[R_2]_j \). Contradiction.

- \( C = \left( \frac{1-F(v^*)}{f(v^*)} \right) \left( \frac{dE[R_2|V = v^*]_j}{dv} \right) \) for some \( v^* \).

By Assumption 7, the right hand side of the above equation is decreasing on \( v \). Therefore, \( z^*(v) = 1 \) for any \( v \geq v^* \), and \( z^*(v) = 0 \) for any \( v < v^* \). It follows that \( z^*(\cdot) \) is non-decreasing, and the monotonicity condition (1.23) is satisfied. Plugging \( z^*(\cdot) \) on equation (1.24), we obtain

\[
t^*(v) = \begin{cases} 
0 & \text{if } v < v^* \\
E[R_2|V = v^*]_j & \text{otherwise.}
\end{cases}
\] (1.28)

Therefore the optimal mechanism \((z^*(\cdot), t^*(\cdot))\) is equivalent to a take it or leave it offer at price \( E[R_2|V = v^*]_j \).

- **Relaxing Assumptions 8 an 9**

Now we check if Assumptions 8 and 9 are satisfied in the take it or leave it offer equivalent to \((z^*(\cdot), t^*(\cdot))\).

(i) Assumption 8: A take it or leave it offer is not fully revealing.

(ii) Assumption 9: Define the indicator \( \Phi \) by setting \( \Phi = 1 \) if the take it or leave it offer at price \( E[R_2|V = v^*]_j \) is rejected, and \( \Phi = 0 \) otherwise. Then Assumption 9 is satisfied if only if \( E[R_2|\Phi = 1]_j \geq C \). In this case, it is optimal for the board to hire the auditor when the manager rejects the contract. But \( \Phi(v) = 1 \) if and only if \( E[R_2|V = v]_j < E[R_2|V = v^*]_j \). By Lemma 3, this happens if and only if \( v < v^* \). Therefore, \( E[R_2|\Phi = 1]_j = E[R_2|V < v^*]_j \). By Lemma 6, \( C \leq E[R_2|V < v^*]_j \) implies that the take it or leave it offer at price \( E[R_2|V = v^*]_j \) is optimal. On the other hand, consider the case where \( C > E[R_2|V < v^*]_j \). We show that the take it or leave it offer at price \( t' = E[R_2|V = v']_j \) is the optimal contract, where \( v' \) is implicitly defined by \( E[R_2|V < v']_j = C \). Note that \( t' \) is the lowest price, such that a take it or leave it offer satisfies Assumption 9. Call this contract \( y' \). We divide the argument in two parts. First we show that \( y' \) dominates any contract that satisfies Assumption 9. Then we show that \( y' \)
cannot be dominated by a contract that does not satisfy Assumption 9.\footnote{We do not consider contracts that do not satisfy Assumption 8 because they do not have any value for the manager by Proposition 2.}

- Contracts that Satisfy Assumption 9

By construction \(y'\) satisfies Assumptions 8 and 9. Consider, by contradiction, that an optimal contract \(y''\) satisfies Assumptions 8 and 9, and dominates \(y'\). By the Revelation Principle, \(y''\) is equivalent to some direct mechanism \((x''(.), t''(.)\)), that satisfies constraints (1.22) and (1.23).

(i) Suppose \(y''\) is a take it or leave it offer at price \(t'' < t'\). This contract defines a cut-off value \(v''\) for the acceptance of the offer as the solution of: \(E[R_2|V = v'']_j = t''\). By the monotonicity of \(E[R_2|V = v]_j\) we have that \(v'' < v'\). Define the indicator \(\Phi''(.)\) by setting \(\Phi''(v) = 1\) if \(x''(v) < 1\), and \(\Phi''(v) = 0\), otherwise. Then Assumption 9 implies that \(E[R_2|\Phi'' = 1]_j \geq C\). But, \(E[R_2|\Phi'' = 1]_j = E[R_2|V < v'']_j < E[R_2|V = v']_j = C\). Contradicting \(y''\) satisfying Assumption 9. On the other hand, suppose that \(t'' > t'\). Then \(y'\) and \(y''\) differ only in the interval \([v', v'']\). Where \(y'\) sets \(z'(v) = 1\), while \(y''\) sets \(z''(v) = 0\). However, one can easily check that the objective function (equation (1.25)) is positive for any \(v\) in this interval. It follows that \(y'\) dominates \(y''\).

(ii) Consider now a generic contract \(y''\) satisfying Assumptions 8 and 9. Monotonicity implies that \(x''(v) \geq x''(v')\) for any \(v \geq v'\). Moreover, we cannot have \(\frac{dx''(v)}{dv} > 0\) for all \(v\) because \(x''\) would be fully revealing. Then, \(x''(v) = x''(v)\), for some \(v < \bar{v}\). Using monotonicity once more we find that \(\frac{dx''(v)}{dv} = 0\) for this \(v\).\footnote{Where \(\frac{dx''(v)}{dv}^+\) is the right hand side derivative.} Define \(v^* \equiv \inf\{v : \frac{dx''(v)}{dv}^+ = 0\}\), and \(v^* \equiv \sup\{v : x''(v) = x''(v)\}\). If \(v = 0\) we claim that \(v^* \geq v'\). Otherwise \(E[R_2|x'' = 0]_j < C\), contradicting Assumption 9. But for any \(v' \geq v', y'\) dominates \(y''\) because the latter is at best a take it or leave it offer. Now, suppose \(v > 0\). Incentive compatibility implies that \(x(v)\) is strictly increasing for any \(v < v'\). Consider first that \(y > y'\). Then \(v^* < v\), implying that \(E[R_2|x'' < x''(v')]_j = E[R_2|V < v']_j < C\), contradicting Assumption 9. Now suppose that \(y < v'\). Then \(x''(v) < 1\) for some \(\bar{v} < v\). Call \(\bar{z} \equiv x''(\bar{v})\).

Then \(E[R_2|x'' < \bar{z}]_j = E[R_2|V < \bar{v}]_j < C\), contradicting Assumption 9.

- Contracts that Do Not Satisfy Assumption 9
Suppose that contract \( y'' \) does not satisfy Assumption 9 and dominates \( y' \). Because \( y'' \) does not satisfy Assumption 9, for some \( v \) the auditor will not be hired with probability 1, when \( z''(v) < 1 \). Consider the same direct mechanism \( \bar{y} \) used in Lemma 6. Then \( \bar{y} \) satisfies Assumption 9, and is equivalent to \( y'' \) in terms of allocation. However, as shown in the previous subsection, \( \bar{y} \) cannot dominate \( y' \). We conclude that \( y' \) cannot be dominated by \( y'' \). □

**Proposition 5**

Theorem 1 characterized the expected utilities by partitioning the values of \( C \) in three subsets: \{ \( E[R_2]_j < C \), \( E[R_2]_j \geq C, E[R_2|V \leq v^*]_j \geq C \), \( E[R_2]_j \geq C, E[R_2|V \leq v^*]_j < C \} \). We start considering changes that leave \( C \) in the same subset. Later we consider changes to other subsets.

**Local Changes**

**Case I:** \( E[R_2]_j < C \)

The contract is not accepted, but the auditor is not hired. The expected utilities do not depend on \( C \).

**Case II:** \( E[R_2]_j \geq C \), and \( E[R_2|V \leq v^*]_j \geq C \)

In this case the optimal price is \( E[R_2|V = v^*]_j \), which changes in the opposite direction of \( C \), as shown below:

\[
\frac{dE[R_2|V = v^*]_j}{dC} = \frac{\partial E[R_2|V = v^*]_j}{\partial v^*} \frac{dv^*}{dC} \leq 0. \tag{1.29}
\]

The partial derivative in the RHS of equation (1.29) is positive by Lemma 3. While \( v^* \) varies inversely to \( C \) because the right hand side of equation (1.12) (see the statement of Theorem 1) is decreasing on \( v \) by Assumption 7. Now we can evaluate the impact of changes in \( C \) in the expected payoffs.

**II.1 The Board:**

In this region the expected payoff of the board under the optimal mechanism is given by

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43 Note that \( v^*(C) \) is differentiable almost everywhere because it is monotonic.

44 To see this plug \( (z^*(.), t^*(.) \) in equation (1.15) in the proof of Theorem 1.
\[ EU_0(t, C) = E[V] - C + \int_{v^*}^{\bar{V}} \{ C + E[R_2|V = v^*] - E[R_2|V = v]\} dF(v). \]  \hspace{1cm} (1.30)

Differentiating equation (1.30) with respect to \( C \):

\[ \frac{dE[U_0(y, C)]}{dC} = -F(v^*) + \frac{dE[R_2|V = v^*]}{dv^*} \left[ 1 - F(v^*) \right] - C f(v^*) = -F(v^*) < 0. \]  \hspace{1cm} (1.31)

Where the last equality comes from the construction of \( v^* \).

We are already in a position to prove that the expected payoff of the auction is strictly decreasing on \( C \) for \( C \) small enough. Suppose that exists \( C^0 > 0 \) such that \( E[R_2|V \leq v^*(C^0)]_j = C^0 \). In this case take \( C = \min\{E[R_2]_j, C^0\} \). Then for any \( C < C \), we are in case II. Equation (1.31) then implies that the expected payoff of the shareholders is strictly decreasing for increases in \( C \) that do not change the subset. Now consider an increase of \( C \) that violates \( E[R_2]_j \geq C \). Then the board is worse off because the contract is not implementable anymore. Now consider an increase in \( C \) that violates \( E[R_2|V \leq v^*]_j \geq C \). Then the board is worse off because they must distort the optimal price to commit the hiring of the auditor. Now suppose that it does not exist such \( C^0 \). Then \( E[R_2|V \leq v^*(C)]_j \geq C \), for any \( C \).\(^45\) Take any \( C < E[R_2]_j \). Then any increase on \( C \) implies that the board is strictly worse off by equation (1.31).

\( II.2 \) The Manager

The expected utility of the manager in this region is given by

\[ EU_1(t, C) = \begin{cases} E[R_2|V = v]_j - E[R_2|V = v^*]_j & \text{if } v \geq v^* \\ 0 & \text{otherwise.} \end{cases} \]  \hspace{1cm} (1.32)

Differentiating equation (1.32):

\[ \frac{dE[U_1(y, C)]}{dC} = \begin{cases} -\frac{dE[R_2|V = v^*]}{dC} \geq 0 & \text{if } v \geq v^* \\ 0 & \text{otherwise.} \end{cases} \]  \hspace{1cm} (1.33)

**Case III:** \( E[R_2]_j \geq C \), and \( E[R_2|V \leq v^*]_j < C \).

\(^45\)This follows because \( E[R_2|V \leq v^*(0)]_j = E[R_2]_j > 0 \), and \( E[R_2|V \leq v]_j \) is continuous on \( v \). Continuity follows because we assumed that \( E[R_2|V = v]_j \) is differentiable on \( v \).
In this case the optimal price is \( E[R_2|V = v'] \), which changes in the same direction of \( C \), as shown below:

\[
\frac{E[R_2|V = v']}{dC} = \frac{\partial E[R_2|V = v']}{\partial v'} \frac{dv'}{dC} \geq 0.
\]

The sign of the partial derivative is positive by Lemma 3, and the the second derivative is also positive since

\[
\frac{dv'}{dC} = \frac{1}{\frac{\partial E[R_2|V < v']}{\partial v'}} > 0. \quad (1.34)
\]

**III.1 The Board**

The board’s expected utility in this region is

\[
EU_0(t, C) = E[V] - C + \int_{v'}^{V} (C + E[R_2|V = v'] - E[R_2|V = v]j)dF(v). \quad (1.35)
\]

One can check that a sufficient condition to obtain a negative sign for the derivative of equation (1.35) with respect to \( C \) is \( \frac{dv'}{dC} > 0 \), which is true by equation (1.34).

**III.2 The Manager**

The expected utility of the manager in this region is given by

\[
EU_1(t, C) = \begin{cases} 
E[R_2|V = v]j - E[R_2|V = v']j & \text{if } v \geq v' \\
0 & \text{otherwise.} 
\end{cases} \quad (1.36)
\]

Differentiating equation (1.36):

\[
\frac{dE[U_1(y, C)]}{dC} = \begin{cases} 
-\frac{dE[R_2|V = v']}{dC} \leq 0 & \text{if } v \geq v' \\
0 & \text{otherwise.} 
\end{cases} \quad (1.37)
\]

**Global Changes**

We now consider changes that move \( C \) to different subsets. We will use the following notation: the subset characterized by \( E[R_2]j < C \) was analyzed in case I, therefore we call it region I. The same reasoning applies to the other subsets.

**I and II, or I and III**: In the case of a reduction that moves \( C \) from I to II or III the board is better off because, after the reduction, the board can take a stake from the
manager through the optimal contract. For the same reason the manager is worse off. The opposite effects hold if an increase moves C from II or III to I.

**II and III (The Board):** The board is better off if a reduction moves C from III to II. In this case the board does not need to distort the price anymore. The price will be the unconstrained optimum $E[R_2|V = v^*]_j$ after the reduction. For the same reason, the board is worse off if an increase moves C from II to III.

**II and III (The Manager):** Define $C^0$ as the value of C that solves $E[R_2|V \leq v^*(C)]_j = C$. By construction, $v^*(C^0) = v'(C^0)$. Moreover, monotonicity of $v^*$, $v'$ and $E[R_2|V = v]_j$ imply that

$$t^*(C) = \begin{cases} E[R_2|V = v'(C)]_j & \text{if } C > C^0 \\ E[R_2|V = v^*(C)]_j & \text{otherwise.} \end{cases} \quad (1.38)$$

Because $E[R_2|V = v'(C)]_j$ is increasing on C, while $E[R_2|V = v^*(C)]_j$ is decreasing, $t^*(C)$ reaches the global minimum at $C = C^0$. Moreover, continuity of $E[R_2|V = v]_j$ allows us to choose convenient initial points for C, and discrete changes of C such that $t^*(C)$ can increase or decrease with C. Therefore, the manager's utility can vary either way with C.

\[\square\]

---

*Where $v^*(C^0)$ and $v'(C^0)$ are, respectively, the values of $v^*$ and $v'$ when $C = C^0$.\]
References


TIME Magazine 1988: December, 5, cover story.

Chapter 2

Buying vs Hiring: A New Theory of Mergers

Abstract

This chapter explains why managers want to grow by buying other companies, rather than by investing in new assets. The basic idea is that the acquiring management does not go after the assets but after the management of the acquired company. Changes in the business environment may demand managerial skills that the incumbent managers do not possess. Rather than hiring new managers, and laying off their own peers, the self interested incumbent managers seek an acquisition. They look for a target with a management team that can be used to complement their skills. Inside the new conglomerate tasks can be reallocated, and efficiency enhanced. However, after the merger, there will be cross-subsidization across the divisions and managers will enjoy control rents. This leaves scope for a subsequent disciplinary takeover that resets the existing incentive schemes. The model provides new testable implications on the interaction between managerial labor market, and takeovers. In addition, it is able to explain why targets experience an abnormal positive return at the announcement of the acquisition and bidders do not.

1This chapter is joint work with Luigi Zingales.
It is a fairly established notion that managers like to increase the size of their companies. From the early work of Williamson (1964) up to the more recent work of Hart and Moore (1990) economists have assumed that managers derive a special pleasure from running larger corporations. Despite this long tradition, very little attention has been dedicated to explain from first principles why managers prefer to run larger companies and why this predilection cannot be restrained by appropriate compensation packages. The only theory of why managers want to increase the size of their company is due to Amihud and Lev (1981). They argue that managers try to diversify the returns of their human capital by buying into unrelated sectors. Yet, this theory does not explain why managers should prefer to buy an entire company rather than its assets.

The purpose of this chapter is to provide a new theory of why managers want to grow by buying other companies rather than by investing in new assets. The idea is very simple: the acquiring management does not go after the assets but after the management of the acquired company. Mergers provide the most convenient way (from the managers’ point of view, not necessarily from shareholders’ point of view) of reallocating managerial talents. This amazingly simple answer immediately poses a new question: why do managers prefer to buy a company rather than to hire the employees of that company? The answer is also simple: nobody is willing to hire his own successor, nobody is willing to trigger his own firing.

In a nutshell the idea of this chapter is the following. We consider a public company in which shareholders are dispersed. In this case they have no direct say in inside the company. The only way they can restrain managerial discretion is by suing directors/managers for breach of fiduciary duties. To make this notion precise we assume that the corporation’s founders wrote a set of rules in the corporate charter, which the managers are supposed to follow. In other words, managers are in control, but they are not the residual claimants since they must follow the corporate charter. It is exactly from this separation between control and residual claims, typical of public corporations, that arises the scope for mergers driven by managerial concerns.

Sometimes technological changes make the incumbent management inappropriate for its job. Then, it becomes efficient to hire a new manager with different talents. However, this solution is not easy to implement. We cannot trust the incumbent manager to voluntarily leave his job, especially if he is enjoying some rents. On the other hand, we cannot expect
the board of directors to fire him. Board members are generally chosen by managers. They may enforce some discipline when their reputation is at great risk, like when a company is consistently losing money. However, very unlikely they force out of office an incumbent manager who is running a profitable company, even if better alternatives are available. Therefore, the incumbent manager neither leave nor is fired. A possible solution is to hire a new talented manager giving the incumbent a compensation for his past services, i.e., a severance payment. This severance payment should cover the present value of all future control rents enjoyed by the manager. Otherwise, he would prefer to stay in his job. However, shareholders lose the chance of repossessing part of the managerial rents through a disciplinary takeover, if these are paid out. Therefore, this alternative may be too costly.²

A merger is the optimal way out of this impasse. It increases the number of managers but also the number of managerial jobs. In the new conglomerate each manager retains a job, but, at the same time, tasks can be reallocated so that efficiency is enhanced. The company succeeds to place the most adequate manager in the job, keeping the incumbent in the firm with his control rents. Therefore a merger enhances efficiency and keeps alive the possibility of eliminating the control rents through a disciplinary takeover.

In summary, mergers happen because the incumbent manager will not voluntarily quit when he becomes inadequate to the position. By merging, the manager enhances efficiency without quitting. On the other hand, the founders do not allow a severance payment high enough to induce a voluntary quit because they would lose the opportunity of eliminating the control rents through a disciplinary takeover.

Our model gives content to the often heard claim that acquiring companies buy the target’s management. According to the press this was one of the main reasons why Philip Morris bought Kraft.³ The model also provides some new insights in the reallocation of managers in merged companies. To our knowledge, both in the empirical and in the theoretical literature, very little attention has been dedicated to the eventual fate of the top executives of companies acquired in friendly mergers. Casual observation suggests that in some important mergers the management of the acquired company ended up in a leading

²More precisely, in section 2.3 we shall show that this alternative is costly because the founders cannot enforce a severance payment contingent on the probability of a takeover threat, if this probability is ex-ante uncertain and noncontractible.

³For example, Newsweek (10/31/88) reports that, by buying Kraft, Philip Morris “would also gain a sharp management team led by Kraft CEO John Richman and including marketing whiz Michael Miles.”
position in the new conglomerate. This happened in the Nabisco acquisition of Standard Brands, in the RJR acquisition of Nabsico Brands and in the Time acquisition of Warner. This aspect represents one of the newest insights of this chapter, which deserves further empirical investigation.

Finally, this chapter is able to explain why the target company’s stock shows abnormal positive return at the announcement of an acquisition, while the acquiring company’s stock does not. In our model the value of the acquisition for the bidder is already incorporated into its stock price by the time the acquisition is announced, because it is just a consequence of a previously observed technological shock. On the contrary, there are many potential targets, therefore the stock price of the acquired company will rise at the announcement that it has been chosen as a target. The reason why the target succeeds in extracting some surplus out of the bidder, despite there are many potential targets but only one bidder, is that the target shareholders are dispersed, and so they can free ride on any improvement in corporate profitability.

The chapter is organized as follows. Section 2.1 describes the general framework. Section 2.2 derives the optimality of buying versus hiring from a managerial point of view. The result is obtained in a simplified framework, in which, among other things, technological shocks are unexpected. This section provides most of the intuition of the more general model presented in Section 2.3, where the technological shocks are anticipated, but they are not contractible. Section 2.5 explores the empirical implications of the model. Finally in the conclusion we summarize the results and give directions for future research.

2.1 General Framework

The goal of this chapter is to explain why managers buy other companies to acquire new managerial talents. We shall show why it is in the managers’ interest to buy another company, rather than to hire new managers, and why it is not in the shareholders’ interest to forbid such mergers. In this section we describe the main assumptions used to obtains these results.
2.1.1 Firms

Firms share a common production function, indexed by a technological parameter $\beta_i$.\footnote{We could also interpret $\beta_i$ as a parameter that captures the demand for the firm's product.} The index $i$ takes value 0 or 1, reflecting the existing potential profitability levels. Without loss of generality we assume that a firm with parameter $\beta_1$ has higher profitability potential than a firm with parameter $\beta_0$. Therefore, we call the former a high type firm, and the latter a low type one.

We assume that the level of production in number of units ($q$) is just a function of managerial effort ($e$), and of the technological parameter $\beta_i$, i.e.

$$q = f(e, \beta_i).$$

We also assume that $f(e, \beta_1) \geq f(e, \beta_0)$, with equality only when $e = 0$. In such case $f(0, .) = 0$. Moreover $f(e, .)$ is increasing on $e$, with decreasing returns, i.e., $\frac{\partial f(e, \beta_i)}{\partial e} > 0$, and $\frac{\partial^2 f(e, \beta_i)}{\partial e^2} < 0$, for any $e$, and $\beta_i$. Finally, better firms (i.e. $\beta_1$ firms) have higher marginal productivity of effort. More precisely, for any $e$, $\frac{\partial f(e, \beta_1)}{\partial e} \geq \frac{\partial f(e, \beta_0)}{\partial e}$, with equality only when $e = 0$.$^5$

We consider only one employee in the production function. Implicitly, we subsume in the Chief Executive Officer (CEO) all agency relations inside the firm. The idea is that if the founders succeed to put the CEO in the optimal incentive scheme, the latter should be able to do the same with his subordinates.

Relative prices are fixed and equal to 1. Therefore, the number of units produced corresponds to the dollar value of the production. The only factor of production is managerial effort, that is paid a wage $w$. Therefore, each firm's profits can be written as

$$\Pi(e, w, \beta_i) = f(e, \beta_i) - w.$$

We assume that low type firms (parameter $\beta_0$) may be hit by a positive technological shock.$^6$ The shock happens when $\beta_0$ changes to $\beta_1$. The technological shock is observable but not verifiable, therefore it is not contractible.

$^5$This is known in the incentive literature as the Spence-Mirrlees condition.

$^6$We could also consider the possibility that a high type firm turns into a low type one. However, this would not add any new insight.
2.1.2 Managers

We want to consider managers with different talents. For simplicity, we assume just two types of managers: high quality and low quality managers.

The diversity among managers arises from a different marginal disutility of effort. Hard working managers discount the effort exerted with a parameter $\theta$ less than 1. We choose a specific utility function, linear in effort and wages.\(^7\)

The utility function of the low type manager is given by

$$U^l(e, w) = w - e,$$

and a high type manager's utility function is given by

$$U^h(e, w) = w - \theta e,$$

where $0 < \theta < 1$.

Contrary to most of the literature we assume that the firms' and the managers' types are observable by the parties involved in the contract (founders, and managers). Our interest is in the interaction between managerial talents and firms' technology when managers are in control of firms. Therefore, we abstract from possible asymmetries of information.

Finally, we assume that the managers are credit constrained. Otherwise, there would be no role for incentive schemes or corporate charters. All agency problems could be trivially solved by selling the firm to the managers.

2.1.3 Markets

Each firm operates in a separate product market, in which it is a price taker. However, there is no free entry in each product market. Therefore, firms can earn positive profits. These assumptions are clearly extreme, but they help us isolating the effects of managerial synergies from other effects due to strategic interactions in the product market. By contrast, all firms compete in the same market for managers. This implies the universality of managerial talents, a fairly realistic hypothesis. The managerial market is fully competitive.

\(^7\)Our results do not change if we adopt a more generic function $U(w - g(e))$, where $U(.)$ is concave and $g(.)$ is convex.
and the compensation contract can be freely negotiated.

A crucial assumption of the model is that there are more high type managers than high type firms. However, there are not enough high type managers to supply all firms. If high quality managers outnumber firms, the difference in managerial talents would be irrelevant. On the contrary, if the number of high quality managers were smaller than the number of high type firms, then there would not be scope for a reallocation of talents: all high type managers would work in the high type firms. Only under our assumption the emergence of a better technology in a low-tech firm creates an interesting matching problem. By contrast, we assume that the supply of low quality managers is infinitely elastic.

We assume that the managerial labor market is efficient in the following weak sense. At each period prices will be adjusted so that the high type managers have the correct incentives to move to the high type firms. Moreover, in equilibrium, high quality managers will receive the same level of utility, independently of the firm that employs them. In other words, we do not expect that wages induce high type managers to move to low type companies, because this would be inefficient. The market is only weakly efficient because we do not require that the low type managers have the correct incentives to move to a low type firm if they end up running a new high type firm.

2.1.4 Timing and the Market for Corporate Control

Figure 2-1: Timing

<table>
<thead>
<tr>
<th>Time</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Manager is hired</td>
</tr>
<tr>
<td>1</td>
<td>Value of $\beta$ appears</td>
</tr>
<tr>
<td>2</td>
<td>Company liquidated</td>
</tr>
</tbody>
</table>

Production takes place
Raider may appear

Figure 2-1 presents the timing of the game. At time 0 the founders of the corporation hire the manager that will run the new public company, and impose on him an incentive scheme. The incentive scheme cannot be modified unless a very large majority of shareholders want it. For all practical purposes this requirement makes any change infeasible for a public company with dispersed shareholders. The only way out is an acquisition of the whole
company by a single party.\footnote{In this way the founders commit that the incentive scheme will be in place as long as the company stays alive.}

At time 1 the manager of a low type firm observes if he can implement a (costless) technological improvement that makes the firm a high type one. The technological improvement will be available with probability $p > 0$. In the second period production will take place according to the initial contract, and then the company is liquidated.

A priori it is not obvious that the new public company will be run in the best interest of shareholders. Dispersed shareholders lack the correct incentives to monitor the manager. Although incentive schemes are intended to align shareholders and managers' interests, it is very unlikely that they will be able to eliminate all agency problems. The main difficulty lies in the fact that the manager can observe the realization of some uncertainty before reacting to the incentive scheme. This allows the manager to enjoy some control rents.

On the other hand, managers also face external constraints. In particular, a disciplinary takeover can eliminate the control rents. Takeovers are made possible by the founders by allowing in the corporate charter future raiders to dilute part of the company's value. Without such provision takeovers would be impossible, because dispersed shareholders would extract all the raider's surplus (Grossman and Hart, 1980). However, the \textit{ex ante} probability of a takeover is uncertain. Among other things, corporate law may change the antitakeover legislation. This affects the likelihood that the manager successfully fights a hostile takeover to preserve his control rents.

For simplicity we assume that the founders allow a level of dilution $\Phi$ in the corporate charter. This dilution level gives the correct incentives for a raider to try a hostile takeover on an underperforming company. However, the attempt will not succeed with probability 1 because there is uncertainty on how the court will view the takeover defenses adopted by the incumbent manager. For what we said in the previous paragraph, we assume that the probability of a takeover is itself a random variable at time 0. With probability $q > 0$, the probability of a disciplinary takeover is $r_1$, and with probability $1 - q$ the probability is $r_0$. This captures the uncertainty on the future antitakeover legislation. Without loss of generality we assume that $r_1 = r > r_0 = 0$. Therefore at time 0 the average probability that a raider will appear conditioned on suboptimal profits is $\bar{p} = q r$. Moreover, if the raider actually comes the company will be taken over at a price equal to its value under the
optimal incentive scheme less the dilution $\Phi$.

2.1.5 Feasible Contracts

In terms of feasible contracts we assume that effort levels and technological changes are observable but not verifiable by a court. The nonverifiability of effort is not a serious limitation. In the absence of uncertainty, a wage $w$ contingent on profit $\Pi(w,e,\beta_i)$ is equivalent to wage $w$ contingent on effort $e$. A more serious issue is posed by the nonverifiability of a technological improvement.

As we said before, efficiency requires the replacement of a low type manager upon the appearance of a technological shock. Nevertheless, the manager will not voluntarily quit, specially if he is enjoying control rents. Therefore, the founders of a low type firm must give the low type manager some incentive to quit if they want to replace him. This can be done by promising a severance payment $S$.

A second alternative open to the founders is a merger. The founders could induce the manager to merge with a low type firm run by a high quality manager, shifting positions inside the new conglomerate. More precisely, the low type manager would end up running the acquired firm (which is a low type one), while the new manager (a high quality one) would run the original company (which became a high type one). The merger would enhance efficiency, without necessarily firing the incumbent manager.\footnote{A third alternative would be to hire the new manager, leaving the incumbent in the job doing nothing, but receiving a wage equal to the severance payment cited in the first alternative. We do not consider this alternative because it is dominated by the merger if there are nonpecuniary private benefits of control. The point is that the incumbent manager loses private benefits if he has only a nominal position in the organization. The merger strategy creates a second control position. Therefore the incumbent does not lose his private benefits. On the other hand, simply hiring an additional employee makes more sense for a middle management position, where private benefits of control are not so important. This may explain why public companies tend to be overstaffed in the middle management.}

In section 2.3 we analyze each strategy, showing how the market for corporate control can explain why the founders prefer to allow a merger, rather than giving incentives for the incumbent manager to quit. However, we will first use a simpler framework to point out the manager’s incentives to seek a merger in the absence of severance payments. This is the task of the next section.
2.2 Merger as a Matching Mechanism

This section shows the manager's incentives to merge in a simplified framework. The major shortcut is that technological changes are unexpected. This is clearly unsatisfactory. However this simple framework provides an easy way to understand our main results. In the next section we shall show that the results survive if the founders anticipate that a technological shock may happen in the future, as long as technological shocks are not verifiable.

In this section we consider a particular form for the production function:

- High Type Firm: $2\beta\sqrt{\epsilon}$, with $\beta > 1$.
- Low Type Firm: $2\sqrt{\epsilon}$.

It can be easily verified that the above functional forms satisfy the technological assumptions described in section 2.1. We want to emphasize that these simplifying assumptions are harmless, and they are introduced only to reduce the amount of notation.

2.2.1 The Optimal Incentive Schemes with Unexpected Technological Shocks

The founders' problem is to design a contract that maximizes profits. This contract should depend on the manager's quality (l for low, or h for high), and the firm's type (H for high, or L for low). Technological shocks are not expected, therefore the only non contractible variable is managerial effort. However, this incompleteness does not represent a real limitation on the the set of feasible contracts. The founders can elicit the optimal effort from managers through an incentive contract where wage is contingent on profits. More precisely, the incentive contract is a tuple $(w_t^i, \Pi_t^i)$ where a firm of type $i$ ($i = L$ or $H$) offers to a manager of type $t$ ($t = l$, or $h$) wage $w_t^i$ if he delivers profit $\Pi_t^i$. Under complete information this contract is equivalent to a direct mechanism $(w_t^i, e_t^i)$, where the manager is paid $w_t^i$ if he exerts effort $e_t^i$.

From the perspective of the founders at time 0, there is no role for raiders or mergers. The above contracts obtain the first best conditioned on the existing technology.\(^{10}\)

In equilibrium there are three types of contracts. The contract of a high type firm hiring a high type manager $(w_H^h, \Pi_H^h)$, the contract of a low type firm hiring a high type manager

\(^{10}\)Recall that in this section we assume that the technological shock is unexpected.
(w^L, \Pi^L), and the contract of a low type firm hiring a low type manager (w^L, \Pi^L).^{11}

Low quality managers are in infinite supply, therefore competition drives their utility level to zero. On the other hand, high quality managers can pick the firm in which they want to work. Hence, a simple arbitrage argument requires that they achieve the same level of utility in both types of firm. This positive level of utility (R^h) is the rent obtained by high quality managers because they represent a scarce factor.

Firms are also free to choose the manager they want to hire. In principle, all firms would prefer to have a high type manager. However, this is not possible, because, by assumption, there are less high type managers than firms. Therefore, in equilibrium, prices will be such that a low type firm is just indifferent between hiring a low type or a high type manager.

In the following we briefly derive the optimal contracts in this simple set-up. The high type firm hiring the hard working manager maximizes

\[
Max_{w, e} \beta \sqrt{e} - w
\]  \hspace{1cm} (2.3)

\[
s.t. \quad w - \theta e \geq R^h;
\]  \hspace{1cm} (2.4)

where R^h is the rent of high type managers. The first order conditions of the above program imply that the optimal contract is given by

\[
(w^h_H, \Pi^h_H) = \left( \frac{\beta^2}{\theta} + R^h, \frac{\beta^2}{\theta} - R^h \right);
\]  \hspace{1cm} (2.5)

with effort level

\[
e^h_H = \left( \frac{\beta}{\theta} \right)^2.
\]  \hspace{1cm} (2.6)

The low quality firm hiring the low type manager maximizes

\[
Max_{w, e} \beta \sqrt{e} - w
\]  \hspace{1cm} (2.7)

\[
s.t. \quad w - e \geq 0.
\]  \hspace{1cm} (2.8)

\[^{11}\text{It can be easily proved that it is not optimal for a high type firm to hire a low type manager.}\]
In this case the optimal contract is given by

\[(w^I_L, \Pi^I_L) = (1, 1);\]  \hspace{1cm} (2.9)

with effort level

\[e^I_L = 1.\] \hspace{1cm} (2.10)

Low type firms will compete to hire a high type manager. They will be willing to raise his wage as long as the profits obtained with him are as large as the profits obtained with a low type manager. Therefore, a low type firm that is trying to hire a high type manager can be seen as maximizing the high quality manager’s utility, subject to a profitability constraint, i.e.

\[\text{Max}_{w,e} \: w - \theta e\] \hspace{1cm} (2.11)

\[\text{s.t.} \quad \Pi^I_L(e, w) \geq \Pi^I_L(e^I_L, w^I_L).\] \hspace{1cm} (2.12)

In this case the optimal contract is given by

\[(w^h_L, \Pi^h_L) = \left(\frac{2}{\theta} - 1, 1\right);\] \hspace{1cm} (2.13)

with effort level

\[e^h_L = \frac{1}{\theta^2}.\] \hspace{1cm} (2.14)

The resulting level of utility is

\[U^h_L = \frac{2}{\theta} - 1 - \theta \frac{1}{\theta^2} = \frac{1 - \theta}{\theta}.\] \hspace{1cm} (2.15)

Note that a high type manager exerts more effort when he is hired by a high type firm rather than by a low type firm \(((\frac{2}{\theta})^2 > \frac{1}{\theta^2})\). Furthermore, in a low type firm a high type manager will always exert more effort than a low type one \((\frac{1}{\theta^2} > 1)\). Finally, in equilibrium, the utility of a high type manager should be independent of the firm he runs, therefore

\[U^h_L = U^h_H = R^h = \frac{1 - \theta}{\theta}.\] \hspace{1cm} (2.16)
2.2.2 Merger as an Optimal Response to Innovation

Assume that at time 0 the firms hire their managers under the incentive schemes computed in the previous subsection. Suppose that, at time 1, a superior technology unexpectedly becomes available to a low type firm run by a low type manager. In such companies the incumbent manager is tied to an incentive contract like the one described in equation (2.9). Thanks to the new technology, the manager can satisfy the profit requirement with a lower effort level than previously anticipated by the shareholders. The optimal level of shirking will be determined by the equality

\[ 2 \beta \sqrt{\bar{e}_L^2} - w_L = 1. \]

(2.17)

This yields \( \bar{e}_L = 1/\beta^2 < 1 \), that corresponds to a manager's utility equal to \( \bar{U}_L = \beta^2 - 1/\beta^2 \). This first reaction to innovation is obvious. The technological improvement allows the manager to appropriate the productivity increase by shirking.

Efficiency would require replacing a low type manager with a high type one. However, this implies that the manager should leave the job when he starts to enjoy some rents. This is clearly not in the manager's interest. So a voluntary quit would require a severance payment. However, in the present context this is impossible because it was not anticipated by the initial contract. In this scenario, the best solution from the manager's perspective is to merge with a low type company run by a high quality manager, and to reallocate the tasks after the merger. The resulting increase in efficiency allows the low quality manager to extract more utility out of the firm, still satisfying the initial contract.

This result can be easily obtained by observing that the shareholders of a low type firm run by a high type manager should be willing to accept a merger proposal if the price offered is not less than the profit obtained under the current incentive contract (i.e., 1). Moreover, the target's manager should be willing to go along with the merger proposal if the job gives him an utility level of at least \( 1/\beta^2 \). Therefore, the manager of the company hit by an innovation will make an offer.

---

12Technological shocks may also happen in low type firms run by a high type manager. However, a high type manager does not gain anything through a merger. For this reason we overlook this case.

13Therefore, contrary to a hostile takeover the probability that a friendly acquisition will succeed is 1.
\[(Price, Effort, Wage) = (1, \left(\frac{\beta}{\theta}\right)^2, \frac{\beta^2}{\theta} + \frac{1 - \theta}{\theta}). \quad (2.18)\]

Note that the high type manager's incentive scheme embedded in this offer is contingent on effort. This is possible because the incumbent manager observes effort and he can threaten to fire the new manager if he does not work properly. He has the correct incentives to monitor the new manager because he is the true residual claimant of his output. Each additional dollar delivered by the new manager is one dollar less the incumbent needs to deliver himself to satisfy the conglomerate's profit requirement.\(^{14}\)

This offer will give the control of the low type firm to the manager of the new high-tech company. Given the price paid, the new conglomerate should generate at least 2 in profits.\(^{15}\) This condition on profits can be satisfied with a lower managerial effort if talents are reallocated inside the firm. The low quality manager can allocate some of his tasks to the high quality manager, while maintaining control of the firm. Under the existing incentive schemes the high quality manager exerts more effort than the low quality one.\(^{16}\) Therefore, there is an increase in overall efficiency by putting him to work in the division with the highest marginal productivity of effort. This division is the new high type company, where the marginal productivity of effort is \(\frac{\beta}{\sqrt{\epsilon}} > \frac{1}{\sqrt{\epsilon}}.\)

The low type manager will minimize his effort given the profit constraint. Therefore, his effort \(e\) will be determined by

\[\Pi_L(e, w_L) + \Pi_H(e_H, w_H) = 2. \quad (2.19)\]

This implies that the optimal level of effort for the manager \((e^*)\) is

\[e^* = \begin{cases} 
(1 - \frac{1}{2} \frac{\beta^2 - 1}{\theta})^2 & \text{if } \beta \leq \sqrt{1 + 2\theta} \\
0 & \text{if } \beta > \sqrt{1 + 2\theta}.
\end{cases}\]

Therefore, by merging, the low type manager changes his utility from \(\frac{\beta^2 - 1}{\beta^2}\) to \(1 - e^*\). It is

\(^{14}\)The low type manager must also obtain the approval of his shareholders to proceed with the merger. But this is accomplished by assuring that the new conglomerate will pay at least the same level of dividends that it would have been paid without the merger, i.e. 1.

\(^{15}\)The new profit requirement pays the firm's acquisition price (equal to 1), and delivers the pre-acquisition dividend level to the shareholders (also equal to 1).

\(^{16}\)See the paragraph after equation (2.17), and equation (2.18).
easy to show that

\[ 1 - e^* \geq \frac{\beta^2 - 1}{\beta^2}. \]  

(2.20)

This implies that the low type manager is better off with the merger. The increased efficiency achieved by matching the high tech division with the hard-working manager allows the low type manager to decrease even more his effort level.

Therefore, in this simplified framework we have proved that it is optimal from the manager's point of view to acquire a company to complement his managerial skills. The new conglomerate will be characterized by cross-subsidization across divisions. The high type division will generate higher profits to offset the lower profits of the low type division.

This section may give the false impression that mergers are a mistake, the result of an inefficient incentive scheme that failed to induce voluntary quit after changes in technology. On the contrary, we shall show in section 2.3 that an optimal incentive scheme might not induce voluntary quit even when technological improvements are anticipated, as long as they are not contractible. The difference in the two contexts is not whether mergers will take place, but how they will take place. The founders will regulate mergers, asking for a higher profit level to approve them. In this way they capture part of the technological gains. Moreover, by avoiding the severance payment they keep the chances of capturing the control rents through a disciplinary takeover. In the next section we formalize these arguments.

2.3 The Optimal Contract

The purpose of this section is to derive the optimal contract offered by the founders to the managers at the time the corporation goes public. As a benchmark, we start describing the first best. Subsequently we analyze the optimal contract in a more realistic environment, where technological shocks and the probability of a disciplinary takeover are not verifiable by a court. In this case, we shall show that an optimal contract might not allow severance payments to induce CEO turnover. In this case, the reallocation of talents would take place through mergers.
2.3.1 First Best: Technological Shocks Are Contractible

Low Type Manager

We assumed that the managerial labor market is efficient in the sense that high type firms are better off employing high type managers. Therefore, we do not need to worry about the possible contract a high type firm offers to a low type manager. The optimal contract of a low type firm (indexed by 0) employing a low type manager, \((\bar{w}_0, \Pi_0)\), maximizes profits at time 2 subject to the low type manager participation constraint, i.e.

\[
\max_{w, e} f(e, \beta_0) - w \quad \text{s.t.} \quad w - e \geq 0. \tag{2.21}
\]

The first order conditions, which are also sufficient, for program (2.21) are

\[
\frac{\partial f(e, \beta_0)}{\partial e} = 1 \quad \bar{w}_0 = \bar{e}_0; \tag{2.22}
\]

implying that

\[
\Pi_0 = f(\bar{e}_0) - \bar{e}_0. \tag{2.23}
\]

Under the optimal incentive scheme, \((\bar{w}_0, \Pi_0)\), the manager will receive \(\bar{w}_0\) if he delivers \(\Pi_0\) to the shareholders at time 1.

High Type Manager

Low type firms (indexed by 0) and high type firms (indexed by 1) employ high type managers. The optimal contract, \((\bar{w}_i, \Pi_i)\), where \(i = 0 \text{ or } 1\), solves

\[
\max_{w, e} f(e, \beta_i) - w \quad \text{s.t.} \quad w - \theta e \geq R^h \tag{2.24}
\]

Note that the main difference in program (2.24) when compared to program (2.21) is in the manager's participation constraint. Here, the disutility of effort is decreased by the factor \(\theta\). Moreover, the firm must pay the manager a rent \(R^h\), because he is a scarce factor.

The first order conditions, which are also sufficient, for program (2.24) are

\[
\frac{\partial f(e, \beta_i)}{\partial e} = \theta \quad \bar{w}_i = \theta e_i^h + R^h; \tag{2.25}
\]
implying that
\[ \Pi_i^h = f(e_i^h, \beta_i) - \theta e_i^h - R^h. \] (2.26)

The first order conditions (2.22) and (2.25) determine the optimal amount of effort and profits according to the firm's technology. We should expect that a manager with a smaller disutility of effort works more. Furthermore, a high type firm has a larger marginal productivity of effort. Therefore, effort should increase when there is some technological improvement. We also expect profits to be larger when productivity is larger. On the other hand, in equilibrium, the profits of a low type firm should not depend on the type of its manager. These intuitive results are formally stated and proved in Proposition 1 below.

**Proposition 1** Under our assumptions on \( f(e, \cdot) \) we have \( \varepsilon_i^h > \varepsilon_0^h > \varepsilon_0 \), and \( \Pi_i^h > \Pi_0^h = \Pi_1^h \).

**Proof:** From equation (2.25) we have that \( \frac{\partial f(e_i^h, \beta_i)}{\partial e_i} = \frac{\partial f(e_i^0, \beta_0)}{\partial e_i} \). But \( \frac{\partial f(e_i^h, \beta_i)}{\partial e_i} > \frac{\partial f(e_i^0, \beta_0)}{\partial e_i} \) for any \( e > 0 \). Since \( f(e, \cdot) \) is concave on \( e \), it follows that \( \varepsilon_i^h > \varepsilon_0^h \). Comparing equations (2.25) and (2.22), and recalling that \( \theta < 1 \), we have that \( \frac{\partial f(e_i^0, \beta_0)}{\partial e_i} < \frac{\partial f(e_i^h, \beta_0)}{\partial e_i} \). Concavity of \( f(e, \cdot) \) then implies that \( \varepsilon_0^h > \varepsilon_0^1 \), proving the first part of the proposition. To prove the second part note that \( \Pi_i^h = f(e_i^h, \beta_1) - \theta e_i^h - R^h > f(e_0^h, \beta_1) - \theta e_0^h - R^h > f(e_0^h, \beta_0) - \theta e_0^h - R^h = \Pi_0^h = \Pi_1^h \). The first inequality arises from the strict concavity of the profit function and the optimality of \( \varepsilon_i^h \). The second inequality derives from \( f(e, \beta_1) > f(e, \beta_0) \). The last equality is an equilibrium condition: low type firms hiring low type managers must be as well off as low type firms hiring high type managers. \( \square \)

### 2.3.2 Technological Shocks and Takeover Threat Are Not Contractible

The noncontractibility of a technological shock is not a problem for a high type firm, since we assumed that they do not bear any technological uncertainty. Therefore, we will concentrate on low type firms. More specifically, we will focus our attention on a low type firm run by a low manager. This is the only interesting case, because if the incumbent is already a high type manager, then there is no need for mergers to reallocate talents.

When the technological shocks are not verifiable, the state contingent contract computed in the previous subsection, \( \{(\overline{w}_0^h, \Pi_0^h), (\overline{w}_1^h, \Pi_1^h)\} \) is not optimal anymore. The problem is that there is no incentive for the incumbent manager to replace himself by a high type one, upon the appearance of the technological improvement. The incumbent manager can
enjoy control rents by staying in the job under the contract \((w_0^0, \Pi_0^0)\). The technological improvement enables him to deliver \(\Pi_0^1\) with an effort level smaller than \(w_2^0\). Indeed, the manager can shirk even more by merging with a low type firm run by a high type manager, as we showed in the previous section.

Under rational expectations, this self interested behavior should be anticipated by the founders. Therefore, they should write a contract that induces the manager to quit upon the appearance of the technological shock, or that allows a merger conditioned on higher profits.\(^{17}\)

In principle both alternatives should be identical. The low type manager gets control rents because he can observe the firm's type before reacting to the incentive scheme. If they want to induce him to quit, the founders must pay him the present value of his control rents. Therefore, both strategies seem to be equally costly.

However, this reasoning does not consider that the control rent itself can be eliminated after time 1 by a raider. In this section we shall show that the market for corporate control and the noncontractibility of the probability of a takeover make the severance payment alternative less attractive. Intuitively, the severance payment reduces the benefits of the market for corporate control. A raider cannot deliver back the control rents to shareholders, because they have already been paid out before he appeared. The next two subsections formalize this discussion by comparing the company's value under each alternative.

**The Severance Payment Strategy**

In this strategy the founders allow a severance payment \(S\), such that the manager will be willing to quit if and only if the technological shock appears. The mechanism is a set \(((w^*, \Pi^*), S^*)\), that should be understood as follows. If the manager stays in the company after time 1, he will be paid \(w^*\) at time 2 if he delivers \(\Pi^*\) to the shareholders, and nothing otherwise. On the other hand, if the incumbent manager voluntary quits and \(\Pi_1^h\) is delivered to the shareholders at time 2, then he receives a severance payment equal to \(S^*\).\(^{18}\) Therefore, to cash \(S^*\) the outgoing manager must hire a high type manager, and impose on him the

\(^{17}\)Alternatively, the board of directors could authorize the hiring of a new manager, who would absorb some of the tasks of the incumbent, without reducing the incumbent manager's compensation. However, this alternative is dominated by the merger strategy if there are nonpecuniary benefits of control. In this case the incumbent manager would prefer the merger because it would keep him on a control position. Therefore, his private benefits would not be lost. Because of this we do not consider this alternative.

\(^{18}\)This state contingent severance payment can be implemented by paying \(S\) in stock options.
optimal incentive scheme of a high type firm.

The optimal mechanism solves\(^\text{19}\)

\[
\max_{((w,e), S)} \left\{ (1 - p) [(1 - \pi) (f(e, \beta_0) - w) + \pi (\Pi_0^d - \Phi)] + p S \right\} \tag{2.27}
\]

\[
\text{s.t.} \quad (1 - p) [(1 - \pi) (w - e)] + p S \geq 0 \tag{2.28}
\]

\[
S \geq 0 \tag{2.29}
\]

\[
w - e \geq 0 \tag{2.30}
\]

\[
f(\dot{e}^*, \beta_1) - w = f(e, \beta_0) - w \tag{2.31}
\]

\[
S \geq w - \dot{e}^*. \tag{2.32}
\]

The objective function is the firm's value at time 0. With probability \((1 - p)\) the firm continues a low type one. The low type manager stays in the job under the incentive scheme \((w, e)\). A priori, we cannot be sure that the incentive scheme \((w, e)\) is inefficient. However, we shall shortly show that this is actually true.\(^\text{20}\) Therefore with probability \(\pi\) the raider comes, and implements the optimal incentive scheme.\(^\text{21}\) When the raider appears the existing shareholders anticipate that he will restore efficiency. Therefore, they will have the incentive to free ride on the increased profitability. By doing this they will capture all the gains from the restructuring except for the dilution \(\Phi\). Hence the firm's value in case there is no shock and the raider shows up is the first best profit, \(\Pi_0^d\), minus \(\Phi\). With probability \(p\) the firm turns into a high type one. In such case the manager is paid \(S\), and hires a high type manager under the optimal incentive scheme. Note that in this case there is no role for a raider since the firm will deliver the optimal profits to the shareholders.

Equation (2.28) is the manager's participation constraint at time 0, while equations (2.29) and (2.30) are respectively the manager's participation constraint at time 2 if the positive shock appeared at time 1, and if it did not. It should be clear that if equations (2.29) and (2.30) are satisfied, then equation (2.28) is also automatically satisfied. Therefore, we can drop it from the program.

\(^{19}\)Note that an incentive compatible mechanism \((w, \Pi)\) is equivalent to \((w, e)\).

\(^{20}\)We could introduce in the objective function an indicative function to take into account that the incentive scheme might be efficient. We do not do this to simplify the notation.

\(^{21}\)Recall that at time 0 the probability that a raider comes conditioned on suboptimal profits is \(\pi = qr\).
Equation (2.31) defines the minimum effort that the manager must exert when the shock happened at time 1, but he renounces to the severance payment and stays in the firm with contract $(w, e)$. Because $f(e, \beta_1) > f(e, \beta_0)$, equation (2.31) implies that $\hat{e}^* > e$.\footnote{More precisely, we have weak inequality, with equality only if $e = 0$.}

Equation (2.32) is the incentive compatibility condition. It assures that the manager is better off accepting the severance payment rather than hiding the technological improvement. This explains the control rents enjoyed by the manager. By hiding the technological improvement the manager gets utility (conditioned on the nonappearance of a raider)

$$U(\hat{e}^*, w) = w - \hat{e}^* > w - e \geq 0.$$  

Where the last inequality comes from equation (2.30).

However, the manager cannot fully count on the control rents. With some probability the raider shows up and eliminates any rent. Therefore, at time 1 the manager’s expected utility is $(1 - r_i)(w - \hat{e}^*)$, where $r_i = 0$ or $r$. Nevertheless, the founders cannot write a severance payment contingent on the probability that a raider comes, since this is not verifiable by a court. Hence, the founders must promise severance payment $S \geq w - e$ to obtain voluntary quit whenever the technological upgrading appears. In practice this implies that the founders give up the market for corporate control as a mechanism to deliver the control rents to the shareholders.\footnote{In the more general case that $r_0 > 0$, the founders would be giving up $(r - r_0)(w - e)$. Note that the idea is the same, the severance payment strategy decreases the positive aspects of the market for corporate control.}

By monotonicity of the objective function equations (2.30) and (2.32) will be binding at the optimum. On the other hand, the manager’s participation constraint (when the technological shock happens (equation (2.29)) will not be binding. Therefore, program (2.27) can be rewritten as

$$\text{Max}_{\{(w,e), S\}} (1 - p)[(1 - \Phi)(f(e, \beta_0) - w) + \Phi(\Pi^d_0 - \Phi)] + p[\Pi^h_1 - S]$$  

$$= w - e = 0$$  

$$f(\hat{e}^*, \beta_1) = f(e, \beta_0)$$  

$$S = w - \hat{e}^*.\footnote{In the more general case that $r_0 > 0$, the founders would be giving up $(r - r_0)(w - e)$. Note that the idea is the same, the severance payment strategy decreases the positive aspects of the market for corporate control.}$$  

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The F.O.C. on $e$ (which is also sufficient) for the above program is

$$\frac{\partial f(e^*, \beta_0)}{\partial e} = \frac{(1 - p) + \frac{p}{1-p}}{(1 - p) + \frac{p}{\sigma(\frac{\partial \beta_0}{\partial e})}}. \quad (2.37)$$

Then the optimal mechanism is $\{(w, e), S\} = \{(e^*, e^*), (e^* - \delta^*)\}$. And the firm's profit in case the shock does not appear is $\Pi^* = f(e^*, \beta_0) - e^*$. It is easy to show that the effort level when the shock does not happen is suboptimal, i.e., $e^* < \bar{e}_0$. This implies that $\Pi^* < \bar{\Pi}_0$.

The firm's value at time 0 under the severance payment strategy ($V^*$) is given by

$$V^* = (1 - p)[(1 - \bar{\tau})\Pi^* + \bar{\tau}(\bar{\Pi}_0 - \Phi)] + p[\bar{\Pi}_h - (e^* - \delta^*)]. \quad (2.38)$$

**The Merger Strategy**

Now suppose that the founders do not write in the manager’s incentive scheme a provision that gives him a severance payment for leaving the company. In this case the manager will not quit, since he would be foregoing control rents. On the other hand, he cannot try to convince the shareholders that it is a good idea to pay him to quit. By doing this the manager would be inviting the shareholders to fire him without any severance payment. Therefore, the manager stays, and enjoys the extra perks due to the technological improvement. Actually, as we showed in section 1, the manager can increase his shirking if he merges with a low type firm run by a high quality manager.

Can the founders capture at least part of the technological gains without making use of severance payments? This is certainly possible: a standard incentive scheme contingent on profits can do it. What is interesting from our prospective is that the optimal incentive scheme will prescribe a merger. To understand why this is the case it is sufficient to remember a general result in the incentive literature: optimal incentive schemes sacrifice efficiency in the less productive states to enhance efficiency in the most productive ones. Without the option of the severance payment the best outcome in the good state is a merger. Therefore, an optimal incentive scheme will prescribe a merger when the firm turns into a high type one, and it will require the manager a higher profit level.

The merger enhances efficiency by shifting the managers’ positions in the new conglomerate. The incumbent manager will end up running the acquired company (i.e. the low type firm), while the high type manager will run the acquirer (i.e. the new high type firm).
In summary the optimal mechanism is a menu of incentive schemes:

\[\{(w^m_0, e^m_0), (w^m_1, e^m_1), (w^m_2, e^m_2)\}\].

The incumbent manager will be under the incentive scheme \((w^m_0, e^m_0)\) if the company does not merge, and \((w^m_1, e^m_1)\) if there is a merger. In this case the new manager should run the new high type firm under the incentive scheme \((w^m_2, e^m_2)\).\(^{24}\)

At this point we need to add some notation. Define the profits of the high type and the low type divisions in the new conglomerate as \(\Pi^m_2\), and \(\Pi^m_1\), respectively. Then the total profits in the new conglomerate will be \(\Pi_M = \Pi^m_2 + \Pi^m_1 - \Pi^h_0\). The last term is the price paid to acquire a low type firm run by a high quality manager. We are assuming that the acquisition will cost the first best profit level. This is justified by the free-riding hypothesis. The target shareholders know that a raider can implement the first best strategy, therefore they will not sell for less than this.\(^{25}\) Finally, in case there is no merger we define the firm’s profit as \(\Pi^m_0\). Then, the optimal mechanism is found by solving\(^{26}\)

\[
\max_{\{(w^m_i, e^m_i)\}} (1 - p)[(1 - \bar{r})\Pi^m_0 + \bar{r}(\Pi^m_0 - \Phi)] + p[(1 - \bar{r})\Pi_M + \bar{r}(\Pi^h_1 - \Pi^h_0 + \Pi^l_0 - \Phi)]
\]

\[(2.39)\]

\[\text{s.t. } w^m_i - e^m_i \geq 0 \text{ for } i = 0 \text{ or } 1 \]

\[(2.40)\]

\[w^m_2 - \theta e^m_2 \geq R^h \]

\[(2.41)\]

\[\Pi^m_2 = f(e^m_2, \beta_1) - w^m_2 \]

\[(2.42)\]

\[\Pi^m_i = f(e^m_i, \beta_0) - w^m_i \text{ for } i = 0 \text{ or } 1 \]

\[(2.43)\]

\[\Pi_M = \Pi^m_2 + \Pi^m_1 - \Pi^h_0 \]

\[(2.44)\]

\(^{24}\)In the description of the mechanism we implicitly assumed that the profits of each division in the conglomerate are verifiable. Nevertheless, the mechanism can be implemented if only total profits are verifiable. This can be done by imposing a limit in the new manager’s compensation, and making the incumbent manager’s compensation contingent on total profits.

\(^{25}\)In principle, we should subtract the searching cost \(\Phi\). We did not do it because we assume that the target’s corporate charter allows the acquirer to dilute the target shareholders up to \(\Phi\).

\(^{26}\)This problem is formally equivalent to the standard hidden information model of the Principal-Agent literature, except that the agent is risk neutral. Here the distortion of effort happens because the manager is credit constrained at time 0. The credit constraint does not allow the initial entrepreneur (the principal) to recover the managerial control rents through a front fee payment. Therefore they distort effort in the less productive states to minimize the control rent.
\[ f(\hat{e}^m, \beta_1) - w_0^m = f(e_0^m, \beta_0) - w_0^m \]  \hspace{1cm} (2.45)

\[ w_1^m - e_1^m \geq w_0^m - \hat{e}^m. \]  \hspace{1cm} (2.46)

The objective function is the firm's expected value at time 0. The first term (under probability \((1 - p)\)) is the expected profit in the case that there is no shock. We need to take expectations because the firm's profit will depend on the appearance of a raider. The second term is the expected profit in case the shock appeared, taking into account that there will be a merger at time 1.

Equations (2.40) and (2.41) are the low type and the high type manager's participation constraint at time 1, respectively. Equations (2.42) and (2.43) define the profits of each unit of the conglomerate under its respective incentive scheme. Equation (2.44) defines the total profits of the conglomerate.

Equation (2.45) defines \(\hat{e}^m\) as the minimum effort that the low type manager must exert to satisfy \((w_0^m, e_0^m)\) when the technological shock happens. As in program (2.27), \(\hat{e}^m < e_0^m\). Equation (2.46) is the incentive compatibility constraint. It is also totally analogous to the one in program (2.27).

Standard arguments in the mechanism design literature and \(\Pi_0^h = \Pi_0^l\) allow us to rewrite program (2.39) as

\[ \text{Max}_{(w_1^m, e_1^m)} (1 - p)[(1 - \varphi)\Pi_0^m + \varphi(\Pi_0^l - \Phi)] + p[(1 - \varphi)(\Pi_2^m + \Pi_1^m - \Pi_0^m) + \varphi(\Pi_1^h - \Phi)] \]  \hspace{1cm} (2.47)

s.t. \quad w_0^m - e_0^m = 0 \hspace{1cm} (2.48)

\[ w_2^m - \theta e_2^m = R^h \]  \hspace{1cm} (2.49)

\[ \Pi_2^m = f(e_2^m, \beta_1) - w_2^m \]  \hspace{1cm} (2.50)

\textsuperscript{27}We did not consider the low type manager's participation constraint at time 0 because this is automatically satisfied when equation (2.40) is satisfied. Moreover, we should consider that a raider could eliminate the rents after time 1. This would require multiplying the participation constraints by the probability that a raider comes. Since this does not change the analysis, we disconsider it to simplify the notation.

\textsuperscript{28}We should also include a second incentive compatibility constraint to assure that the low type manager will not seek a merger when the shock did not happen. However, standard arguments in the mechanism design literature show that this constraint is not binding in the optimum. Therefore, we did not write it in the program.

\textsuperscript{29}See Hart (1983) for the type of proofs in a slightly different framework.
\begin{align*}
\Pi_i^m &= f(e_i^m, \beta_0) - w_i^m \text{ for } i = 0 \text{ or } 1 \\
f(\hat{e}^m, \beta_1) &= f(e_0^m, \beta_0) \\
w_1^m - e_1^m &= w_0^m - \hat{e}^m.
\end{align*}

The first order conditions, which are also sufficient, are

\begin{align*}
e_2^m : \quad & \frac{\partial f(e_2^m, \beta_1)}{\partial e} = \theta \\
e_1^m : \quad & \frac{\partial f(e_1^m, \beta_0)}{\partial e} = 1 \\
e_0^m : \quad & \frac{\partial f(e_0^m, \beta_0)}{\partial e} = \frac{1}{(1 - p) + \frac{p}{\frac{\theta}{\beta_0} - 1}}.
\end{align*}

Comparing the first order conditions for \(e_2^m\) and \(e_1^m\) (equations (2.54) and (2.55)) with those of the first best effort levels (equations (2.22) and (2.25)) one can check that the first best effort levels are obtained in the merger. However, the shareholders do not obtain the first best profit level. Profits are suboptimal because the mechanism gives a control rent to the low type manager equal to \(e_0^m - \hat{e}^m\). Therefore, there is scope for a disciplinary takeover after the merger.

Proposition 2 below shows that there is undereffort when the shock does not appear, and it also shows that the inefficiency is smaller in the mechanism that allows mergers than in the mechanism that allows for a severance payment. The intuition for this comes from the control rents. These are larger when they allow for a severance payment because, ex-ante, the founders must pay them as if a raider would not appear. On the other hand, in the merger strategy the control rents can be eliminated by a raider. This implies that the control rent is not so expensive in expectation, therefore there are less incentives to distort efficiency.\(^{30}\)

**Proposition 2** The low type manager exerts an inefficiently low effort level, \(e_0^m\), when the shock does not appear. However, the inefficiency is lower in the merger case rather than in

\(^{30}\)Recall that efficiency is sacrificed to decrease the control rents in the best state.
the severance payment case, i.e., $e^* < e_0^m < \bar{e}_0^m$. Therefore, $\Pi^* < \Pi_0^m < \Pi_0^I$.

**Proof:** To prove that $e_0^m < \bar{e}_0^m$, it suffices to show that the right hand side of equation (2.56) is greater than 1. To see this note that $\frac{\partial f(e^m, \beta)}{\partial e} > \frac{\partial f(e_0^m, \beta)}{\partial e}$ (this follows from concavity of $f(e, \cdot)$, $e^m < e_0^m$, and $\frac{\partial f(e^m, \beta)}{\partial e} > \frac{\partial f(e_0^m, \beta)}{\partial e}$). Therefore, $\frac{\partial f(e_0^m, \beta)}{\partial e} > (1 - p)^{-1} \frac{1}{\frac{\partial f(e_0^m, \beta)}{\partial e}} \rightarrow \frac{\partial f(e_0^m, \beta)}{\partial e} > 1$. To prove that $e_0^m > e^*$ it suffices to prove that the right hand side of equation (2.56) is smaller than the right hand side of equation (2.37). But this is true because the latter is equal to the former, except for $\frac{1}{1 - \bar{r}} > 1$. The second part of the proposition follows from the first part, and the strict concavity of the profit function on $e$.

We can write the firm's value at time 0 under the optimal mechanism that allows for merger, $V^m$, as

$$V^m = (1 - p)(1 - \bar{r})\Pi_0^m + \bar{r}(\bar{\Pi}_0 - \Phi) + p((1 - \bar{r})(\bar{\Pi}_1 - (e_0^m - e^m)) + \bar{r}(\bar{\Pi}_1 - \Phi)) \quad (2.57)$$

Comparing equations (2.57) and (2.38) we have that the merger alternative is better to the founders if and only if

$$\bar{r} \bar{\Phi} \leq \{1 - \bar{r}\} \{(1 - p)[\Pi_0^m - \Pi^*] - p[(e_0^m - e^m) - (e^* - e^*)(\frac{1}{1 - \bar{r}})]\}. \quad (2.58)$$

The intuition for the above condition is the following. On the one hand, the merger alternative distorts less effort in case the technological upgrading does not happen. On the other hand, it allows greater rents when the technological shock happens. The right hand side of equation (2.58) captures this trade-off. The first term is the difference in profits and the second term is the difference in the control rents. Note that this last term is weighted by $(1 - \bar{r}) > 1$. This is so because the merger alternative (contrary to the severance payment strategy) can benefit of a disciplinary takeover that eliminates the control rents after time 1. Nevertheless there is a cost for the merger strategy which is not present in the severance payment strategy. In the latter case the firm will obtain the first best profit level at time 2. Therefore, there is no need for a raider. The shareholders save (in expectation) $\bar{r} \bar{\Phi}$.

If the right hand side of equation (2.58) is positive, then the merger strategy is optimal for a sufficiently low takeover cost $\bar{\Phi}$. Proposition 3 below proves that this is indeed true.

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31Note in equations (2.52) and (2.35) that $e_0^m$ and $e^*$ are defined by the same implicit function.
**Proposition 3** For $\Phi$ sufficiently small, the founders allow mergers conditioned on the delivery of a higher profit level, and forbid severance payments.

**Proof:** It suffices to prove that the right hand side of equation (2.58) is strictly positive. This happens if and only if

$$\Pi^m_0 - \Pi^* \geq \frac{p}{1 - p}[(e^m_0 - \hat{e}^m) - (e^* - \hat{e}^*)(\frac{1}{1 - p})].$$

Since $\frac{1}{1 - p} > 1$, the above inequality is automatically satisfied if

$$\Pi^m_0 - \Pi^* \geq \frac{p}{1 - p}[(e^m_0 - \hat{e}^m) - (e^* - \hat{e}^*)].$$

Since $e^* < e^m_0$, it suffices to show that the function $F(e) = (f(e, \beta_0) - e) - \frac{p}{1 - p}(e - \hat{e})$ is increasing on $e$ for $e < e^m_0$. To see this take the derivative of $F(e)$:

$$F'(e) = \left(\frac{\partial f(e, \beta_0)}{\partial e} - 1\right) - \frac{p}{1 - p}(1 - \frac{d\hat{e}}{de}).$$

But the above equation is the F.O.C. for $e^m_0$. Therefore it is zero (by construction) when $e = e^m_0$. Moreover, the derivative is positive for any $e < e^m_0$, since the F.O.C. refers to the maximization of a strictly concave profit function. Finally, to prove that the mechanism asks for more profits note that $\Pi^m_0 < \Pi^d_0$. But since the latter profit is feasible to the program that picked the merger as the optimal mechanism (you could just offer to the low type manager the first best contract without shock $(\overline{w}_0, \overline{e}_0)$), then we must have $\Pi^d_1 - (e^m_0 - \hat{e}^m) \geq \Pi^d_0 > \Pi^m_0$.

$\square$

Therefore, the founders of a firm that is transparent to raiders, in the sense that the searching cost $\Phi$ is low, should not use severance payments to induce new hirings at CEO level. They should opt for a regulated merger.

In summary, we proved in this section that buying firms rather than hiring new employees is a better alternative for the shareholders, when they can count on the market for corporate control, i.e. $\Phi$ is not too large. An optimal mechanism does not forbid mergers in general. However, it requires higher profits after the merger.
2.4 Empirical Implications

Our model provides a consistent explanation of why the value of future acquisitions is already embedded into the acquiring company's stock, but not into the target's stock. At the time the positive shock hits a company, the stock price should reflect the perspective of a future merger, i.e. the stock price should go from $V^m = (1 - p)(1 - \bar{r})(P_0^m + \bar{r}((P_0^i - \bar{h})) + p((1 - \bar{r})(P_1^m - (e_0^m - \bar{h}^m)) + \bar{r}((P_1^i - \bar{h})) to (1 - \bar{r})(P_1^m - (e_0^m - \bar{h}^m)) + \bar{r}((P_1^i - \bar{h})].$ This is consistent with the finding that acquiring firms experienced a positive excess return in the announcement of an acquisition program (Schipper, and Thompson 1983).

When the actual merger is announced there will be no release of new information as far as the bidder is concerned. On the contrary, the announcement of an acquisition will be a big positive news for the target. Ex-ante there are many possible targets. All low type firms run by a high manager are potential targets. These firms are run inefficiently. Therefore, when the target is publicly announced this is good news for the target shareholders. They know that the inefficient incentive scheme will be removed, and that they can extract part of this efficiency gain because of free riding (Grossman and Hart, 1980). This explains the large positive abnormal return experienced by acquisition targets.

The model also provides a useful framework to interpret other stylized facts present in the takeover literature. First of all, Morck, Shleifer and Vishny (1988) find some empirical correlation between the mood of a takeover and the characteristics of the target company. They interpret it as a proof that synergistic takeovers are friendly, and disciplinary takeovers are hostile. However, they do not explain why public companies controlled by self-interested managers should exploit synergies that go to the advantage of shareholders. It is also unclear why, if these synergies are real, friendly mergers are frequently followed by hostile takeovers that undo what the friendly merger did. This chapter provides a model consistent with their results, which also takes into account the incentives behind different types of takeovers. The driving force behind a synergistic takeover is the reallocation of managerial talents. A conflict with the target management will destroy the very same reason of the acquisition: the possibility to hire a better management team. On the contrary, the purpose of a disciplinary

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32 We did not discuss explicitly the incentive scheme of these low type firms with high type managers. However, the general result of distortion of effort in the bad states applies to these firms as well. Given that they are good targets of an acquisition only if they were not hit by a technological shock, it follows that they will be run under an inefficient incentive scheme.
takeover is to eliminate control rents by stopping the cross-subsidization. Therefore, it is natural to expect a fierce opposition from the incumbent management.

Our model can also explain why shareholders may sometimes benefit from a merger that is purely driven by managerial concerns. Matsusaka (1990) finds that bidding companies earned significantly positive announcement period returns in diversifying acquisitions in 1968. He interprets his results as “evidence consistent with the hypothesis that managers were trying to maximize shareholder value by buying into unrelated lines of business in order to share general managerial skills with target managers.” He arrives to these conclusions because announcement period returns are higher when the managers of the acquired company are retained after the acquisition. We do not share such an optimistic view of managerial behavior. Nevertheless, our model is able to incorporate Matsusaka results in a theoretical framework in which the incentives of the different parties involved are spelled out clearly. As shown in Proposition 3, we should expect higher profits after a merger.

Despite the merger may be well received by shareholders, it allows for control rents, which leave scope for a subsequent takeover. This is consistent with the empirical findings that acquiring companies are more likely to become targets of hostile acquisitions.

This chapter can also help reconciling the two main conflicting views about hostile takeovers. Financial economists are divided between those who believe that hostile takeovers are just a transfer of wealth from workers to shareholders (as Shleifer and Summers, 1988) and those who believe takeovers enhance efficiency. This chapter argues that both elements are present. In a disciplinary takeover the incumbent manager loses the rent he enjoys in his jobplace in favor of the raider. However, it can be shown that there may be inefficient incentive schemes after a merger if there is more than one type of technological upgrading, and only total profits can be verified by a court. In this case, hostile takeovers may also enhance efficiency, as found by Litchenberg, and Siegel (1990).

The model can also provide some new testable implications. First of all, the model predicts a reallocation of managerial talents inside the new conglomerate. We expect the manager of the acquired company to assume some responsibilities in the acquiring company. To the best of our knowledge this phenomenon has not been studied systematically, even if there is some empirical evidence in this direction. For example, when Nabisco Biscuits acquired Standard Brands, the CEO of the latter eventually became the chief executive officer of the conglomerate.
The model predicts not only the existence of cross-subsidization inside a conglomerate, but also which division is subsidized. It should be the division formed by the acquiring company that becomes more profitable, supporting the division created from the acquired company.

2.5 Conclusions

This chapter presents a new theory of mergers based on the role of acquisitions in reallocating managerial talents. Mergers are the most convenient way to reallocate talents from the managers' point of view. We prove that in a world of incomplete contracts they may become the optimal mechanism also from the shareholders' point of view.

In a world without agency costs mergers would be unnecessary. The labor market would efficiently reallocate talents. However, the labor market works only if less skillful managers can be fired at wish. This assumption does not apply to top managerial positions, especially to the position of chief executive officer. In the absence of a reliable board of directors to manage the hiring process, the CEO would be the one deciding his own replacement. However, nobody is willing to trigger his own firing.

If the labor market is affected by these agency problems mergers become the optimal mechanism to reallocate talents. We prove this proposition in two steps. First, we show that for a given incentive scheme managers want to merge, because they can exploit the increased efficiency to their own advantage. Then, we go back one step to look whether shareholders can design better incentive schemes to curb managerial control rents. It turns out that the only alternative that can dominate a merger is to induce the incumbent manager to leave with a severance payment. However, this alternative is too costly because shareholders lose the opportunity of eliminating the control rents through a disciplinary takeover. By allowing mergers shareholders capture part of the efficiency gains derived by the reallocation of talents, and they can hope to recover the rest later thanks to a raider.

This chapter is intended to stimulate empirical research in at least three directions. The model highlights the role played by the reallocation of managerial talents in the new conglomerate. This unexplored aspect of mergers deserves further study. A second testable implication is the direction of cross-subsidization across divisions of a conglomerate. Our theory suggests that the division formed by the acquiring company should subsidize the
acquired one. This would be in line with the often mentioned bad performance of acquired companies after a merger. It would be interesting to conduct an accounting study of the internal cash flow of the new conglomerate. The third aspect highlighted by this chapter is the connection between technological shocks (or more generally shocks to the profit function) and mergers. We believe that this is one of our most interesting results, and we plan to test whether this relation is present in the data.
References


Newsweek 1988, October 31.


Chapter 3

Financial Distress as a Collapse of Incentive Schemes

Abstract

This chapter explains why workers lack motivation near bankruptcy, why they tend to leave companies in financial distress, and why those who remain require higher compensation.\(^1\) These indirect costs of financial distress arise because the optimal combination of debt and incentive schemes, designed to minimize agency costs, ends up underpaying managers when there is a bankruptcy threat. The chapter also provides new empirical implications on the interaction between financial restructuring and changes in managerial compensation. These predictions are supported by the findings of Gilson and Vetsuypens (1992).

\(^1\)This chapter is joint work with Luigi Zingales.
Financial distress is not only a financing problem, but it is also an organizational problem. In a financially distressed company the best employees tend to leave, and the ones who remain lack proper motivation. Other authors have recognized that firms in financial distress produce less efficiently (e.g., Cutler and Summers, 1988). An explanation often advanced is "the diversion of time and energies of management from task of greater productivity" (Miller, 1977). However, we claim that the problem is deeper than that: in financial distress employees work less effectively because they lack proper motivation, and they lack proper motivation because incentive schemes become inadequate.

With very few exceptions,² the research on financial distress has focused on the effects of poor financial conditions on the firms' ability to invest. The lack of a theory that relates financial distress to the internal organization is particularly striking since the source of financial distress, debt, is generally considered an important part of a firm's incentive mechanism.

This chapter focuses on the interaction between debt and incentive schemes to analyze the source of financial distress and its effects on a firm's internal organization. Our starting point is the need for incentive schemes to restrain managerial discretion. In public companies managers are left in control of their companies without being the residual claimants. Incentive schemes are meant to resolve this problem, so is debt.

However, in an uncertain economic environment incentive schemes are not perfect. Managers can observe the actual business environment before reacting to the incentive scheme. This discretion decreases the power of incentive schemes and generates a control rent for the managers. The attempt to minimize this control rent forces a distortion in the amount of effort elicited in the worst economic environments. In a nutshell, we show that inefficiency near bankruptcy is optimally chosen to curb managerial control rents. This \emph{ex-post} inefficiency is a necessary evil to maximize \emph{ex-ante} the profits.

This wider perspective proves itself very useful in analyzing mechanisms to avoid financial distress, in particular renegotiation schemes such as exchange offers for public debt and the Chapter 11 of the US bankruptcy code. One of the main points of this chapter is that financial distress is not only a renegotiation problem. Financial distress is a monitoring problem as well. In this context, we shall prove that Chapter 11 may be a potentially good

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²The only theoretical work outside this mainstream is Titman (1984). On the empirical side the only exception is Gilson and Vetsuypens (1992).
form of renegotiation if the court's monitoring is effective.

To our knowledge no other paper analyzes the interaction between financial distress and the internal organization of a company. The existing theories of financial distress can be classified into three groups. The first group focuses on the effects on investment of costly renegotiation. High debt can sometimes produce an overinvestment problem (Jensen and Meckling, 1976) and other times an underinvestment problem (Myers, 1977).

The second type of explanation focuses on liquidation costs in the bankruptcy process. Liquidation can be costly because of transaction costs (legal costs) or because of imperfect capital markets (Shleifer and Vishny, 1991). The third explanation looks at the consumer's reaction to the belief that bankruptcy will lead to a rise in the product's maintenance cost (Titman, 1984).

If we interpret effort as an investment decision, our model can be related to Myers (1977). Myers showed that, in a highly indebted company, shareholders may not have the correct incentives to invest due to the distribution of the investment's payoff between debtholders and shareholders. In our framework the assumption of a given payoff distribution corresponds to taking managerial incentive schemes as given. For this reason we believe it is uninteresting to show inefficiency for a given incentive scheme. However, our model shows that even an a priori optimal incentive scheme can a posteriori generate an inefficiently low effort (underinvestment problem). Therefore, a corollary of our model is that the inefficiency result of Myers (1977) is robust to optimal contracting. Moreover, our broader approach suggests that financial distress is not only important to a company with growth opportunities. Financial distress hurts whenever there are many non contractible acts in a firm's activities.

Our explanation for the costs of financial distress is complementary and not alternative to the above theories. But, it provides some unique empirical implications on the trade off between financial restructuring and changes in managerial compensation. We shall show in Section 3.3 that there are two possible ways to eliminate the deadweight cost of financial distress. The first one is to increase the CEO compensation at the onset of financial distress. The alternative way is to reduce the face value of the debt. Companies that implement either of these strategies should more likely survive financial distress. Moreover, our model predicts a negative correlation between the use of the two strategies, i.e., if debt is reduced we should not see an increase in the CEO's compensation. These predictions find empirical

In contrast to the existing theories, our model can also provide an explanation for the huge cost of financial distress in the Texaco case. In 1984, Texaco was sued by Pennzoil for breach of contract. The court’s decision called for a $10 billion transfer from Texaco to Pennzoil. In 1987, Texaco filed for bankruptcy protection under Chapter 11 claiming to be unable of continuing its normal operations due to the financial burden imposed by the legal fine. Cutler and Summers (1988) estimate the cost of financial distress for Texaco in 3.0 billion dollars. Given Texaco’s lack of investment opportunities, the strength of the oil industry at that time, and the limited importance of maintenance in the oil business, none of the existing explanations can account for such a huge loss.

By contrast, our theory predicts that the probability of bankruptcy, created by the huge fine imposed on Texaco, induced a collapse on the firm’s incentive schemes. The abrupt change in the environment made the employees’ incentive schemes obsolete. The expectation that the efficient effort level would not be fully rewarded would eventually lead to an inefficient reduction of effort.

The chapter is organized as follows. Section 3.1 describes the general framework of the model. Section 3.2 shows that the optimal incentive scheme allows for inefficient effort near default. This section considers only debt levels and incentive schemes that trigger default after a negative shock occurs. In Appendix A we prove that this is without loss of generality. Section 3.3 discusses optimal recontracting, and it explains why Chapter 11 might be a good renegotiation device for the shareholders. Section 3.4 discusses the empirical implications.

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3 Consistent with Cutler and Summers we assume that the decline in the joint value of the two companies is due to the cost of financial distress in Texaco and not to larger agency costs in Pennzoil. For a different interpretation see Blanchard, Lopez de Silanes, and Shleifer (1992).

4 The underinvestment problem can hardly explain the loss borne by Texaco. According to Cutler and Summers, Texaco had very high exploration costs compared to the rest of the industry. Therefore, its investment opportunities were most likely negative present value projects. In addition, oil prospects are clearly transferable projects, and this violates one of the necessary conditions for debt overhang to be a problem. Overinvestment for the purpose of shifting risk from debtors to creditors cannot be an explanation either. In fact, it is very unlikely that managers want to undertake risky projects to favor shareholders at the expense of bondholders, jeopardizing their career opportunities. Therefore, we do not believe this is a convincing explanation for the cost of financial distress in the case of Texaco, which is a publicly held company. Liquidation costs cannot explain Texaco’s cost of financial distress either. Cutler and Summers dismiss legal costs as a convincing explanation given the size of the loss ($3.0 billion). On the other hand, it is hard to believe that a possible liquidation of Texaco would be costly in the Shleifer and Vishny (1991) sense, because Texaco’s problems were totally idiosyncratic, i.e., unrelated to industry-wide movements. Therefore, even if the market expected a sale of Texaco’s assets, it should not foresee any costs due to an illiquid market. Finally, gasoline is not a product that needs maintenance. Therefore, Titman’s explanation fails to provide a justification for the large costs of financial distress borne by Texaco.
Finally, we draw some conclusions, highlighting the importance of our new perspective of financial distress.

3.1 General Framework

We believe that the collapse of incentive schemes involves all employees of a distressed company. Nevertheless, we focus on the chief executive officer (CEO) because we subsume on him all agency problems inside a firm. It is a CEO's job to make sure his subordinates work efficiently. However, he will fail to motivate them whenever his effort is not properly rewarded. Therefore, the collapse of the CEO's incentive scheme implies that all employees will lack proper motivation and the best ones will prefer to leave.\(^5\)

We want to provide the simplest model that captures the effects of an imminent bankruptcy on a company's internal organization. Our starting point is the interaction between debt and incentive schemes. In particular, we want to explain why debt can be useful to complement incentive schemes.

Debt has no additional role in eliminating agency costs in a world where profits are verifiable: incentive schemes alone can minimize them. The need for debt is generally obtained by assuming that profits are not verifiable at all (Hart and Moore, 1989; Harris and Raviv, 1992), or by assuming that only total profits are verifiable, and incentive contracts do not work because managers care only about their firm's size (Hart and Moore, 1990). The first alternative is generally adopted for privately held firms on the ground that public firms are subject to outside certification of their financial statements.

We believe that, even in public companies, managers have large discretion in manipulating accounting profits.\(^6\) Therefore, we take the stand that profits are observable but not verifiable.\(^7\)

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\(^5\)The model can be extended to take into account different types of employees. In this case we expect that, after the collapse of the CEO's incentive scheme, an average skilled employee would obtain his reservation utility by shirking. On the contrary, we expect that the most skilled ones should need a high effort level to attain their higher reservation utility. Therefore, they should leave the distressed company for another job once the CEO stop enforcing high effort levels inside the company.

\(^6\)Healy (1985) finds great distortion in accounting measures when managerial bonuses are made contingent on them. On a more anecdotal basis there is the famous example of RJR Nabisco (Burrough and Helyar; 1990). The CEO, Ross Johnson, used to require the head of the baking unit to spend all the "excess cash" generated by his division to reduce the level of earnings. RJR Nabisco's financial statements were regularly audited, nevertheless these hidden profits were not uncovered.

\(^7\)Introducing asymmetric information would only strengthen our results, at the cost of a more complex model.
If profits are nonverifiable and there is no alternative mechanism to restrain managerial discretion, then managers would be able to dissipate the company's cash-flow in their own interest. In our model we do not assume that managers can steal the profits, but only that they can consume the cash-flow in projects that are useless for the company but increase their own pleasure. For example, a CEO could buy perquisites or pursue negative net present value investments that enhance his social status.

In this context a standard debt contract can be used to force managers to disgorge profits. A CEO cannot avoid to repay the debt by manipulating accounting profits, because default allows creditors to seize the company’s assets. Therefore, credit markets work even if profits are not verifiable. On the other hand, the existence of an active credit market implies that CEO’s expenses are not constrained by the firm’s current cash holdings. A CEO can borrow to finance his pet projects or his perquisites. A bank should be willing to provide him a loan, independently of his motivation, if the repayment is backed by future cash inflow. Therefore, only a high level of initial debt prevents the CEO from wasting the company’s future cash flow. The point is that a large enough initial debt does not allow him to finance self interested investments.8

To have a notion of optimality we assume that the incentive schemes and the debt level are chosen by the company’s founders. This is a controversial assumption. Most managers, with the consent of a friendly board, can generally alter the capital structure and their own compensation. Our defense to this potential criticism is at three different levels.

First, analyzing the problem from the founders’ perspective is similar to a model where a takeover threat induces optimal incentive schemes inside a firm. Second, incentive schemes should be interpreted in a broader sense. Even if the company’s founders do not literally set up an incentive scheme for the rest of the company's life, they do impose certain rules that tend to survive. They choose the initial board members and establish a “corporate culture” in terms of compensation, promotions and so on. The board members will choose successors who share the same “vision” of the company. In this way the corporate culture is transmitted through the years. Sometimes unwritten rules are as powerful as written ones (see for example the British constitution). It is not easy to model soft constraints. Therefore, we choose to formalize them in the form of incentive schemes.

Last, but not least, we assume that the initial entrepreneurs can impose the future

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8This is the central role of debt in Hart and Moore (1990).
incentive schemes to achieve full generality. We shall prove that the founders may not be able to prevent the deadweight cost of financial distress even being able to write incentive schemes. A fortiori the result will apply if we restrict the number of instruments available. Actually, an even more dramatic reduction of efficiency is obtained if we assume that the founders' only instrument is debt.

We assume that debt and equity claims are distributed among dispersed debtholders and shareholders. The need for dispersed shareholders is usually explained by risk sharing considerations.\(^9\) However, these considerations are less convincing in the case of debt. Nonetheless, even if the founders choose to have only one lender, the company may end up with several creditors (for example, supply creditors or tort creditors). It is beyond the scope of this chapter to explain why firms have multiple creditors. Therefore, we assume that debtholders are dispersed.\(^10\) For all practical purposes, the assumption of dispersed bondholders and dispersed shareholders preclude future renegotiation of the debt contracts and the incentive schemes.\(^11\)

Having laid down our main assumptions we can now describe our economy. We consider a company with a one period production horizon, as shown in Figure 3-1. The company is run by a self-interested manager (the CEO), whose effort is the only input in the production function. At period 1 the CEO exerts some effort, and at period 2 the proceeds of his effort are obtained and distributed. We assume that effort is observable but nonverifiable by a court.

At time 0 the firm's technology is characterized by the following profit function:

\[
\Pi(e, w) = f(e) - w, \quad (3.1)
\]

where \(e\) is managerial effort and \(w\) is the wage paid to the manager. As usual, we assume that production is increasing in effort \((\frac{df(e)}{de} > 0)\) with decreasing returns \((\frac{d^2f(e)}{de^2} < 0)\), and \(f(0) = 0\).

With probability \(p > 0\), there is a technological shock at time 1 that reduces the company's profitability. We assume that the shock is observable but it is not verifiable by a

\(^9\) For a different explanation why it might be optimal to sell equity claims to dispersed shareholders see Zingales (1992).

\(^{10}\) See Bolton-Scharfstein (1992) for a paper that endogenizes this choice in the case of a private company.

\(^{11}\) We will relax this assumption in section 3.3 when we discuss Chapter 11 and exchange offers for public debt as renegotiation devices.
court. It reduces the firm’s productivity, implying a new profit function

$$\Pi(e, w) = g(e) - w,$$

(3.2)

where $\frac{dg(e)}{de} > 0$, $\frac{d^2g(e)}{de^2} < 0$, $g(e) \leq f(e)$ for every $e$, and $\frac{dg(e)}{de} \leq \frac{df(e)}{de}$, with equality holding only when $e = 0$.

The first two conditions say that the shock does not change the usual assumptions of the production function. The new production function is still increasing on effort, with decreasing returns. The third condition says that, for the same effort level, the output after the shock is lower. In other words the shock is a negative one. Finally, the last condition says that the shock reduces the marginal productivity of effort.12

For simplicity, we assume that the CEO’s utility function is linear on effort and wages. In addition we assume that for the CEO a dollar of free cash flow inside the firm is worth as much as one dollar in wage.13 This is equivalent to assuming that the user cost of a perquisite is equal to its price. As a result the total utility of the CEO is given by

$$U(w, e, D) = (w - e) + \max\{\Pi(e, w) - D, 0\}.$$

(3.3)

The first term is simply the difference between his salary and the effort exerted. However, in addition to that, the CEO can consume any free cash flow in perquisites or pet projects. The free cash flow is defined as the net profit minus the outstanding debt level due at time 2 ($\max\{\Pi(e, w) - D, 0\}$).

12 This is the usual Spence-Mirrlees condition of the incentive literature.
13 If we relax this assumption it is possible to obtain a positive value of outside equity, but our main results are unchanged. We plan to develop these ideas in a follow up paper.
Since we assumed that the CEO is risk neutral, we also have to assume that he is credit constrained at time 0. Otherwise all agency costs would be trivially solved by selling the company to the CEO.

In the basic model we overlook any possible nonmonetary private benefit of control. We take this stand because we can show the emergence of inefficiency independently of the existence of private benefits. However, private benefits can explain why a manager does not seek the help of a bankruptcy court to reset the incentive scheme before the actual default. For this reason we shall introduce private benefits in section 3.3 when we discuss Chapter 11.\(^{14}\)

We assumed that the effort level is not verifiable. Therefore, the initial entrepreneurs must link the CEO’s compensation to the firm’s performance. The incentive literature accomplishes this through a menu of wages contingent on profits. Nevertheless, here this is not possible because profits are not verifiable. It turns out that the initial entrepreneurs can also use debt to link the CEO’s compensation to the firm’s performance. This can be done by conditioning his compensation to the level of debt repayment \(R\). More precisely, the incentive scheme will be formed by a compensation schedule where the CEO is paid \(w(R)\) if \(R\) is paid to the creditors.

In summary, the initial entrepreneurs will leverage up their firm for two reasons. First, debt does not allow future managers to dissipate the firm’s profits, since it precludes the financing of perks and pet projects. Second, it provides the manager an incentive scheme, by conditioning his compensation on the amount of debt repayment. Therefore, the task of the initial entrepreneurs is to determine the optimal debt level \((D^*)\) and the CEO’s compensation in the cases of full repayment and default. This mechanism should maximize the value of the firm at time 0.

\[\text{3.2 Risky Debt and Financial Distress}\]

In this section we limit our attention to mechanisms that trigger default only when the negative shock occurs. At an intuitive level it should be clear why we focus on these strategies: the need to reset the incentive scheme only arises when a shock occurs, so only in such cases an outside intervention (default) should be efficient. In Appendix A we shall

\(^{14}\text{It is worth saying that the introduction of private benefits does not alter the basic model of section 3.2.}\)
show that this intuition is correct for a wide range of sensible direct costs of bankruptcy.

Within this set of mechanisms, we show that the optimal incentive scheme induces efficient effort if the negative shock does not occur, but it leaves a control rent for the manager. On the contrary, the optimal incentive scheme will induce an inefficiently low effort, if the negative shock occurs. We also show that the inefficiency is larger in firms that did not expect a negative shock with high probability.

3.2.1 The First Best

In order to establish what the efficient solution is, we initially assume that the initial entrepreneurs can contract on profits and on the appearance of the technological shock. In this case, writing contracts contingent on profits is equivalent to writing contracts directly on effort. At time zero the founders write a contract that maximizes profits in each state. More formally the optimal contract in case the shock does not happen solves

$$\text{Max}_{w,e} f(e) - w$$

$$\text{s.t.} \quad w - e \geq 0.$$  \hspace{1cm} (3.4) (3.5)

The first order conditions (F.O.C.), which are also sufficient, are

$$\frac{df(e^*)}{de} = 1 \quad \text{and} \quad w^* = e^*,$$  \hspace{1cm} (3.6)

implying that

$$\Pi^* = f(e^*) - e^*.$$  \hspace{1cm} (3.7)

Under the optimal incentive scheme (represented by \((w^*, \Pi^*)\)) the manager will receive salary \(w^*\) if at time 1 he delivers profit \(\Pi^*\) to the shareholders, and nothing otherwise.

By contrast, if the negative shock happens the optimal incentive contract is given by the solution of the modified program

$$\text{Max}_{w,e} g(e) - w$$

(3.8)
\[ s.t. \quad w - e \geq 0. \]  \hspace{1cm} (3.9)

The F.O.C. (which are also sufficient) are

\[ \frac{dg(\bar{e})}{de} = 1 \quad \text{and} \quad \bar{w} = \bar{e}, \]  \hspace{1cm} (3.10)

implying that

\[ \bar{\Pi} = g(\bar{e}) - \bar{e}. \]  \hspace{1cm} (3.11)

In this case the optimal incentive contract at time 2 is given by \((\bar{w}, \bar{\Pi})\).

It is easy to show that concavity of \(f(e)\) and \(g(e)\), and the lower marginal productivity of effort of \(g(e)\) imply that

\[ \bar{e} < e^* \]

and

\[ \bar{\Pi} < \Pi^*. \]

As expected, the negative shock reduces the firm’s profit. The ex-ante value of the firm, \(V^0\), under the complete contract case is given by

\[ V^0 = (1 - p)\Pi^* + p\bar{\Pi}. \]  \hspace{1cm} (3.12)

The first term in equation (3.12) is the firm’s profit in case the shock does not happen, which is an event with probability \(1 - p\). The second term is the firm’s profit in case the shock happens. We can write the optimal contract as a menu \(\{(w^*, \Pi^*), (\bar{w}, \bar{\Pi})\}\). For instance, if the shock happens, then the CEO’s incentive scheme is \((\bar{w}, \bar{\Pi})\), under which he receives \(\bar{w}\) if he delivers profit \(\bar{\Pi}\), and nothing otherwise. On the other hand, if the shock does not occur the incentive scheme is \((w^*, \Pi^*)\). The important point to be noted is that the manager is not allowed to select the incentive scheme. This will be imposed on him according to the realization of the uncertainty.
3.2.2 Profits and Technological Shock Are Not Verifiable

In this subsection we characterize the optimal mechanism when the profits and the technological shock are not verifiable. The founders' problem is to choose a compensation schedule \( \tilde{w}(R) \), which depends on the amount \( R \) paid to the creditors, and a debt level \( \tilde{D}^* \) due at time \( 2 \) that trigger default only when the negative shock occurs.

Since there are only two states of nature we can replace the compensation schedule by a menu \( \{ (w_1, R_1), (w_2, R_2) \} \) where the index denotes the state of nature. We say that \( i = 1 \) when the negative shock did not occur at time \( 1 \), and \( i = 2 \) otherwise. Therefore, under the optimal incentive scheme the CEO will be paid \( w_i \) if the creditors are paid \( R_i \), and nothing otherwise. Note that, contrary to the previous subsection, the founders cannot impose a state contingent incentive scheme on the manager: the state of nature is not verifiable. Therefore, the founders must induce the manager to select the incentive scheme according to the realization of the uncertainty. More intuitively, the founders will try to induce the CEO to pay a larger amount of debt when the negative shock does not happen. This self selection requirement is the source of the control rents enjoyed by the manager.

We restrict our attention to mechanisms that trigger default only when the negative shock occurs.\(^{15}\) Therefore, the optimal repayment in state \( 1 \) cannot be lower than the face value of the debt, i.e., \( R_1^* \geq \tilde{D}^* \). On the other hand, the manager will never pay more than what is required by the debt contract. Therefore, the optimal level of debt cannot be lower than the largest repayment induced by the optimal incentive scheme, i.e., \( \tilde{D}^* \geq \max \{ R_1^*, R_2^* \} \). Then, it follows that \( R_1^* = \tilde{D}^* \). Therefore, once we have solved the optimal incentive scheme \( \{ (w_1^*, R_1^*) \} \) we have automatically determined the optimal debt and wage schedule \( \{ \tilde{D}^*, \tilde{w}(R) \} \).

The optimal incentive scheme \( \{ (w_i, R_i) \} \) such that \( R_2 \leq R_1 = \tilde{D}^* \) solves\(^{16}\)

\[
\text{Max}_{\{ (w_1, R_1), (w_2, R_2) \}} \ (1 - p)D + pR_2
\]

\[\text{s.t.} \quad D = f(e_1) - w_1 \]  

\[ (3.13) \quad (3.14) \]

\(^{15}\)Appendix A shows that this is without loss of generality if we take into account the direct costs of bankruptcy.

\(^{16}\)This problem is formally equivalent to the standard hidden information model of the Principal-Agent literature, except that the agent is risk neutral. Here the distortion of effort happens because the manager is credit constrained at time 0. The credit constraint does not allow the shareholders to recover the control rents through a front fee payment. Therefore, they distort effort in the less productive states to minimize the managerial control rents. See Hart (1983) for the hidden information models.
\[ R_2 = g(e_2) - w_2 \]  \hspace{1cm} (3.15)

\[ w_1 - e_1 + \text{Max}\{[f(e_1) - w_1] - D, 0\} \geq 0 \]  \hspace{1cm} (3.16)

\[ w_2 - e_2 + \text{Max}\{[g(e_2) - w_2] - D, 0\} \geq 0 \]  \hspace{1cm} (3.17)

\[ R_2 = f(\dot{e}) - w_2 \]  \hspace{1cm} (3.18)

\[ w_1 - e_1 + \text{Max}\{[f(e_1) - w_1] - D, 0\} \geq w_2 - \dot{e} + \text{Max}\{[f(\dot{e}) - w_2] - D, 0\}. \]  \hspace{1cm} (3.19)

The objective function is the value of the debt. It should be clear that maximizing the value of the firm at time 0 is equivalent to maximizing the value of debt. Equations (3.14) and (3.15) define the minimum effort that the CEO must exert if he selects contracts \((w_1, D)\) in state 1, and \((w_2, R_2)\) in state 2. Equations (3.16) and (3.17) are the CEO’s participation constraint in each state under the proposed contracts. They assure that in each state the CEO is willing to remain in the firm under the contract appropriate for that state.\(^{17}\)

Equation (3.18) defines \(\dot{e}\) as the minimum effort that the CEO must exert if he selects contract \((w_2, R_2)\) when the shock did not occur (state 1). Equation (3.19) is the incentive compatibility constraint. It requires that, in state 1, the CEO must be better off selecting \((w_1, D)\) rather than \((w_2, R_2)\).\(^{18}\) It can be easily shown that the incentive compatibility constraint (equation (3.19)) and the CEO’s participation constraint in the worst state (equation (3.17)) are binding, while the one in the best state (3.16) is not.\(^{18}\) Finally, one can easily show that the “perks” component can be eliminated from the CEO’s utility function.\(^{20}\)

By substituting equation (3.18) into equation (3.15) we determine the value of \(\dot{e}\) as a function of \(e_2\):

\(^{17}\) Note that Equations (3.16) and (3.17) imply that the CEO will be willing to sign the contract at time 0.

\(^{18}\) Actually, we should have a second incentive compatibility constraint to assure that the CEO does not gain by selecting contract \((w_1, D)\) if the true state is the bad one. However, it can be shown that this constraint is not binding. This proof is standard in the incentive literature. Therefore, we will omit it. The interested reader can look at Appendix B for a similar proof in a slightly different context.

\(^{19}\) The proof that the two constraints are binding follows by showing that otherwise we would be able to increase effort a little bit, without violating any constraint. This increases the value of the objective function contradicting the optimality of the initial effort. Finally, one can see that the participation constraint in the best state is not binding by substituting constraint (3.17) (which is binding) in the incentive compatibility constraint.

\(^{20}\) To see this substitute equations (3.14) and (3.15) into equations (3.16), (3.17) and (3.19), and recall that \(R_2 \leq D\).
\[ \hat{e} = f^{-1}[g(e_2)]. \]  

(3.20)

Because \( f(e) \geq g(e) \), with equality only when \( e = 0 \), equation (3.20) implies that the optimal effort, \( e_2^* \), should satisfy

\[ \hat{e} \leq e_2^*, \]  

(3.21)

with equality only when \( e_2^* = 0 \).

After substituting equations (3.14) and (3.15) in the objective function, the original program can be rewritten as

\[ \max_{\{e_i\}} \ (1 - p)[f(e_1) - w_1] + p[g(e_2) - w_2] \]  

(3.22)

\[ \text{s.t. } w_1 = e_1 + (w_2 - \hat{e}) \]  

(3.23)

\[ w_2 = e_2 \]  

(3.24)

\[ \hat{e} = f^{-1}[g(e_2)]. \]  

(3.25)

By substituting equation (3.24) into equation (3.23), we have

\[ w_1 = e_1 + (e_2 - \hat{e}). \]

Therefore, the CEO enjoys control rents equal to \( (e_2^* - \hat{e}) \) in the best state of nature. Moreover, by inequality (3.21), the rent is strictly positive whenever the optimal mechanism induces some effort in the worst state of nature, i.e., \( e_2^* > 0 \). The rent should be seen as the price paid by the shareholders to induce the CEO to select the contract according to the realization of uncertainty.

The F.O.C. (which are also sufficient) are

\[ \frac{df(e_1^*)}{de_1} = 1, \]  

(3.26)

and

\[ \frac{dg(e_2^*)}{de_2} - 1 = \frac{1 - p}{p} \left[ 1 - \frac{dg(e_1^*)}{df(e_1)} \right]. \]  

(3.27)
Simple inspection of equations (3.26) and (3.6) shows that effort is efficient in the case that there is no shock, i.e.

\[ e_1^* = e^*. \]

Nevertheless, profits are suboptimal

\[ \Pi_1^* = D^* = [ \hat{f}(e^*) - e^* ] - (e_2^* - \hat{e}) = \Pi^* - (e_2^* - \hat{e}). \]

Recall that \((e_2^* - \hat{e}) > 0\) whenever \(e_2^* > 0\). In such case \(\Pi_1^* < \Pi^*\). The incentive scheme does not obtain the first best profit level in the good state whenever the CEO enjoys a control rent. This rent is needed to induce the CEO to exert a higher effort level in the good state. Of course the rent is not necessary if the mechanism does not want to induce effort in the worst state, i.e., \(e_1^* = 0\). In this case \((e_2^* - \hat{e}) = 0\), and the mechanism obtains the first best profit at state 1.

The control rent also explains why there will be an inefficient effort level in the event that the shock happens. The optimal incentive scheme asks for a lower effort level in the bad state to reduce the rent. In short, it is too costly for the initial entrepreneurs to allow an incentive scheme that fully adjusts to negative shocks.

The inefficiency can be easily seen as follows. Note that the left hand side (LHS) of equation (3.27) should be equal to zero if \(e_2^* = \bar{e}\).\(^{21}\) However, the right hand side (RHS) of equation (3.27) is strictly positive if \(e_2^* > 0\).\(^{22}\) Then, concavity of \(g(e)\) implies that\(^{23}\)

\[ e_2^* < \bar{e} \quad (3.28) \]

\[ R_2^* < \bar{\Pi} \quad (3.29) \]

Then the optimal incentive scheme, \(((w_1^*, D^*), (w_2^*, R_2^*))\), and the firm's value at time zero are:

\(^{21}\)To see this check that the LHS of equation (3.27) is equal to the first order condition of the first best program in the case that the shock occurred (equation (3.10)).

\(^{22}\)To see this recall that, for any \(e_2^* > 0\), \(\hat{e} < e_2^*\). Then, concavity and the Spence-Mirrlees conditions on \(f(e)\), and \(g(e)\) imply that \(\frac{df}{de} > \frac{df(\hat{e})}{de} > \frac{df(e_2^*)}{de}\).

\(^{23}\)Since \(\bar{e} > 0\), the statement below also follows for \(e_2^* = 0\).
\[(w_1^*, D^*) = (e^* + (e_2^* - f^{-1}[g(e_2^*)]), \Pi^* - (e_2^* - f^{-1}[g(e_2^*)])), \quad (3.30)\]

\[(w_2^*, R_2^*) = (e_2^*, \Pi_2^*) = (e_2^*, g(e_2^*) - e_2^*), \quad (3.31)\]

\[V^*(p) = (1 - p)[\Pi^* - (e_2^* - \hat{e})] + p[\Pi_2^*]. \quad (3.32)\]

Note from equation (3.27) that \(e_2^*\) depends on \(p\). Therefore, \(\Pi_2^*\) and the control rent \((e_2^* - \hat{e})\) also depend on \(p\). Economic intuition suggests that \(\Pi_2^*\), and \(e_2^* - \hat{e}\) should decrease if the probability \(p\) that the shock happens decreases. The idea is that the shareholders should be willing to sacrifice more profits in state 2 to reduce the control rents in state 1 when the likelihood of state 2 decreases. Indeed, this result is proved in Proposition 2 in Appendix A. As a result the deadweight loss in financial distress \((\overline{\Pi} - \Pi_2^*)\) will be larger the smaller the \(ex\ ante\) probability of a bad shock is.

Therefore, one prediction that comes out of this model is that firms with more stable cash flow (low \(p\)) will use high power incentive schemes, and will suffer higher costs of financial distress. In Figure 3-2 we show the relationship between the \(ex\ ante\) probability of a negative shock and the size of the deadweight loss in financial distress. In the graph we use \(f(e) = 2\sqrt{e}\) as production function in the absence of a shock. If the shock occurs, then the production function becomes \(g(e) = \sqrt{e}\). The size of the deadweight loss is expressed as a percentage of the optimal profits in state 2 \((\overline{\Pi})\).

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\(^{24}\)Note that \(f(e)\) and \(g(e)\) satisfy our assumptions.
Figure 3-2: Profit Loss in Financial Distress as a Percentage of the Optimal Profit
3.3 Recontracting

In the previous section we showed that an optimal incentive scheme is inefficient near bankruptcy. This inefficiency is ex-ante optimal because it curbs managerial rents. In this section we analyze how the possibility of recontracting and the existence of Chapter 11 affect our results.

3.3.1 Optimal Recontracting Ex-Post

Given an inefficient incentive scheme, there are two strategies to restore efficiency at time 1: increasing the CEO compensation or forgiving some debt and cutting the CEO compensation. The first strategy consists in resetting the incentive scheme with no consequences on the outstanding debt. For instance, take the incentive scheme of section 3.2. It promises wage $w = e^* + (e_2^* - \delta)$ if the whole debt is repaid, $w = e_2^*$ if creditors collect at least $R_2 = \Pi_2^*$, and $w = 0$ otherwise. If the incentive scheme could be optimally reset (from the perspective of the shareholders or debtholders), the new mechanism would pay $w = \bar{e} > e_2^*$ if $\bar{\Pi} > \Pi_2^*$ is paid to the creditors. Therefore, the new incentive scheme implies an increase in the manager’s compensation when the financial condition deteriorates.

The alternative strategy is that creditors unilaterally reduce the face value of debt. Suppose they could commit to a take it or leave it offer to the manager, where the face value of the debt would be reduced from $D^*$ to $\bar{\Pi}$, and the manager would have his wage reduced (contingent on full debt repayment) from $e^*$ to $\bar{e}$. In principle, the manager should be willing to accept the offer. To see this, note that the optimal effort level in the presence of the shock generates $g(\bar{e})$ in revenues. Therefore, the manager can pay back

$$ R = \bar{\Pi} = g(\bar{e}) - \bar{e}. $$

The manager obtains zero utility by accepting this offer ($w = \bar{e}$). However, if he rejects it he will not gain anything in utility terms. Therefore, an infinitesimal bonus should convince him to accept the take it or leave it offer.

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25If he pays at least $R_2 = \Pi_2^*$ he will receive wage $w = e_2^*$ for effort equals to $e_2^*$. Otherwise, he will receive nothing and will not exert any effort. In both cases his utility is zero.
3.3.2 Problems in Recontracting

If shareholders can trust future bondholders to implement one of the above mechanisms if and only if the negative shock occurs, then they can avoid financial distress. However, there are some problems with this happy solution. First, creditors have no saying inside a corporation before default. In addition, if they succeed in having some influence, they will try to avoid controversial actions (like increasing managerial compensation) to avoid a potential liability towards other creditors (see Hambrecht Douglas-Hamilton, 1975). Therefore, in the current legal environment the first way out from financial distress is not available, independently whether creditors are dispersed or not. On the other hand, the second solution is available only if creditors are not dispersed. Remember that the second solution implies some debt forgiveness. Therefore, if creditors are dispersed they will have the incentive to free ride on the other creditors’ forgiveness, reaping the benefits of the debt relief without paying the costs.

Nevertheless, the manager could use an exchange offer to force the debt reduction. In an exchange offer the incumbent manager offers to debtholders a new debt contract, with a smaller face value but higher seniority, in exchange for the old one. These offers are designed in such a way to overcome the free rider problem among dispersed debtholders without violating the Trust Indenture Act.\textsuperscript{26}

Indeed, exchange offers were a great success in the 1980s, avoiding financial distress in many companies at that time. However, exchange offers disappeared after 1990 when a bankruptcy court sentence greatly reduced its attractiveness. It was ruled\textsuperscript{27} that in case of bankruptcy the claim of shareholders who exchanged is equal to the market value of the debenture at the time of the exchange, and not its face value. This rule penalizes the debtholders who exchanged because the market value of the debenture is generally substantially lower than the face value. In the same year the tax treatment of exchange offers became less favorable.

In the above discussion we did not consider the possibility that a manager tries to use exchange offers to reduce the face value of debt when it is not needed. In our model this strategy would not work because the shock is observable. Under this assumption not

\textsuperscript{26}This transaction was known as the “3(a)9 exchange offer”. See Gertner and Scharfstein (1991) for further details. The Trust Indenture Act requires the consent of all debtholders to allow for changes of principal, interest rate and maturity of a public debt.

\textsuperscript{27}See the LTV bankruptcy case.
accepting the offer is a weakly dominant strategy for any debtholder. However, this is not true if the debtholder cannot observe the shock. In this case there is scope for the manager to obtain a debt reduction when the shock did not happen. This would force the founders to increase the CEO’s control rents, if they want to avoid a needless default. In this case there would be a trade off between the increase of efficiency and the increase of the control rents.\(^{28}\) Therefore, it is not a priori clear if exchange offers are desirable in the presence of asymmetric information.

3.3.3 Chapter 11

One could argue that bankruptcy courts provide a solution to the recontracting problems pointed out in the previous subsection. A bankruptcy court can overcome free riding problems, or the fear of legal suits, enabling the optimal reset of incentive schemes or the optimal debt reduction. Nevertheless, to eliminate the costs of financial distress managers would have to file for Chapter 11 early enough. However, it is not a priori clear whether the managers have the correct incentives to do so. In other words, it could be too expensive for the shareholders to provide the managers the incentives for an early filing.

We want to model Chapter 11 in the simplest possible way to capture two main features: the disciplinary role, and the widespread belief that Chapter 11 is not a perfect renegotiation mechanism. Therefore we assume that when a firm files for Chapter 11 at time 1 the incentive scheme is optimally reset with probability \(r < 1\). If the court fails to write a new incentive scheme we assume that the existing one is maintained.\(^{29}\) If the incentive scheme is optimally reset, by construction, the manager is put on his participation constraint. In this case he loses any control rents. This captures the monitoring role. On the other hand, this happens only with probability \(r < 1\). Therefore, the court is not perfect. Actually, we can allow it to be very inefficient by setting \(r\) close to zero.\(^{30}\)

This subsection proceeds as follows. We first prove that the introduction of Chapter 11

\(^{28}\)Bolton and Scharfstein (1992) formalize this trade-off.

\(^{29}\)Note that we are implicitly assuming that the founders cannot implement a new incentive scheme contingent on filing for Chapter 11. It is true that the incumbent manager has six months to propose a reorganization plan, however this cannot be implemented without the creditors approval. The judge would block any attempt to reorganize the company while the court is still seeking for the best strategy.

\(^{30}\)Note that we are discussing the effects of an early filing for Chapter 11. In practice firms do not file very early. This would correspond in our model to not filing at all. The manager would wait until the end of period 2 when the collapse of the incentive scheme already happened. The effects of Chapter 11 procedures in these late moments are very different, and we will not address them in this context. Our objective here is to explain whether Chapter 11 may be effective in preventing the collapse of the incentive scheme.
alone does not make the shareholders worse off. Then, we prove that shareholders are actually better off if the founders induce managers of distressed firms to file for Chapter 11. Finally, we show how private benefits of control explain why we do not see companies filing for Chapter 11 very early.

The Effects of the Introduction of Chapter 11

Here we prove that giving the manager an option of filing for Chapter 11 does not alter the incentive compatibility constraint of the program designed in Section 3.2. To see this take any incentive scheme \((w, e)\) applicable for a firm that will default on its debt. Under this incentive scheme, the manager’s utility if he does not file for Chapter 11 is \(w - e + \max\{|g(e) - w| - D, 0\}\). On the other hand, if he files he gets \((1 - r)(w - e + \max\{|g(e) - w| - D, 0\})\leq w - e + \max\{|g(e) - w| - D, 0\}\). Therefore, this new option will not alter \(ex\ post\) the incentive compatibility constraint.

As a result if the founders do not want to use Chapter 11 they have to do nothing. In this case the optimal incentive scheme is still the one computed in section 3.2. The value of the firm will be unchanged at

\[
V'(p) = (1 - p)[\Pi' - (e_2' - \hat{e})] + p[\Pi'_2].
\]  
\text{(3.33)}

The Optimal Mechanism that Uses Chapter 11

The intuition deriving from the previous discussion suggests that in order to induce the manager to file for Chapter 11 shareholders have to pay him a bonus, \(S\). This bonus should compensate the manager for the expected loss of the control rents due to a possible optimal resetting of the incentive scheme in Chapter 11. The most natural way to pay \(S\) is to promise a bonus at time 2 (on the top of \((w, e)\)), when the company emerges from Chapter 11. In this way the company gives the correct incentives for the manager to stay in the company, instead of cashing the bonus and quitting.\(^{32}\)

\(^{31}\) Recall that with probability \(r\) the incentive scheme is optimally reset. In this case the manager’s utility will be zero.

\(^{32}\) From Gilson and Vetsuypens (1992) we learn that this type of bonus is fairly frequent in Chapter 11.
\[ S = r(w - e + \text{Max} \{ [g(e) - w] - D, 0 \}). \]  \hspace{1cm} (3.34)

However, the founders can choose a very low \( w \) to force the manager to file for Chapter 11 in case a negative shock happens. In this case, the optimal contract should make sure that the manager is put in his participation constraint when the shock occurs and he files for Chapter 11. In addition, the optimal contract should guarantee that the manager does not have the incentive to file for Chapter 11 when the shock does not occur. In Appendix B we show that the optimal mechanism solves:\textsuperscript{33}

\[ \text{Max}_{\{w_i,e_i\}} \left( 1 - p \right) (f(e_1) - w_1) + p[(1 - r)(g(e_2) - w_2 - S) + r\Pi] \]  \hspace{1cm} (3.35)

\[ \text{s.t. } w_1 = e_1 + (1 - r)(e_2 - \hat{e}^{11}) \]  \hspace{1cm} (3.36)

\[ w_2 = 0 \]  \hspace{1cm} (3.37)

\[ S = e_2 \]  \hspace{1cm} (3.38)

\[ \hat{e}^{11} = f^{-1}[g(e_2)]. \]  \hspace{1cm} (3.39)

Equation (3.35) is the expected value of the debt at time 0. With probability \( 1 - p \) the shock does not happen, and profits are equal to \( (f(e_1) - w_1) \). With probability \( p \) the shock occurs and the manager is induced to file for Chapter 11 by the bonus \( S \). Under Chapter 11, the incentive scheme will be optimally reset with probability \( r \) implying that \( \Pi \) will be paid to the creditors. In all the other cases (probability \( (1 - r) \)), the incentive scheme is not reset, and the manager stays under the old incentive scheme \( (w_2, R_2) \), implying that \( R_2 - S \) will be paid to the creditors.

Equation (3.36) is the incentive compatibility constraint. It assures that in the good state the CEO is better off choosing contract \( (w_1, D) \) instead of going to Chapter 11, and getting control rents \( e_2 - \hat{e}^{11} \) with probability \( 1 - r \). Equation (3.37) punishes the manager as much as possible if he does not go to Chapter 11. Finally, equation (3.38) puts the manager in his participation constraint in Chapter 11. Note that we do not allow the effort to be contingent on Chapter 11, i.e., the effort outside Chapter 11 is equal to the one that

\textsuperscript{33}By the same reasons given in section 3.2, we can eliminate the perks component from the manager’s utility function.
prevails in Chapter 11 if the judge does not succeed in implementing the first best.

The F.O.C. (which are also sufficient) are

\[
\frac{df(e_1^{11})}{de_1} = 1, \tag{3.40}
\]

and

\[
\frac{dg(e_2^{11})}{de_2} - 1 = \frac{1 - p}{p} \left[ 1 - \frac{dg(e_1^{11})}{df(e_1^{11})} \right]. \tag{3.41}
\]

Simple inspection of equations (3.40), (3.41), (3.26), and (3.27) shows that the effort levels are the same of the case without Chapter 11. There is no inefficiency if there is no shock \((e_1^{11} = e^\ast)\). And there is an inefficiently low effort level when the shock happens and the bankruptcy court does no reset the incentive scheme: \(e_2^{11} = e_2^\ast < \bar{e}\).

Moreover, it can be easily checked that the managerial control rents are lower than in the case without Chapter 11. From equation (3.36): \((1 - r)(e_2^{11} - \hat{e}^{11}) = (1 - r)(e_2^\ast - \hat{e}) < e_2^\ast - \hat{e}^\ast\), for any \(r > 0\). Therefore, the firm's value under Chapter 11 is

\[
V^{11}(p,r) = (1 - p)[\Pi^* - (1 - r)(e_2^\ast - \hat{e})] + p[(1 - r)\Pi_2^* + r\Pi]. \tag{3.42}
\]

Simple inspection of equations (3.33) and (3.42) shows that the existence of Chapter 11 makes the shareholders better off. Shareholders gain \(r[(e_2^\ast - \hat{e}) + (\Pi - \Pi_2^*)]\) by inducing the manager to file for Chapter 11. Equation (3.33) also shows that if the court can reset the incentive schemes with probability 1 \((r = 1)\), then the first best is achieved.

**The Effects of Private Benefits of Control**

If the previous model were an accurate description of reality we should see any company close to default filing for Chapter 11. However, this seems far from reality. An often heard claim is that managers do not like to file for Chapter 11 until they are forced to do. This is consistent with the findings of Gilson (1989), who shows that managers are penalized if their company goes bankrupt. Therefore, there should be an additional cost in filing for Chapter 11 that we did not take into account. In this section we shall show that non pecuniary private benefits of control may be the missing element.

In this subsection we consider that managers enjoy private benefits, \(B\), while running
their firms, and that they lose them by filing for bankruptcy.\footnote{After filing for bankruptcy a manager must submit major decisions to the claimholders’ approval, so he loses effective control on the company’s decisions. As a consequence he loses his private benefits of control.} The introduction of private benefits implies an additional component in the manager’s utility function, which is now written as

\[ U(w, e, D) = (w - e) + \max \{ \Pi(e, w) - D, 0 \} + B.1[O], \]

where \( 1[O] \) is an indicative function that takes value 1 if the company stays out of Chapter 11 at time 1, and 0 otherwise.

In principle, the founders could take advantage of the \textit{ex ante} competition for managerial jobs to extract from the managers the value of private benefits. For example, they could reduce the manager’s wage by \( B \) in each state of nature. However, this solution is not time consistent. After being hired, the manager can choose 0 effort, and then he will get \( B \) in utility terms anyway. Therefore, in practice the introduction of private benefits increases the incumbent manager’s reservation utility from 0 to \( B \). The only alternative for the founders would be to charge an “entrance fee” from the manager at time 0. However, we are assuming that managers are credit constrained. Therefore, the introduction of \( B \) alone does not change the incentive compatibility constraints of the program that picked the contract of section 3.2 as an optimum.

As a result if the founders do not want to use Chapter 11 the value of the firm will be unchanged at

\[ V'(p) = (1 - p)[\Pi^* - (e_2 - \hat{e})] + p[\Pi_2]. \quad (3.43) \]

The major difference arises when the founders want to use Chapter 11. In such case the bonus necessary to induce a Chapter 11 filing should compensate the manager for his effort, \( e_2 \), (recall that \( w_2^1 = 0 \) to force the manager to file for Chapter 11 as cheaply as possible) and for the loss of private benefits. Moreover, the bonus should take into account that in case the court optimally resets the incentive scheme the manager will be compensated for his effort, but not for the loss of the private benefits. Therefore, \( S \) is given by

\[ S = \frac{B}{1 - r} + e_2. \quad (3.44) \]
By recomputing the optimal mechanism with this new constraint we obtain as value of the firm

\[ V^{11}(p, r) = (1 - p)[\Pi^* - (1 - r)(e_2^* - \hat{e}^*)] + p[(1 - r)\Pi_2^* + r\Pi] - pB. \]  

(3.45)

Now we are ready to discuss in a meaningful way the costs and benefits of Chapter 11. Filing for Chapter 11 costs the founders a bonus equal to \( B \). The expected cost is \( pB \). On the other hand, by inducing a filing founders can increase the expected value of the company. This trade-off can be formalized by comparing equations (3.45), and (3.43). Chapter 11 will be used if and only if

\[ pB \leq p\tau[\Pi - \Pi_2^*] + (1 - p)r[e_2^* - \hat{e}]. \]  

(3.46)

where the LHS is the expected cost, and the RHS the increase in profits. Note that the RHS is equal to zero for \( r \) equal to zero. Therefore, the real trade off is between the efficiency of the court and the loss of private benefits.

In summary, Chapter 11 increases shareholders' value because it allows for renegotiation and it decreases managerial rents. On the other hand, it also imposes the loss of private benefits on the shareholders. It then follows that the founders will not be willing to compensate the manager for the loss of private benefits if the expected efficiency gains (which depends on the court's efficiency) is not large enough.

A policy implication of the above analysis is that bankruptcy law should let creditors decide when to file. In fact, the latter do not have to compensate the manager for the loss of private benefits. Our analysis also shows that an increase of the likelihood of an optimal resetting of incentive schemes enhances efficiency, and deters managers from seeking default for self interested reasons.

3.4 Empirical Implications

 Independently of the \textit{ex ante} optimality of renegotiation our model has some predictions on the forms this renegotiation should take. Any successful recontracting should involve an increase in managerial compensation or a reduction in debt. In particular, if a company has a large shareholder it should be less prone to financial distress. Near default the large
shareholder should change the managerial incentive scheme increasing the wage for a given debt repayment. In the absence of a large shareholder, managers should prefer exchange offers. If these are not feasible, then renegotiation should take the form of debt forgiveness with a voluntary reduction in the manager's compensation.

Gilson and Vetsuypens (1992) study a sample of firms that survived a period of financial distress. Consistent with our model, they find that changes in managerial compensation are more likely when a large shareholder is present. They also find that stock options are reset at a lower strike price and sometimes the manager's compensation is explicitly tied to the amount of debt repaid. Furthermore, the replacement of a CEO is generally followed by a substantial pay raise. This fact cannot be attributed to the use of highly paid turnaround specialists. In fact, they represent only 7% of the new CEOs, and their compensation is not statistically higher than the one of non specialists.

Gilson and Vetsuypens also regress the change in the CEO salary on the percentage of equity allocated to creditors at the end of the debt restructuring. If we consider that creditors accept equity as a form of debt reduction, then our theory of the trade-off between salary increase and debt reduction predicts a negative effect of the percentage of equity owned by creditors on the change of CEO wage. This is exactly what they find.

Our model predicts that financial distress is necessary to curb managerial rents in the absence of an outside monitor. However, when outside monitors do exist and when they have a better access to a firm's management, then the prospect of a default should not produce a collapse of the incentive scheme. Therefore, it comes as no surprise that Hoshi, Kashyap and Scharfstein (1990) find that in Japan companies belonging to a group perform better close to bankruptcy. Consistently with what we say they also find that "groups do not just infuse money, ... they also actively try to restructure the company."

It is also often claimed that Japanese companies in general suffer less when they are in poor financial conditions. This claim is consistent with the much larger use of leverage in Japan. This result can be explained by creditors' ability to step in earlier in the process, reset the incentive schemes and so avoid the deadweight costs of financial distress. The effectiveness of this intervention has been proven by Kaplan and Minton (1992). They find that banks intervene in the management of poorly performing companies especially when there is a need of downsizing. A bank's appointee also performs a disciplinary role with respect to the troubled company management. In the presence of such effective monitors,
financial distress is no longer necessary.

3.5 Conclusions

We presented a model where financial distress arose endogenously in companies that suffered an economic downturn. Financial distress takes the form of a collapse of the existing managerial incentive schemes. This collapse is *ex ante* optimally chosen in the shareholders' interest to curb managerial rents from control.

We believe that this chapter contributes to the debate on financial distress in at least two ways. First, our model broadens the horizons of the debate: financial distress is not just an investment problem but a more fundamental organizational problem. Near default a firm's incentive scheme becomes inadequate, as a result the best employees tend to leave, and the ones who remain lack proper motivation. The work of Gilson and Vetsuypens (1992) provides support to our predictions. However, more empirical work is needed. We still know very little about the relationship between debt and managerial incentives.

Second, the chapter proves that financial distress is a necessary evil. Removing the costs of financial distress without alleviating the underlying agency problem would be like jumping from the pan to the fire. The distortion in effort is necessary to reduce managerial rents. Any rethinking of the bankruptcy law should keep this aspect in mind.

We also believe that the model itself is somehow interesting. To our knowledge it is the first model that jointly considers debt and incentive schemes. In future research we plan to extend it to analyze optimal capital structure and dividend policy. The model also provides an intuition for the role of large banks belonging to industrial groups. In the future we hope to develop these ideas into a theory of cross-shareholdings among banks and manufacturing companies.
3.6 Appendix A: The Optimal Mechanism

So far we did not consider default costs. This assumption implies that the debt level could be adjusted to support the optimal incentive schemes without any cost. This is not realistic, because default imposes costs that are not necessarily related to the internal organization. In this appendix we prove that the debt level and the incentive schemes of section 3.2 are optimal for reasonable values of default costs. But first we clarify what we mean by default costs.

Consistent with section 3.2 we assume that renegotiation with creditors is impossible. Therefore, whenever the debt is larger than the maximum feasible repayment the company is liquidated at cost $C$. We have in mind a value for $C$ between 1% and 7% of the value of the assets. This is Weiss' (1990) estimation of the legal and administrative costs of a bankruptcy procedure. Most of these costs are fees paid to lawyers, and investment bankers. We also assume that $C$ is born when the company is not liquidated, but it needs a refinancing. In the same spirit, lawyers and investment bankers will be hired to help in the restructuring. Therefore, $C$ will also be born.\(^{35}\) We consider mechanisms that impose debt levels $D_1^*$, and $D_2^*$ due at time 1 and time 2, respectively, and a wage schedule $w^*(R)$ which depends on the debt repayment, $R$.\(^{36}\) In this appendix we do not consider the possibility of the manager filing for Chapter 11 at time 1.

We can simplify the solution of the optimal mechanism by partitioning the opportunity set in two subsets. The first subset comprises mechanisms that force default in the end of the first period. They can be implemented by choosing $D_1^* > 0$, since there is no cash generation in the first period.\(^{37}\) These strategies succeed to eliminate all managerial discretion, since, after default, the debtholders can liquidate the firm and the new owners can reset the incentive scheme according to the realization of uncertainty.\(^{38}\)

The problem with these mechanisms is that they impose the default cost $C$, even when there is no need, i.e., when the negative shock did not happen. This cost is actually born

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\(^{35}\) Those who feel uncomfortable in accepting that the costs of refinancing and liquidation are the same could think of $C$ as the minimum of the two.

\(^{36}\) A priori we allow full generality for the schedule, i.e., it can depend on total repayment, and also on the repayment at each period.

\(^{37}\) Actually, we also need a total debt level $D_1^* + D_2^*$ large enough such that the manager cannot refinance $D_1^*$.

\(^{38}\) Recall that we assumed that the technological shock is observable. Therefore the debtholders or the new owners can implement the correct incentive scheme.
by the initial entrepreneurs who have to compensate the debtholders for the future cost by accepting a higher interest rate in the loan.\footnote{In our model the interest rate is charged through a discount in the face value of the debt. For instance, the debtholders will be willing to pay only $\Pi^* - C$ at time 0 for a claim of $\Pi^*$ at time 1 that will be collected only after default. The discount $C$ should be seen as an increase in the interest rate to compensate for the default cost.}

In short, there is a trade-off in the "liquidation strategy". On the one hand it assures efficient effort by forcing the resetting of the incentive schemes after the shock. On the other hand, it imposes the default cost on shareholders. For this reason we will also consider the complementary partition, i.e., the mechanisms that do not allow for bankruptcy at time 1. The optimal mechanism will be found by comparing the highest value of the firm at time 0 under each partition.

\textbf{A.1 Mechanisms that Do Not Allow for Bankruptcy at Time 1}

In this case $D_i^* = 0$. Therefore, our problem reduces to solve $(D_2^*, w^*(R))$. Moreover, since there are only two states of nature we can write the mechanism as $(D_2^*, \{(w_i^*, R_i^*)\}_{i=1}^2)$. In words, the founders choose the debt level $D_2^*$ that is due at time 2, and a menu of incentive schemes, where the manager is paid $w_i^*$ if the creditors are paid $R_i^*$.

\textbf{Proposition 1} The optimal repayment in the best state is equal to the optimal debt level due at time 2, i.e. $R_i^* = D_2^*$.

\textbf{Proof:} The optimal repayment in state 1 cannot be lower than the face value of the debt, i.e., $R_i^* \geq D_2^*$. Otherwise shareholders would face the default cost $C$ for nothing. On the other hand, the manager will never pay more than what is required by the debt contract, therefore $D_2^* \geq \max\{R_i^*, R_2^*\}$. Then, it follows that $R_i^* = D_2^*$. \hfill $\Box$

We will solve the optimal incentive scheme in two steps. First, we compute the value of the debt when $R_2 = R_1 = D_2^*$, i.e., the strategy avoids bankruptcy in any state. Then, we solve the program for the cases where there will be bankruptcy in the second period if the negative shock occurs, i.e., $R_2 < R_1$. By comparing the value of the firm under the two strategies we obtain the optimal incentive scheme that does not allow for default at time 1.

\textbf{A.1.1 The Safe Debt Strategy}

The maximum level of safe debt is $\Pi^*$.\footnote{This is the first best profit in case the shock happens at time 1.} Clearly, the optimal incentive scheme $\{(w_i^*, R_i^*)\}$
that assures full repayment in any state of nature is given by \((\overline{w}, \overline{\Pi})\), for any \(i\), with \(D^*_i = \overline{\Pi}\).

The value of the firm at time 0 under this incentive scheme is given by\(^{41}\)

\[
V^* = \Pi. \tag{3.47}
\]

**A.1.2 Risky Debt Strategies**

Now we restrict our attention to mechanisms where \(D^*_2 = R^*_1 > R^*_2\). However, this is exactly the problem solved in section 3.2.2 except for the default cost \(C\). Nevertheless, a constant does not change a program’s solution. Therefore, the value of the firm at time 0 under this incentive scheme is given by

\[
V^r(p) = (1 - p)[\Pi^* - (e^*_2 - \hat{e})] + p[\Pi^*_2 - C]. \tag{3.48}
\]

**Proposition 2** The maximizer \(e^*_2\) is strictly increasing and differentiable on \(p\). This is also true for \(\Pi^*_2\) and the control rent \(e^*_2 - \hat{e}\). Therefore, the deadweight loss, \((\Pi^* - \Pi^*_2)\), will be larger the smaller the ex ante probability of a bad shock is.

**Proof:** Implicitly differentiating \(e^*_2\) with respect to \(p\) in equation (3.27):

\[
\frac{de^*_2}{dp} = \frac{-\frac{dg(e^*_2)}{de^*_2}[1 - \frac{1}{\frac{df(\Pi)}{de^*_2}}]}{\frac{p^{2g(e^*_2)}}{de^*_2} + (1 - p)\frac{d\frac{df(\Pi)}{de^*_2}}{de^*_2}}.
\]

Note that the denominator is the second order condition of the maximization program, which is negative by concavity of \(g(\cdot)\). Therefore, by the Implicit Function Theorem, \(e^*_2\) is differentiable with respect to \(p\). On the other hand, the numerator is also negative since the marginal productivity is positive, and \(\frac{df(e)}{de} > 1\). This last inequality follows from concavity of \(f(e)\), and \(\hat{e} < e^*\) with \(\frac{df(e^*)}{de} = 1\). Therefore, \(\frac{de^*_2}{dp} > 0\). Continuity of \(\Pi^*_2\) and \((e^*_2 - \hat{e})\) follows from the fact that they are continuous functions of \(e^*_2\). Actually, one can easily check that they are both differentiable with respect to \(p\). Since \(e^*_2 \leq \overline{e}\), concavity of \(g\) implies that

\(^{41}\)We assumed that the initial managers are liquidity constrained. Therefore, they cannot pay in advance the expected rent they may obtain under this mechanism. One could argue that they could pay through a reduced wage at time 2. This is not a contradiction if we interpret liquidity constraints as an extreme form of risk aversion. A highly risk averse manager would not be willing to pay anything for an uncertain prospect of getting \(\Pi^* - \overline{\Pi}\) at time 1.
profits decrease when effort decreases. Therefore, \( \frac{de_2^*}{dp} > 0 \) implies that \( \frac{d\Pi_2^*}{dp} > 0 \) as well. To see that the control rent is increasing on \( p \) note that

\[
\frac{d(e_2^* - \hat{e})}{dp} = \frac{de_2^*}{dp} \left[ 1 - \frac{d(e_2^*)}{de_2} \right]. \tag{3.49}
\]

Equation (3.49) is strictly positive because the first term is positive (as shown above), and the second term is also positive by the Spence-Mirrlees condition (see footnote on page 94).

By comparing equations (3.47) and (3.48) we obtain that using risky debt is better than safe debt if and only if:

\[
(1 - p)[\Pi^* - (e_2^* - \hat{e}) - \overline{\Pi}] \geq p[C + (\overline{\Pi} - \Pi_2^*)]. \tag{3.50}
\]

The intuition for equation (3.50) comes from the comparison of the inefficiency loss of each strategy. The right hand side (RHS) is the expected cost of the risky strategy when compared to the safe one. With probability \( p \) the shock happens. In this case the company defaults, losing \( C \). Moreover, the incentive scheme distorts effort in such event imposing a loss of profitability when compared to the first best. This is captured by \( (\overline{\Pi} - \Pi_2^*) \). On the other hand, the LHS is the expected cost of the safe strategy when compared to the risky one. The safe strategy has a lower profitability because the debt is not high enough to force the CEO to disgorge the cash in the best scenario.

**Proposition 3** For any \( C > 0 \), there exists a probability \( p^0 > 0 \), which depends on \( C \), such that for any \( p \leq p^0 \), the optimal strategy that allows for bankruptcy only when the shock appears dominates the safe debt strategy.

**Proof:** The proof follows by showing that both sides of inequality (3.50) are continuous on \( p \), and that the inequality is strict when \( p \to 0 \). To prove continuity observe that the RHS and the LHS of inequality (3.50) are continuous functions of \( e_2^*(p) \), which is also continuous on \( p \) by Proposition 2. One can easily check that \( e_2^*(0) = 0 \). Therefore, continuity of \( e_2^*(p) \) implies that \( \lim_{p \to 0} e_2^*(p) = 0 \). Since \( \Pi_2^* \) is a continuous function of \( e_2^* \), it follows that \( \lim_{p \to 0} \Pi_2^*(p) = \Pi_2^*(e_2^*(0)) = 0 \). Therefore the limit of inequality (3.50) when \( p \) converges to zero is:

\[
[\Pi^* - \overline{\Pi}] > 0. \tag{3.51}
\]

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Then, continuity of inequality (3.50) implies that there exists a sufficiently low $p^0 > 0$ such that for any $p \leq p^0$, $V^*(p) > V^*(p)$. □

A.2 Mechanisms that Allow for Bankruptcy at Time 1

The advantage of inducing liquidation at the end of the first period is to force the resetting of the incentive scheme at the occurrence of the shock. In this way you succeed in eliminating any control rent and in attaining a first best effort level. The disadvantage of this strategy is that default imposes the cost $C$ too frequently.

Consider the following mechanism:

- Founders impose debt equal to $\Pi^*$ due at time 1.

- The CEO’s compensation is to be negotiated with the creditors at time 1.

This mechanism clearly forces default. At time 1 the creditors will take over the firm, or they will refinance the debt. In both cases the creditors have the correct incentives, and the authority, to implement the first best incentive scheme after bearing the default cost $C$. It follows that the firm’s value at time 0 under this mechanism is

$$V^l(p) = \Pi^* - C + (1 - p)\Pi^* + p\Pi.$$  (3.52)

Note that the first best value of the firm is obtained except for the liquidation cost $C$. Any strategy that leads to default at time 1 with probability 1 bears this cost. Therefore, the above strategy is an optimal incentive scheme in this class.

By comparing the value of the firm under the risky debt strategy (equation (3.48)) and the forced liquidation strategy (equation (3.52)), we have that risky debt is preferred if and only if

$$(1 - p)[C - (\epsilon_2^* - \hat{\epsilon})] \geq p[\Pi - \Pi^*_2].$$  (3.53)

The LHS is the expected benefit of the risky strategy when compared to forced liquidation. With the risky debt you save the default cost $C$ when there is no shock (probability $1 - p$). But the manager enjoys a control rent $(\epsilon_2^* - \hat{\epsilon})$, which must be subtracted from the benefit. The RHS is the expected cost of the risky strategy. With probability $p$ the shock happens and the company will have suboptimal profits at time 2 contrary to forced
Proposition 4. For any $C > 0$, there exists a probability $p^1 > 0$, which depends on $C$, such that for any $p \leq p^1$, the optimal strategy that allows for bankruptcy only when the shock appears dominates forced liquidation.

Proof: The proof follows the one given for Proposition 3. It suffices to show that both sides of inequality (3.53) are continuous on $p$, and that the inequality is strict when we take the limit of $p$. By Proposition 2 $e^*_2$ is continuous on $p$. Since the RHS and the LHS of inequality (3.53) are continuous functions of $e^*_2$, they are also continuous on $p$. Recalling that $\lim_{p \to 0} e^*_2(p) = 0$, we obtain that the limit of inequality (3.53) when $p \to 0$ is given by

$$C > 0. \quad (3.54)$$

□

When inequalities (3.50) and (3.53) are simultaneously satisfied, the debt level and the incentive scheme computed in section 3.2 form an optimal strategy.

Proposition 5. For any $C > 0$, there exists a probability $\overline{p} > 0$, which depends on $C$, such that for any $p \leq \overline{p}$, the risky debt strategy $\{D^*_2, (w^*_i, R^*_i)\}$ is optimal.

Proof: Take any $C > 0$, and let $\overline{p} = \text{Min}\{p^0, p^1\}$, where $p^0$ is defined in Proposition 3, and $p^1$ is defined in Proposition 4. Then for any $p < \overline{p}$, conditions (3.50) and (3.53) are simultaneously satisfied. □

To show that conditions (3.50) and (3.53) can be satisfied for reasonable parameters we provide a numerical example.

Example 1: The production functions are $f(e) = 2\sqrt{e}$, and $g(e) = \sqrt{e}.^{42}$ We also assume that the probability $p$ that the shock occurs is 0.2. By using these values we obtain $(\Pi^*, e^*) = (1, 1)$, $(\overline{\Pi}, \overline{e}) = (0.25, 0.25)$, $(\Pi^*_2, e^*_2) = (0.109, 0.016)$, and $(\Pi^*_1, e^*_1) = (0.99, 1)$. The difference between $\Pi^*$ and $\Pi^*_1$ is due to the CEO’s control rent, which is equal to 0.01.

By replacing these numbers in conditions (3.50) and (3.53) we find that risky debt is preferable to safe debt if and only if $0.046 \leq C \leq 2.813$.

Note that $f(e)$ and $g(e)$ satisfy our assumptions.
Suppose $C = 0.046$. Then the strategy of section 3.2 is optimal. The debt level due at time 2 is $D_2^* = 0.99$. The CEO's compensation at time 2 will be 0.015, provided the creditors are paid 0.105, and 1.01 if the debt is fully paid at time 2. Under this incentive scheme, any adverse shock that makes impossible for the CEO to meet the debt payment will be followed by an inefficiently low effort level. The inefficiency creates a deadweight loss equals to

$$\frac{II - II^*}{II} = 0.58.$$ 

Therefore, a default cost amounting to 4.6% of the debt, can lead to a loss of 58% of the potential cash flow. Note that 4.6% of the debt is consistent with Weiss' (1990) estimates of the legal costs in a bankruptcy procedure.\(^4^3\)

\(^{43}\)Weiss measures the value of a firm's assets before bankruptcy as the sum of book value of debt plus market value of equity. In our model the face value of debt is 0.99, and the market value of equity is zero. Therefore, $\frac{0.44}{0.99} = 0.046$. 

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3.7 Appendix B: The Optimal Mechanism under Chapter 11

In this appendix we solve the optimal mechanism that induces the manager to file for Chapter 11 at time 1 when the negative shock happens. A feasible mechanism will be characterized by a set \{\( (w_1, D), (w_2, R_2), S \)\}, where \( (w_1, D) \) is the incentive scheme in case the debt is fully repaid, \( (w_2, R_2) \) is the incentive scheme in case the debt is not fully repaid, and \( S \) is the bonus paid to the manager to file for Chapter 11. The optimal mechanism solves

\[
\begin{align*}
\text{Max}_{\{(w_1, D), (w_2, R_2), S\}} & \ (1-p)D + p[(1-r)(R_2 - S) + r(\Pi)] \\
\text{s.t.} & \quad D = f(e_1) - w_1 \\
R_2 & = g(e_2) - w_2 \\
w_1 - e_1 + \text{Max}\{[f(e_1) - w_1] - D, 0\} & \geq 0 \\
(1-r)(w_2 - e_2 + S + \text{Max}\{[g(e_2) - w_2] - S - D, 0\}) & \geq 0
\end{align*}
\]

\[
(1-r)(w_2 - e_2 + S + \text{Max}\{[g(e_2) - w_2] - S - D, 0\}) \geq w_2 - e_2 + \text{Max}\{[g(e_2) - w_2] - D, 0\}
\]

\[
R_2 = f(\hat{e}^{11}) - w_2
\]

\[
w_1 - e_1 + \text{Max}\{[f(e_1) - w_1] - D, 0\} \geq w_2 - e^{11} + \text{Max}\{[f(\hat{e}^{11}) - w_2] - D, 0\}
\]

\[
w_1 - e_1 + \text{Max}\{[f(e_1) - w_1] - D, 0\} \geq (1-r)(w_2 - e^{11} + S + \text{Max}\{[f(\hat{e}^{11}) - w_2] - S - D, 0\})
\]

\[
D = g(\hat{e}^{11}) - w_1
\]

\[
(1-r)(w_2 - e_2 + S + \text{Max}\{[f(e_2) - w_2] - S - D, 0\}) \geq w_1 - e^{11} + \text{Max}\{[f(\hat{e}^{11}) - w_1] - D, 0\}.
\]

Equation (3.55) is the expected value of the debt at time 0. With probability \( p \) the
shock happens, and the manager is induced to file for Chapter 11 through the bonus $S$. You should think of $S$ as a debt that the company has with the manager, which will be paid when the firm goes out of Chapter 11, if the other creditors are paid at least $R_2 - S$. Under Chapter 11, the incentive scheme will be optimally reset with probability $r$ implying that $\Pi$ will be paid to the creditors.\(^{44}\) However, with probability $(1 - r)$ the incentive scheme is not reset, and the manager stays under $(w_2, R_2)$ implying that $R_2 - S$ will be paid at time 2.

Equations (3.58) and (3.59) are the manager's participation constraint in the good and bad state respectively. Equation (3.60) is an incentive compatibility constraint. It assures that, in the bad state, the manager is better off filing for Chapter 11.

Equation (3.61) defines the minimum effort, $c_1^1$, that the manager must exert if the shock did not appear, but he selects contract $(w_2, R_2)$ and goes to Chapter 11. Note that this definition also applies if the manager does not file for Chapter 11. Equation (3.62) is the second incentive compatibility constraint. It assures that, in state 1, the manager prefers to select contract $(w_1, D)$ rather than $(w_2, R_2)$, and staying out of Chapter 11. In the same way, equation (3.63) assures that the manager prefers $(w_1, D)$ rather than $(w_2, R_2)$, and filing for Chapter 11.

Equation (3.64) defines the minimum effort, $c_1^1$, that the manager must exert if the shock appeared, but he selects contract $(w_1, D)$. Equation (3.65) assures that this is not worth for the manager.

We solve this program by forgetting for a while the last incentive compatibility constraint (3.65). Later we check if the solution of the relaxed program satisfies it. The relaxed program will be solved by proving which constraints are binding, and which are not. These intermediate steps will be shown through a sequence of Lemmas.

**Lemma 1** The 'perk component' in the manager's utility function is always equal to zero. Therefore, it can be eliminated from the constraints.

**Proof:** From equations (3.59) and (3.60) one can prove by contradiction that $S \geq 0$. Then replace equations (3.56) and (3.57) on the other constraints, and recall that $R_2 \leq D$.

\[\square\]

\(^{44}\)Note that the court knows that $S$ is promised to the manager. However, the court can adjust his incentive scheme to keep him in his participation constraint after considering for $S$. 

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Therefore we can rewrite the relaxed program as

$$\max_{\{(w_1, e_1), (w_2, e_2), s\}} (1 - p)[f(e_1) - w_1] + p[(1 - r)(g(e_2) - w_2 - S) + r\Pi]$$

(3.66)

s.t. \hspace{1cm} w_1 - e_1 \geq 0 \hspace{1cm} (3.67)

(1 - r)(w_2 - e_2 + S) \geq 0 \hspace{1cm} (3.68)

(1 - r)S \geq r(w_2 - e_2) \hspace{1cm} (3.69)

$$g(e_2) = f(\hat{e}^{11})$$ \hspace{1cm} (3.70)

$$w_1 - e_1 \geq w_2 - \hat{e}^{11}$$ \hspace{1cm} (3.71)

$$w_1 - e_1 \geq (1 - r)(w_2 - \hat{e}^{11} + S).$$ \hspace{1cm} (3.72)

**Lemma 2** The manager's participation constraint is binding in the worst state, equation (3.68), and not binding in the best state, equation (3.67).

**Proof:**

(i) *Worst State:* Suppose not, i.e., in the optimum \((1 - r)(w_2^{11} - e_2^{11} + S^*) > 0\). Then we can increase \(e_2^{11}\) by some \(\epsilon > 0\) without violating this constraint. This increases the value of the objective function. Therefore, if we can prove that the other constraints are not violated by the \(\epsilon\) increase, then this contradicts optimality of \(e_2^{11}\).

Equation (3.67) is not affected by \(\epsilon\). The incentive compatibility constraint (3.69) is relaxed. By equation (3.70), \(\hat{e}^{11}\) increases. But this relaxes the last two incentive compatibility constraints (3.71), and (3.72). Contradiction.

(ii) *Best State:* Plugging equation (3.68) (taking into account that it is binding) into equation (3.72), we obtain \(w_1^{11} - e_1^{11} \geq (1 - r)(e_2^{11} - \hat{e}^{11})\). But \(e_2^{11} - \hat{e}^{11} > 0\) by equation (3.70), and \(f(e) > g(e)\). \(\Box\)

**Lemma 3** It is optimal to set \(w_2^{11} = 0\). In this case \(S^* = e_2^{11}\), and constraint (3.69) is not binding.

**Proof:** By simple inspection of the objective function one can easily check that what matters is \(w_2 + S\), not the value of \(w_2\) or \(S\) alone. But for any fix sum, \(w_2 + S = k\), setting...
\( w_2 = 0 \) and \( S = k \) relaxes constraints (3.69) and (3.71) without affecting the remaining ones. On the other hand, \( k \) is determined by the participation constraint (3.68), which is binding by Lemma 2. Therefore \( S + w_2 - e_2 = 0 \rightarrow S = e_2 \), when \( w_2 = 0 \). Furthermore, constraint (3.69) is not binding since \( S = e_2 \geq 0 \). \( \square \)

From the above Lemmas we can replace the relaxed program by

\[
\begin{align*}
\max_{\{(w_1,e_1)\in \mathbb{R}^2\}} & \quad (1 - p)[f(e_1) - w_1] + p[(1 - r)(g(e_2) - e_2) + r\bar{q}] \\
\text{s.t.} & \quad g(e_2) = f(\hat{e}_1) \\
& \quad w_1 \geq e_1 - \hat{e}_1 \\
& \quad w_1 \geq e_1 + (1 - r)(e_2 - \hat{e}_2).
\end{align*}
\]

(3.73)

(3.74)

(3.75)

(3.76)

Constraint (3.75) is not binding, because it is automatically satisfied when constraint (3.76) is satisfied (recall that \( e_2 - \hat{e}_2 \geq 0 \)). Finally it is easy to prove that the last constraint (3.76) must be binding in the optimum. Otherwise we could reduce \( w_1 \), without violating the other constraints. This would increase the objective function.

We have just proved that the program used to solve the optimal mechanism in section 3.3 solves the relaxed program. Now we prove that the solution of the relaxed program satisfies the incentive compatibility constraint that we left out. But first we prove a lemma that we will use later.

**Lemma 4** For any \( a > b \geq 0 \), \( f(a) - g(a) > f(b) - g(b) \).

**Proof:** \( (f(a) - g(a)) - (f(b) - g(b)) = \int_b^a f'(x) - g'(x) dx \). But \( f'(x) > g'(x) \) for any \( x > 0 \). \( \square \)

**Lemma 5** The incentive compatibility constraint (3.65) is satisfied by the solution of the relaxed program.

**Proof:** Manipulating the incentive compatibility, and using \( S^* = e_2^{11}, w_2^{11} = 0 \), and \( w_1 = e_1 + (1 - r)(e_2^{11} - \hat{e}_1) \) we obtain

\[
\hat{e}_1^{11} - e_1^{11} \geq (1 - r)(e_2^{11} - \hat{e}_2^{11}).
\]
Therefore it suffices to prove that $\bar{e}^{11} - e_1^{11} \geq (e_2^{11} - \bar{e}^{11})$. To see this note that 
\[
\frac{f(e_1^{11}) - g(e_1^{11})}{e_2^{11} - \bar{e}^{11}} = \frac{f(e_1^{11}) - f(\bar{e}^{11})}{e_1^{11} - \bar{e}^{11}} > \frac{f(\bar{e}^{11}) - f(e_1^{11})}{\bar{e}^{11} - e_1^{11}} \geq \frac{g(\bar{e}^{11}) - g(e_1^{11})}{\bar{e}^{11} - e_1^{11}} = \frac{f(e_1^{11}) - g(e_1^{11})}{e_2^{11} - e_1^{11}}.
\]

The first inequality follows from Lemma 4, and $e_1^{11} > e_2^{11}$ (as proven in Section 3.3). The subsequent equality follows the definition of $\bar{e}^{11}$. The second inequality follows from the concavity of $f(e)$. The third inequality follows from Lemma 4, and the last equality follows the definition of $\bar{e}^{11}$. The Lemma follows by putting together the first and the last expression. \(\square\)
References


