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[Assinatura]

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Financial Distress as a Collapse of Incentive Schemes

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Abstract

This paper explains why workers lack motivation near bankruptcy, why they tend to leave companies in financial distress, and why those who remain require higher compensation. 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 paper 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).

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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 energy 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,¹ 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 paper 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 ex-post inefficiency is a necessary evil to maximize 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

¹The only theoretical work outside this mainstream is Titman (1984). On the empirical side the only exception is Gilson and Vetsuypens (1992).
Chapter 11 of the US bankruptcy code. One of the main points of this paper 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 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 ex ante optimal incentive scheme can ex post 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 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 support in the work of Gilson and Vetsuypens (1992).

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 cost of financial distress in Texaco, is due to the cost of financial distress in Texaco and not to larger agency costs in Pennzoil. For a different interpretation see Blanchard, Lopes de Silanes, and Shleifer (1992). 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, jeopardising 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.
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 paper is organized as follows. Section 1 describes the general framework of the model. Section 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 discusses optimal recontracting, and it explains why Chapter 11 might be a good renegotiation device for the shareholders. Section 4 discusses the empirical implications. Finally, we draw some conclusions, highlighting the importance of our new perspective of financial distress.

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.

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.

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4 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 could 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.
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. Therefore, we take the stand that profits are observable but not verifiable.

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.

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5Healy (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.

6Introducing asymmetric information would only strengthen our results, at the cost of a more complex model.
flow. The point is that a large enough initial debt does not allow him to finance self interested investments.\textsuperscript{7}

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 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.\textsuperscript{6} However, these considerations are less convincing in the case of debt.

\textsuperscript{7}This is the central role of debt in Hart and Moore (1990).

\textsuperscript{6}For a different explanation why it might be optimal to sell equity claims to dispersed shareholders see Zingales (1992).
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 paper to explain why firms have multiple creditors. Therefore, we assume that debtholders are dispersed. For all practical purposes, the assumption of dispersed bondholders and dispersed shareholders preclude future renegotiation of the debt contracts and the incentive schemes.

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 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.

Figure 1: Timing

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

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

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

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9See Bolton-Scharfstein (1992) for a paper that endogenizes this choice in the case of a private company.

10We will relax this assumption in section 3 when we discuss Chapter 11 and exchange offers for public debt as renegotiation devices.
\[ f(0) = 0. \]

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 court. It reduces the firm's productivity, implying a new profit function

\[
\Pi(e, w) = g(e) - w, \tag{2}
\]

where \( \frac{d g(e)}{d e} > 0, \frac{d^2 g(e)}{d e^2} < 0, g(e) \leq f(e) \) for every \( e \), and \( \frac{d g(e)}{d e} \leq \frac{d f(e)}{d e} \), 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.\(^{11}\)

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.\(^{12}\) 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

\[
U(w, e, D) = (w - e) + \max\{\Pi(e, w) - D, 0\}. \tag{3}
\]

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 \( (\max\{\Pi(e, w) - D, 0\}) \).

Since we assumed that the CEO is risk neutral, we also have to assume that he is credit

\(^{11}\)This is the usual Spence-Mirrlees condition of the incentive literature.

\(^{12}\)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.
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 when we discuss Chapter 11.13

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.

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

13It is worth saying that the introduction of private benefits does not alter the basic model of section 2.
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 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.

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

$$\max_{w,e} f(e) - w$$

(s.t. $w - e \geq 0$).

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

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

implying that

$$\Pi^* = f(e^*) - e^*.$$

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

\[ \text{Max}_{w,e} g(e) - w \]  
\[ \text{s.t. } w - e \geq 0. \]  

(8)  
(9)

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

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

(10)

implying that

\[ \Pi = g(\bar{e}) - \bar{e}. \]  

(11)

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

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

\[ \Pi < \Pi^*. \]

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

\[ V^o = (1 - p)\Pi^* + p\Pi. \]  

(12)

The first term in equation (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 \( \{(w^*, \Pi^*), (w, \Pi)\} \). For instance, if the shock happens, then the CEO' s incentive scheme is \((w, \Pi)\), under which he receives \(w\) if he delivers profit \(\Pi\), 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.

### 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 \(w^*(R)\), which depends on the amount \(R\) paid to the creditors, and a debt level \(D^*\) 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.\(^{14}\) Therefore, the optimal repayment in state 1 cannot be lower than the face value of the debt, i.e., \(R_1^n \geq D^n\). 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

\(^{14}\)Appendix A shows that this is without loss of generality if we take into account the direct costs of bankruptcy.
largest repayment induced by the optimal incentive scheme, i.e., \( D^* \geq \max\{R_1^*, R_2^*\} \). Then, it follows that \( R_1^* = D^* \). Therefore, once we have solved the optimal incentive scheme \((w_i^*, R_i^*)\) we have automatically determined the optimal debt and wage schedule \((D^*, w^*(R))\).

The optimal incentive scheme \(\{(w_1, R_1)\}\) such that \(R_2 \leq R_1 = D^*\) solves\(^{15}\)

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

\(\text{s.t.} \quad D = f(e_1) - w_1\) \hfill (13)

\[R_2 = g(e_2) - w_2\] \hfill (14)

\[w_1 - e_1 + \max\{f(e_1) - w_1 - D, 0\} \geq 0\] \hfill (15)

\[w_2 - e_2 + \max\{g(e_2) - w_2 - D, 0\} \geq 0\] \hfill (16)

\[R_2 = f(\hat{e}) - w_2\] \hfill (17)

\[w_1 - e_1 + \max\{f(e_1) - w_1 - D, 0\} \geq w_2 - \hat{e} + \max\{f(\hat{e}) - w_2 - D, 0\}.\] \hfill (18)

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 (14) and (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 (16) and (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.\(^{16}\)

Equation (18) defines \(\hat{e}\) 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 (19) is the incentive com-

\(^{15}\)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.

\(^{16}\)Note that Equations (16) and (17) imply that the CEO will be willing to sign the contract at time 0.
patibility constraint. It requires that, in state 1, the CEO must be better off selecting \((w_1, D)\) rather than \((w_2, R_2)\).\(^{17}\) It can be easily shown that the incentive compatibility constraint (equation (19)) and the CEO's participation constraint in the worst state (equation (17)) are binding, while the one in the best state (16) is not.\(^{18}\) Finally, one can easily show that the "perks" component can be eliminated from the CEO's utility function.\(^{19}\)

By substituting equation (18) into equation (15) we determine the value of \(\hat{e}\) as a function of \(e_2\):

\[
\hat{e} = f^{-1}[g(e_2)]. \tag{20}
\]

Because \(f(e) \geq g(e)\), with equality only when \(e = 0\), equation (20) implies that the optimal effort, \(e^*_2\), should satisfy

\[
\hat{e} \leq e^*_2, \tag{21}
\]

with equality only when \(e^*_2 = 0\).

After substituting equations (14) and (15) in the objective function, the original program can be rewritten as

\[
\begin{align*}
\text{Max}_{\{e_1\}} & \ (1 - p)[f(e_1) - w_1] + p[g(e_2) - w_2] \\
\text{s.t.} & \ w_1 = e_1 + (w_2 - \hat{e}) \\
& \ w_2 = e_2
\end{align*} \tag{22}
\]

\[
\begin{align*}
\text{s.t.} & \ w_1 = e_1 + (w_2 - \hat{e}) \\
& \ w_2 = e_2 
\end{align*} \tag{23}
\]

\[
\begin{align*}
\text{s.t.} & \ w_1 = e_1 + (w_2 - \hat{e}) \\
& \ w_2 = e_2 
\end{align*} \tag{24}
\]

\(^{17}\)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.

\(^{18}\)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 (17) (which is binding) in the incentive compatibility constraint.

\(^{19}\)To see this substitute equations (14) and (15) into equations (16), (17) and (19), and recall that \(R_2 \leq D\).
\[ \hat{e} = f^{-1}[g(e_2)]. \]  

By substituting equation (24) into equation (23), we have

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

Therefore, the CEO enjoys control rents equal to \((e^* - \hat{e})\) in the best state of nature. Moreover, by inequality (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

\[ \frac{df(e_1)}{de_1} = 1, \]  \(\text{Eq. (26)}\)

and

\[ \frac{dg(e_2)}{de_2} - 1 = \frac{1 - p}{p} \left[ 1 - \frac{dg(e^*_2)}{df(e_1)} \right]. \]  \(\text{Eq. (27)}\)

Simple inspection of equations (26) and (6) shows that effort is efficient in the case that there is no shock, i.e.,

\[ e^*_1 = e^*. \]

Nevertheless, profits are suboptimal

\[ \Pi^*_1 = D^* = [f(e^*) - e^*] - (e^*_2 - \hat{e}) = \Pi^* - (e^*_2 - \hat{e}). \]

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 best 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., $e^*_x = 0$. In this case $(e^*_x - \bar{e}) = 0$, 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 (27) should be equal to zero if $e^*_x = \bar{e}$. However, the right hand side (RHS) of equation (27) is strictly positive if $e^*_x > 0$. Then, concavity of $g(e)$ implies that

$$e^*_x < \bar{e} \quad (28)$$

$$R^*_x < \Pi^* \quad (29)$$

Then the optimal incentive scheme, $\{(w^*_1, D^*), (w^*_2, R^*_2)\}$, and the firm's value at time zero are:

$$(w^*_1, D^*) = (e^* + (e^*_x - f^{-1}[g(e^*_x)]), \Pi^* - (e^*_x - f^{-1}[g(e^*_x)])) \quad (30)$$

$$(w^*_2, R^*_2) = (e^*_x, \Pi^*_2) = (e^*_x, g(e^*_x) - e^*_x) \quad (31)$$

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20To see this check that the LHS of equation (27) is equal to the first order condition of the first best program in the case that the shock occurred (equation (10)).

21To see this recall that, for any $e^*_x > 0$, $\bar{e} < e^*_x$. Then, concavity and the Spence-Mirrlees conditions on $f(e)$, and $g(e)$ imply that $\frac{d^2f(e)}{de^2} > \frac{d^2g(e)}{de^2} > \frac{d^2f(e)}{de^2}$.

22Since $\bar{e} > 0$, the statement below also follows for $e^*_x = 0$. 

16
\[ V'(p) = (1 - p)[\Pi^* - (e_2^* - \hat{e})] + p[\Pi_2^*]. \] (32)

Note from equation (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 \( (\Pi - \Pi_2^*) \) will be larger the smaller the \textit{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 2 we show the relationship between the \textit{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 (\( \Pi \)).

\[ \text{Note that } f(e) \text{ and } g(e) \text{ satisfy our assumptions.} \]
Figure 2: Profit Loss in Financial Distress as a Percentage of the Optimal Profit.

![Profit Loss in Financial Distress as a Percentage of the Optimal Profit](chart.png)
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.

3.1 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 2. It promises wage $w = e^* + (e^*_2 - \zeta)$ if the whole debt is repaid, $w = e^*_2$ if creditors collect at least $R = \Pi^*_2$, 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 $w = \varepsilon > e^*_2$ if $\Pi > \Pi^*_2$ 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 $\Pi$, and the manager would have his wage reduced (contingent on full debt repayment) from $e^*$ to $\varepsilon$. 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 $g(\varepsilon)$ in revenues. Therefore, the manager can pay back

$$R = \Pi = g(\varepsilon) - \varepsilon.$$

The manager obtains zero utility by accepting this offer ($w = \varepsilon$). However, if he rejects it he will not gain anything in utility terms. Therefore, an infinitesimal bonus should convince

\[24\]
him to accept the take it or leave it offer.

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.25

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 ruled26 that in case of bankruptcy the claim of shareholders who exchanged is equal to the market value of the debenture at the time nothing and will not exert any effort. In both cases his utility is zero.

25This 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.

26See the LTV bankruptcy case.
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 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. Therefore, it is not a priori clear if exchange offers are desirable in the presence of asymmetric information.

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.\(^{27}\) If the incentive scheme is optimally

\(^{27}\)Bolton and Scharfstein (1992) formalise this trade-off.

\(^{28}\)Note that we are implicitly assuming that the founders cannot implement a new incentive scheme contin-
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.\footnote{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.}

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

### 3.3.1 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 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 $(1 - r)(w - e + \max\{g(e) - w - D, 0\}) \leq w - e + \max\{g(e) - w - D, 0\}$.\footnote{Recall that with probability $r$ the incentive scheme is optimally reset. In this case the manager's utility will be zero.} Therefore, this new option will not alter \textit{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 2. The value of the firm
will be unchanged at
\[ V^*(p) = (1 - p)[\Pi^* - (e_1^* - \hat{\epsilon})] + p[\Pi^*_2]. \]  

(33)

3.3.2 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.\(^{31}\)

From what we just said the size of this bonus should be at least equal to

\[ S = r(w - e + \max\{g(e) - w - D, 0\}). \]  

(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:\(^{32}\)

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

(35)

s.t. \[ w_1 = e_1 + (1 - r)(e_2 - \hat{\epsilon}) \]  

(36)

\[ w_2 = 0 \]  

(37)

\(^{31}\)From Gilson and Vetsuypens (1992) we learn that this type of bonus is fairly frequent in Chapter 11.\(^{32}\)By the same reasons given in section 2, we can eliminate the perks component from the manager's utility function.

23
\[ S = e_2 \]  
\[ \varepsilon^{11} = f^{-1}[g(e_2)]. \] (38) (39)

Equation (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 (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 \( e_2 - \varepsilon^{11} \) with probability \( 1 - r \). Equation (37) punishes the manager as much as possible if he does not go to Chapter 11. Finally, equation (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 prevails in Chapter 11 if the judge does not succeed in implementing the first best.

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

\[ \frac{df(e^{11}_1)}{de_1} = 1, \]  
\[ \frac{dg(e^{11}_2)}{de_2} - 1 = \frac{1 - p}{p} \left[ 1 - \frac{de^{11}_2}{df(e^{11}_1)} \right]. \] (40) (41)

Simple inspection of equations (40), (41), (26), and (27) shows that the effort levels are the same of the case without Chapter 11. There is no inefficiency if there is no shock \( (e^{11}_1 = e^*) \). And there is an inefficiently low effort level when the shock happens and the bankruptcy court does no reset the incentive scheme: \( e^{11}_2 = e^* < \bar{\varepsilon}. \)
Moreover, it can be easily checked that the managerial control rents are lower than in the case without Chapter 11. From equation (36):

\[(1 - r)(e^*_{11} - \hat{\epsilon}) = (1 - r)(e^*_{3} - \hat{\epsilon}) < e^*_{2} - \hat{\epsilon}^*,\]

for any \( r > 0 \). Therefore, the firm's value under Chapter 11 is

\[V^{11}(p, r) = (1 - p)[\Pi^* - (1 - r)(e^*_{2} - \hat{\epsilon})] + p[(1 - r)\Pi^* + r\bar{\Pi}].\] (42)

Simple inspection of equations (33) and (42) shows that the existence of Chapter 11 makes the shareholders better off. Shareholders gain \( r[(e^*_{2} - \hat{\epsilon}) + (\Pi^* - \Pi^*_2)] \) by inducing the manager to file for Chapter 11. Equation (33) also shows that if the court can reset the incentive schemes with probability 1 (\( r = 1 \)), then the first best is achieved.

### 3.3.3 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.\(^{33}\) 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.

\(^{33}\)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.
In principle, the founders could take advantage of the *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 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

$$V'(p) = (1 - p)[\Pi^* - (e_2^* - \delta)] + p[\Pi_*].$$  \hspace{1cm} (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 $w_{21}^* = 0$ 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

$$S = \frac{B}{1 - r} + e_2. \hspace{1cm} (44)$$

By recomputing the optimal mechanism with this new constraint we obtain as value of the firm

$$V^{11}(p, r) = (1 - p)[\Pi^* - (1 - r)(e_2^* - \delta^*)] + p[(1 - r)\Pi_{*2} + r\Pi] - pB. \hspace{1cm} (45)$$
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 (45), and (43). Chapter 11 will be used if and only if

$$pB \leq pr[\Pi - \Pi^*_2] + (1 - p)r[e^*_m - \hat{e}].$$

(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.

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.

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 \textit{ex ante} optimally chosen in the shareholders’ interest to curb managerial rents from control.

We believe that this paper 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 paper 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.
Appendix

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 2 are optimal for reasonable values of default costs. But first we clarify what we mean by default costs.

Consistent with section 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.34 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, \( R \).35 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.36 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.37

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 by the initial entrepreneurs who have to compensate the debtholders for the future cost by accepting a higher interest rate in the loan.38

34 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.
35 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.
36 Actually, we also need a total debt level \( D_1^* + D_2^* \) large enough such that the manager cannot refinance \( D_1^* \).
37 Recall that we assumed that the technological shock is observable. Therefore the debtholders or the new owners can implement the correct incentive scheme.
38 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 \( II^* - C \) at time 0 for a claim of \( II^* \) 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.

A.1 Mechanisms that Do Not Allow for Bankruptcy at Time 1

In this case $D^*_1 = 0$. 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 $R_i^*$.

**Proposition 1** The optimal repayment in the best state is equal to the optimal debt level due at time 2, i.e. $R^*_1 = D^*_2$.

**Proof:** The optimal repayment in state 1 cannot be lower than the face value of the debt, i.e., $R^*_1 \geq D^*_2$. 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 $D^*_2 \geq \max\{R^*_1, R^*_2\}$. Then, it follows that $R^*_1 = D^*_2$. 

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.

A.1.1 The Safe Debt Strategy

The maximum level of safe debt is $\bar{\Pi}$.

Clearly, the optimal incentive scheme $\{(w^*_i, R^*_i)\}$ that assures full repayment in any state of nature is given by $(\bar{w}, \bar{\Pi})$, for any $i$, with $D^*_2 = \bar{\Pi}$. The value of the firm at time 0 under this incentive scheme is given by

$$V^* = \bar{\Pi}.$$  

(1)

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 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

\[ V^*(p) = (1 - p)[\Pi^* - (\epsilon^*_2 - \hat{\epsilon})] + p[\Pi_2^* - C]. \]  

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

Proof: Implicitly differentiating \( \epsilon^*_2 \) with respect to \( p \) in equation (27):

\[ \frac{d\epsilon^*_2}{dp} = \frac{-\frac{dy(\epsilon^*_2)}{d\epsilon^*_2}[1 - \frac{1}{\delta(\epsilon^*_2)}]}{p \frac{d^2g(\epsilon^*_2)}{d\epsilon^*_2} + (1 - p) \frac{-\frac{dy(\epsilon^*_2)}{d\epsilon^*_2}}{d\epsilon^*_2}}. \]

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, \( \epsilon^*_2 \) is differentiable with respect to \( p \). On the other hand, the numerator is also negative since the marginal productivity is positive, and \( \frac{dy(\epsilon^*_2)}{d\epsilon^*_2} > 1 \). This last inequality follows from concavity of \( f(\epsilon) \), and \( \hat{\epsilon} < \epsilon^* \) with \( \frac{dy(\epsilon^*_2)}{d\epsilon^*_2} = 1 \). Therefore, \( \frac{d\epsilon^*_2}{dp} > 0 \). Continuity of \( \Pi^*_2 \) and \( \epsilon^*_2 - \hat{\epsilon} \) follows from the fact that they are continuous functions of \( \epsilon^*_2 \). Actually, one can easily check that they are both differentiable with respect to \( p \). Since \( \epsilon^*_2 \leq \hat{\epsilon} \), concavity of \( g \) implies that profits decrease when effort decreases. Therefore, \( \frac{d\epsilon^*_2}{dp} > 0 \) implies that \( \frac{dy(\epsilon^*_2)}{d\epsilon^*_2} > 0 \) as well. To see that the control rent is increasing on \( p \) note that

\[ \frac{d(\epsilon^*_2 - \hat{\epsilon})}{dp} = \frac{d\epsilon^*_2}{dp} - \frac{\frac{dy(\epsilon^*_2)}{d\epsilon^*_2}}{d\epsilon^*_2}. \]

Equation (3) 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 16). □

By comparing equations (1) and (2) we obtain that using risky debt is better than safe debt if and only if:

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

The intuition for equation (4) 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 \( (\Pi - \Pi^*_2) \). 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 $p^* > 0$, which depends on $C$, such that for any $p \leq p^*$, 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 (4) 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 (4) 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 (4) when $p$ converges to zero is:

$$[\Pi^* - \Pi] > 0.$$  \hfill (5)

Then, continuity of inequality (4) implies that there exists a sufficiently low $p^* > 0$ such that for any $p \leq p^*$, $V^*(p) > V^*(p)$. \hfill \Box

**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

$$V^*(p) = \Pi^* - C + (1 - p)\Pi^* + p\Pi.$$  \hfill (6)

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 (2)) and the forced liquidation strategy (equation (6)), we have that risky debt is preferred if and only if

$$(1 - p)[C - (e^*_2 - \hat{e})] \geq p[\Pi - \Pi^*_2].$$  \hfill (7)
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 $(e^* - \hat{c})$, 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 liquidation.

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 (7) 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 (7) 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 (7) when $p \to 0$ is given by

$$C > 0.$$  

When inequalities (4) and (7) are simultaneously satisfied, the debt level and the incentive scheme computed in section 2 form an optimal strategy.

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

Proof: Take any $C > 0$, and let $\bar{p} = \min\{p^0, p^1\}$, where $p^0$ is defined in Proposition 3, and $p^1$ is defined in Proposition 4. Then for any $p < \bar{p}$, conditions (4) and (7) are simultaneously satisfied.

To show that conditions (4) and (7) can be satisfied for reasonable parameters we provide a numerical example.

Example 1: The production functions are $f(e) = 2\sqrt{e}$, and $g(e) = \sqrt{e}$. We also assume that the probability $p$ that the shock occurs is 0.2. By using these values we obtain $(\Pi^*, e^*) = (1, 1)$, $(\bar{\Pi}, \bar{e}) = (0.25, 0.25)$, $(\Pi^*_2, e^*_2) = (0.109, 0.016)$, 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 (4) and (7) we find that risky debt is preferable to safe debt if and only if $0.046 < C \leq 2.813$.

Suppose $C = 0.046$. Then the strategy of section 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

\[41\text{Note that } f(e) \text{ and } g(e) \text{ satisfy our assumptions.}\]
\[ \frac{\Pi - \Pi^*}{\Pi} = 0.58. \]

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.\(^{42}\)

\(^{42}\)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, \[ \frac{0.99}{0.99} = 0.046. \]
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

\[
\max \{ (w_1, D), (w_2, R_2), S \} \quad (1-p)D + p[(1-r)(R_2 - S) + r\Pi]
\]

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

\[R_2 = g(e_2) - w_2 \]

\[w_1 - e_1 + \max\{(f(e_1) - w_1) - D, 0\} \geq 0 \]

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

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

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

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

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

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

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

Equation (1) 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.\(^{43}\) 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 (4) and (5) are the manager’s participation constraint in the good and bad state respectively. Equation (6) is an incentive compatibility constraint. It assures that, in the bad state, the manager is better off filing for Chapter 11.

Equation (7) defines the minimum effort, \( \hat{e}^{11} \), 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 (8) 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 (9) assures that that the manager prefers \((w_1, D)\) rather than \((w_2, R_2)\), and filing for Chapter 11.

Equation (10) defines the minimum effort, \( \hat{e}^{11} \), that the manager must exert if the shock appeared, but he selects contract \((w_1, D)\). Equation (11) assures that this is not worth for the manager.

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 (5) and (6) one can prove by contradiction that \( S \geq 0 \). Then replace equations (2) and (3) on the other constraints, and recall that \( R_2 \leq D \). \( \square \)

We solve the program by forgetting for a while the last incentive compatibility constraint (11). 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. Therefore we can rewrite the relaxed program as

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

\(^{43}\)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 \( S \).
Lemma 2 The manager's participation constraint is binding in the worst state, equation (14), and not binding in the best state, equation (13).

Proof:
(i) Worst State: Suppose not, i.e., in the optimum \((1 - r)(w_{11} - e_{11} + S^*) = 0\). Then we can increase \(e_{11}\) 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 \(e_{11}\).

Equation (13) is not affected by \(\epsilon\). The incentive compatibility constraint (15) is relaxed. By equation (16), \(\tilde{e}^{11}\) increases. But this relaxes the last two incentive compatibility constraints (17), and (18). Contradiction.

(ii) Best State: Plugging equation (14) (taking into account that it is binding) into equation (18), we obtain \(w_{11} - e_{11} \geq (1 - r)(e_{11} - \tilde{e}^{11})\). But \(e_{11} - \tilde{e}^{11} > 0\) by equation (16), and \(f(e) > g(e)\).

Lemma 3 It is optimal to set \(w_{11} = 0\). In this case \(S^* = e_{11}\), and constraint (15) 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 (15) and (17) without affecting the remaining ones. On the other hand, \(k\) is determined by the participation constraint (14), which is binding by Lemma 2. Therefore \(S + w_2 - e_2 = 0 \rightarrow S = e_2\), when \(w_2 = 0\). Furthermore, constraint (15) is not binding since \(S = e_2 \geq 0\).

From the above Lemmas we can replace the relaxed program by

\[
\text{Max}_{\{w_1, e_1, e_2\}} (1 - p)[f(e_1) - w_1] + p(1 - r)(g(e_2) - e_2) + r\|I\|
\]

\(s.t.\quad g(e_2) = f(\tilde{e}^{11})\)  
\(w_1 \geq e_1 - \tilde{e}^{11}\)  
\(w_1 \geq e_1 + (1 - r)(e_2 - \tilde{e}^{11})\).

Constraint (21) is not binding, because it is automatically satisfied when constraint (22) is satisfied (recall that \(e_2 - \tilde{e}^{11} \geq 0\)). Finally it is easy to prove that the last constraint (22)
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 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 \( x > 0 \). \( \Box \)

**Lemma 5** The incentive compatibility constraint (11) 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 \( w_1 = e_1 + (1 - r)(e_2^{11} - e^{11}) \) we obtain

\[
\bar{e}^{11} - e_1^{11} \geq (1 - r)(e_2^{11} - \bar{e}^{11}).
\]

Therefore it suffices to prove that \( \bar{e}^{11} - e_1^{11} \geq (e_2^{11} - \bar{e}^{11}) \). To see this note that

\[
\frac{f(e_1^{11}) - g(e_1^{11})}{e_1^{11} - e_2^{11}} = \frac{f(e_2^{11}) - f(e_1^{11})}{e_1^{11} - e_2^{11}} \geq \frac{f(e_2^{11}) - f(e_2^{11})}{e_2^{11} - e_2^{11}} = \frac{g(e_2^{11}) - g(e_2^{11})}{e_2^{11} - e_2^{11}}.
\]

The first inequality follows from Lemma 4, and \( e_2^{11} > e_2^{11} \) (as proven in Section 3). The subsequent equality follows the definition of \( e_2^{11} \). 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 \( e_2^{11} \). The Lemma follows by putting together the first and the last expression. \( \Box \)
References


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Appendix C: The Optimal Mechanism with Chapter 11 and Private Benefits

In this appendix we solve the optimal mechanism that induces the manager to file for Chapter 11 at time 1 taking into account private benefits of control. As we said in section 3, the introduction of private benefits increases the manager's reservation value by $B$. This is so because, once in control, the manager can always get $B$ by choosing $e = 0$. However, he will lose $B$ if he files for Chapter 11 at time 1. This loss requires an increase in the bonus $S$ that is needed to induce the manager to file for Chapter 11. More formally, the optimal mechanism solves

$max_{(w_1,D),(w_2,R_2),S} (1 - p)D + p[(1 - r)(R_2 - S) + r\Pi] $

s.t. $D = f(e_1) - w_1$

$R_2 = g(e_2) - w_2$

$w_1 - e_1 + Max\{[f(e_1) - w_1] - D, 0\} + B \geq B$

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

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

$R_2 = f(\varepsilon^{11}) - w_2$

$w_1 - e_1 + Max\{[f(e_1) - w_1] - D, 0\} + B \geq w_2 - \varepsilon^{11} + Max\{[f(\varepsilon^{11}) - w_2] - D, 0\} + B$

$w_1 - e_1 + Max\{[f(e_1) - w_1] - D, 0\} + B \geq (1 - r)(w_2 - \varepsilon^{11} + S + Max\{[f(\varepsilon^{11}) - w_2] - S - D, 0\})$

$D = g(\varepsilon^{11}) - w_1$

$(1 - r)(w_2 - e_2 + S + Max\{[g(e_2) - w_2] - S - D, 0\}) \geq w_1 - \varepsilon^{11} + Max\{[g(\varepsilon^{11}) - w_1] - D, 0\} + B$. 

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The program is totally analogous to the one presented in Appendix B. The only difference is that $B$ was added to the manager's reservation value in the participation constraints (equations (4) and (5)), and in his utility function in the cases that he does not file for Chapter 11.

**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:** We only need to show that $\max\{g(e_2) - w_2 - D, 0\} = \max\{g(e_2) - w_2 - S - D, 0\} = 0$. Then the Lemma follows by substituting (2), (3), (7), and (10) on the 'perk component'. The first $\max\{.\}$ vanishes because $R_2 \leq D$ by assumption. To prove the second equality, suppose not. In this case we must have $S < 0$ (since $g(e_2) - w_2 = R_2 \leq D$). Then $\max\{g(e_2) - w_2 - S - D, 0\} = g(e_2) - w_2 - S - D$. Plugging this into constraint (5) we obtain $(1 - r)(w_2 - e_2 + S + g(e_2) - w_2 - S - D) \geq B \Rightarrow (1 - r)(g(e_2) - w_2 - D + w_2 - e_2) \geq B \Rightarrow (1 - r)(R_2 - D + w_2 - e_2) \geq B \Rightarrow w_2 > e_2$. Plugging the $\max\{.\}$ in constraint (6) we obtain $(1 - r)(R_2 - D + w_2 - e_2) \geq w_2 - e_2 + B \Rightarrow (1 - r)(R_2 - D) \geq r(w_2 - e_2) + B$. Since $w_2 > e_2$, we must have $R_2 > D$. Contradiction □

As before we first forget for a while the last incentive compatibility constraint (equation (11)), and then we check if the solution of the relaxed program satisfies it. Therefore we can rewrite the relaxed program as

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

(12)

s.t. $w_1 - e_1 \geq 0$

(13)

$(1 - r)(w_2 - e_2 + S) \geq B$

(14)

$(1 - r)S \geq r(w_2 - e_2) + B$

(15)

$g(e_2) = f(\tilde{e}^{11})$

(16)

$w_1 - e_1 \geq w_2 - \tilde{e}^{11}$

(17)

$w_1 - e_1 + B \geq (1 - r)(w_2 - \tilde{e}^{11} + S)$.

(18)

**Lemma 2** The manager's participation constraint is binding in the worst state, equation (14), and not binding in the best state, equation (13).

**Proof:** Same proof of Lemma 2 in Appendix B. □

**Lemma 3** It is optimal to set $w_2^{11} = 0$. In this case $S^* = B + \frac{\tilde{e}^{11}}{1 - r}$, and constraint (15) is not binding.
Proof: Same proof of Lemma 3 in Appendix B. □

From the above Lemmas we can replace the relaxed program by

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

(19)

s.t. \quad g(e_2) = f(\hat{e}^{11})

(20)

\[w_1 \geq e_1 - \hat{e}^{11}\]

(21)

\[w_1 \geq e_1 + (1 - r)(e_2 - \hat{e}^{11}).\]

(22)

Constraint (21) is not binding, because it is automatically satisfied when constraint (22) is satisfied (recall that \(e_2 - \hat{e}^{11} \geq 0\)). Finally, it is easy to prove that the last constraint (22) 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 private benefits of control, after plugging \(S\) into the objective function, only introduces a constant in the relaxed program \((-pB)\). Therefore, the optimal efforts are the same.

Now we prove that the solution of the relaxed program satisfies the incentive compatibility constraint that we left out.

Lemma 4 The incentive compatibility constraint (11) is satisfied by the solution of the relaxed program.

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

\[
\hat{e}^{11} - e_1^{11} \geq (1 - r)(e_2^{11} - \hat{e}^{11}).
\]

But this is the same inequality that we proved to be correct in Lemma 5 in Appendix B. □

Therefore, the firm's value under the Chapter 11 strategy is

\[
V^{11}(p,r) = (1 - p)[\Pi^* - (1 - r)(e_2^* - \hat{e}^*)] + p[(1 - r)\Pi^*_2 + r\Pi] - pB.
\]
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