Payout Policy, Capital Structure, and Compensation Contracts when Managers Value Control

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The optimal contract between managers and investors is endogenously derived when managers have preferences for both monetary compensation and corporate resources under their control. When the optimal payout is privately known to managers, they can be induced to makepayouts by linking their compensation to the payout. Public equity is a claim on this discretionary payout. If investors can obtain new information about the firm's optimal payout level, it can be utilized by transferring the control from management to investors. The new information allows the firm to achieve a more efficient allocation through recontracting. We show that the new information will be obtained if and only if the payout falls below a promised level

The nature of contractual arrangements between modern corporations and their investors has puzzled economic and legal scholars for a long time. Only in recent years have we started to address this issue in a more systematic and rigorous fashion. The standard principal-agent models, however, only address the

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We show that due to asymmetric information and managerial risk aversion, public equity financing can involve excessive on-the-job consumption. The residual payout policy is generally not optimal, though it is optimal in the full-information counterpart of the model.

As a result of excessive on-the-job consumption and due to the managers' minimum utility constraint, a purely discretionary payout policy may not be effective in dealing with the incentive problem. Either too much can be retained in the firm or the managers can be paid more than their reservation utility levels in order to motivate them to pay out the funds. These constitute the costs of public equity financing in this model.

Bankruptcy is taken as an event in which new information about the optimal payout level is generated and the control of the firm's payout and spending decisions is transferred from managers to investors. The contract between managers and investors will be restructured by using the new information. We show that the optimal bankruptcy rule can be achieved by a debtlike contract.

The view of bankruptcy here is similar to that of Harris and Raviv (1990a), who argue that the process of default disseminates considerable information to investors. They analize the firm's optimal debt level and associated liquidation and restructuring decisions.[3] We show why new information is only generated when the firm fails to make a promised payment. The view of bankruptcy here also incorporates the idea of Aghion and Bolton (1988) and Zender (1991) that bankruptcy involves a transfer of control. The control transfer here is from managers (rather than shareholders) to creditors.

Another important contribution of this article is that it endogenously *derives* (rather than imposes) public equity and debt as the optimal financial instruments. Most models that endogenize financial contracts have derived only debt and *inside* equity [see Townsend (1979), Diamond (1984), Gale and Hellwig (1985), Hart and Moore (1989), and Chang (1990)].[4] A special feature of many of these models is that managers can treat all the firm's funds that have not been paid out as their own income (i.e., they can "steal" the funds). This feature appears to be an inappropriate description of large, publicly held corporations in which well-established accounting and auditing systems can easily detect a large amount of expropriation by managers.

We proceed as follows. The model and the assumptions are presented in Section 1. Section 2 analyzes the optimal contract in the

[3]Stulz (1990) also studies the role of financing policies in alleviating the managerial incentive problem of overinvesting. Neither Harris and Raviv (1990a) not Stulz (1590) explicitly consider the optimal contracting problem between managers and investors.

[4]The exceptions are Williams (1989) and Chang (1992). Public equity can exist in those models because accounting mechanisms prevent managers from expropriating the firm's earnings.

absence of the bankruptcy mechanism. Section 3 reconsiders the problem with the bankruptcy mechanism. The investors' incentives to impose bankruptcy ex post are studied in Section 4. Section 5 concludes the paper. The Appendix contains all proofs and more technical results.

1. The Model

The model has three dates. At date 0, the contract between investors and a manager is signed. The manager is charged with the responsibility of making payout and spending decisions at date 1.[5] At date 2, the firm is liquidated. In this model, the results are not driven by date 2 being a terminal date. In principle, the analysis for date 1 can be extended to date 2 and beyond. The manager can be viewed as representing the whole management team and other key employees of the firm. The distinction between the investors who are equity holders and those who are debt holders will be made later.

1.1 The technology

At date 1, the firm's cash flow available for distribution is the difference between its revenues and expenses. The optimal spending level (from the investors' perspective) for many types of expenses is difficult to determine. Examples of these expenses include funds used for reinvestment, bonuses paid to the employees, perks enjoyed by managers and employees, funds wasted in production and management, and corporate donations to other causes.

The *optimal payout*, x, is defined to be the firm's revenue minus the optimal amount of spending (the precise definition of x will be given later). The variable x is random and it is realized at date 1. Since x is difficult for outside investors to evaluate, we assume that the realization of it is observed privately by the manager.[6] Suppose x is distributed on $[L, H]$. The density function of x, $f(x)$, is positive for all x in $[L, H]$.

Let P be the *actual* payout to the investors at date 1. It is chosen by the manager. The difference between the optimal payout and the actual payout, $x - P$, is the amount overspent by the manager. It will be referred to as *on-the-job consumption* (i.e., overspending). On-the-job consumption need not be worthless to the investors. Its date

[5] In practice, the firm's dividend and financial policies have to be approved by the board of directors. In this model, we do not consider the role of the board explicitly. The board can be viewed as being either completely controlled by management or as uninformed as the investors.

[6] Jenscn (1989) defines free cash flow as "cash flow in excess of that required to fund all investment projects with positive net present values." His definition is thus closely related to the concept of optimal payout defined here. Our definition is more general in that we include spending other than investment.

2 payoff to the investors will be denoted by $k(x - P)$. The discount rate is assumed to be zero for simplicity.

It is assumed that in addition to the payoff from on-the-job consumption, $k(x - P)$, the firm's assets are worthy at date 2. The variable y is also random. The date 2 value of the firm (before the manager is paid) is thus $y + k(x - P)$, which can be thought of as the sum of the discounted value of all future payouts of the firm. The variables x and y are assumed to be stochastically independent. Thus, when P is paid out at date 1, the investors receive P at date 1 and $k(x - P) + y$ at date 2 (before the manager is paid).

When we say that x is the optimal payout, we mean that the investors' expected payoff given x, $P + k(x - P) + E[y]$, achieves the maximum at $P = x$. Note that, since this expected payoff is gross of the manager's compensation, x is the optimal payout without considering the manager's compensation and his on-the-job consumption. It is assumed that $k(\cdot)$ is differentiable, $k'(\cdot) > 0$, $k'(0) = 1$, and $k''(\cdot) < 0$. The latter two conditions are the sufficient conditions for $P + k(x - P) + E[y]$ to achieve the maximum at $P = x$.

1.2 The preferences

The investors are risk neutral. As mentioned, the interest rate is assumed to be zero. Thus, the investors maximize their expected payoff.

The manager cares about his monetary compensation and on-the-job consumption. The manager's preferences are represented by the expected utility $E[U(W) + V(x - P)]$, where W is the monetary compensation received the manager. The managerial utilty function is similar to that used in Jensen and Meckling (1976), where $x - P$ are interpreted as "perks." We assume that both $U(\cdot)$ and $V(\cdot)$ are strictly increasing and weakly concave.[7]

The manager directly values the difference between the optimal payout and the actual payout $x - P$ because it allows him to pursue his own objectives. For example, overspending on employees' bonuses improves the manager's working relation with the employees and makes his job more pleasant.

At date 0, there is a competitive supply of managers. The reservation *expected* utility level for the manager is u. For simplicity, the manager's compensation W is assumed to be paid out from the firm's date 2 value.

It is assumed that the manager's ex post utility level cannot fall below a minimum level u_O. Managers generally have the freedom to quit their jobs. Firms are legally constrained in most developed econ-

[7] If $U(\ )$ and $V(\ )$ are linear, we assume that $U' > V'$.

omies from imposing arbitrary financial or other penalties on their employees. The minimum utility level u_O may be interpreted as the utility level that the manager can obtain from alternative jobs minus the disutility of all relocating costs and penalties.[8]

1.3 Feasible contracts

Although x cannot be observed by the investors, a contract between the manager and the investors can be thought of as being contingent on the manager's reported x without loss of generality. By the Revelation Principle [see Harris and Townsend (1981) and Myerson (1979)], any allocation that can be achieved by a feasible contract can also be achieved by a contract in which the manager reports truthfully. Thus, the optimal can always be achieved by such a truth-telling (incentive-compatible) contract. The implementation of a truth-telling contract may also be simpler than non-truth-telling ones. Later we will interpret the optimal contract as depending on the payout rather than literally on the reported x.

A contract between the investors and the manager specifies two schedules as functions of the reported x: a managerial compensation schedule $W(x)$ and a payout schedule $P(x)$. For simplicity, we will use the same notation to denote the realized x and the reported x.

2. Discretionary Payout and Managerial Compensation

In this section, we study the optimal payout schedule $P(x)$ and compensation schedule $W(x)$. We first formulate the investors' optimization problem. Then the optimal contract is characterized, and the costs of external equity financing are studied.

2.1 The optimal contracting problem

The investors' problem at date 0 is to maximize their expected payoff subject to a number of constraints. One constraint is the manager's voluntary participation constraint: the expected utility to the manager should be at least as high as his reservation expected utility level u:

$$E[U(W(x)) + V(x - P(x))] \geq u. \tag{1}$$

Since x is privately know, the manager has incentives to misrepresent it. This constrains the set of feasible contracts. By the Revelation Principle, we need only consider contracts satisfying the truth-telling (incentive compatibility) constraint. The truth-telling constraint states that for two arbitrary realizations of x, x_1 and x_2, if x_1 is

[8] Monetary penalties for quitting could be specified in the contract. However, the penalties are limited by managers' wealth. Managers cannot be put in jail for poor financial performance.

the true realization then the manager will prefer reporting x_1 to reporting x_2.

$$U(W(x_1)) + V(x_1 - P(x_1)) - U(W(x_2)) - V(x_1 - P(x_2)) \geq 0. \quad (2)$$

The third constraint is the manager's minimum utility constraint. That is, for all x in $[L, H]$,

$$U(W(x)) + V(x - P(x)) \geq u_0. \quad (3)$$

The payoff to the investors is the date 1 payout, $P(x)$, plus the date 2 firm value, $y + k(x - P(x))$, minus the manager's compensation, $W(x)$. The investors' maximization problem at date 0 is

$$\max_{W(\ ),\, P(\ )} \; E[P(x) + y + k(x - P(x)) - W(x)]$$

$$\text{s.t.} \quad (1), (2), \text{and } (3).$$

2.2 Characterization of the optimal contract

Since the truth-telling constraint (2) should hold for all possible x_1 and x_2, it represents a continuum of constraints. Therefore, it is difficult to characterize program (4) directly. It is easier to work with a differential version of (2), which is derived by dividing (2) by $x_1 - x_2$ and by taking the limit as x_2 approaches x_1. Since $x_1 - x_2$ can be either positive or negative, the differential version will satisfy both "$\geq$" and "$\leq$." Hence, it is an equality[9]

$$U'(W(x))W'(x) - V'(x - P(x))P'(x) = 0. \quad (5)$$

Constraint (5) is the first-order necessary condition for the manager to report truthfully, but it is not sufficient. That is, (2) implies (5), but not vice versa. Lemma 3 in the Appendix shows that in our model (5) also implies (2). Thus, the "first-order" approach taken here is valid.

Now the maximization problem (4) can be rewritten as

$$\max_{W(\ ),\, P(\ )} \; E[P(x) + y + k(x - P(x)) - W(x)]$$

$$\text{s.t.} \quad (1), (5), \text{and } (3). \quad (6)$$

Program (6) is an optimal control problem. We assume the existence of piecewise continuously differentiable optimal schedules, as in the standard control problem. Standard techniques can be used to derive the first-order conditions. The details of the derivation are carried out in the Appendix. One useful condition for characterizing

[9] Strictly speaking, (5) only holds for x in the interior of $[L, H]$. However, since $x = L$ and $x = H$ are zero-probability events, changing the values of W' and P' at these endpoints will not affect the optimal solution. In fact, all the results on the optimal schedules hold with probability 1 rather than for every x.

the optimal contract is

$$1 - k'(x - P(x)) = V'(x - P(x))/U'(W(x)) - \delta(x)V''(x - P(x)), \tag{7}$$

where $\delta(x)$ is the multiplier for the truth-telling constraint (5). Lemma 2 of Appendix shows that $\delta(x) > 0$ with probability 1.

Equation (7) states that the marginal cost of on-the-job consumption $x - P$ equals the marginal benefit. When on-the-job consumption at x, $x - P(x)$, is increased at the margin, the investors lose one unit of date 1 payout while receiving $k'(x - P)$ units of date 2 payoff. Thus, the direct net marginal cost of raising $x - P$ is $1 - k'(x - P(x))$. The marginal benefit of raising $x - P$ to the manager measured in dollars is $V'(x - P(x))$ divided by $U'(W(x))$. In addition, when on-the-job consumption at x is raised at the margin, it will give the manager more incentive to report the x truthfully. The marginal benefit due to this incentive effect is $\delta(x)V''(x - P(x))$.

The following two propositions state some properties of the optimal contract.

Proposition 1. At the optimum, the on-the-job consumption $x - P(x)$ cannot be negative.

The intuition is as follows. Suppose that $x - P(x)$ is negative for some x. That is, the actual payout is higher than the optimal payout. Then, since x is the optimal payout, paying out more than x will hurt the investors. Thus, both the investors and the manager will be better off by reducing P (increasing $x - P$). An increase in on-the-job consumption $x - P$ at x will also increase the manager's incentive to report the x truthfully. Last, an increase in $x - P$ will make the minimum utility constraint (3) less binding.

Proposition 2. *In the optimal contract, both $W(x)$ and $P(x)$ are nondecreasing in x. In addition, $W(x)$ remains a constant in an interval if and only if $P(x)$ does so in the same interval. Thus, W can be written as an increasingfunction in P.*

Since the objective here is to induce the manager to pay out x, we should expect the optimal compensation and payout schedules to be nondecreasing in x. The result also shows that W is also strictly increasing in the payout P. Thus, Proposition 2 not only states an important property of the optimal contract, it also helps us to interpret it. Note that the manager need not literally report the optimal payout x as we have imagined here. With Proposition 2, the manager can be viewed as paying out P rather than reporting x. His compensation W is contingent on the payout.

The payout $P(x)$ is subject to the manager's discretion because he has the option to report a lower x, which will result in a lower payout. This payout can be interpreted as dividend payout, or it might be achieved through share repurchases.

The standard finance and legal literature views equity as the residual claim. For large, widely held corporations, equity holders have no effective control over what the firm pays. Thus, public equity is essentially a claim on the discretionary payout P. Our model shows that compensation schemes can be structured to provide managers with incentives to make appropriate payouts.

In practice, managers' bonus plans often *explicitly* depend on the dividend payout. In a study of managerial bonuses, Healy (1985) reports that in 22 percent of his sampled firms the maximal amount of funds that can be transferred to the bonus pool is an increasing function of the cash dividend payout. Compensation and payout can also be connected through ways other than bonuses. More empirical work is needed to determine whether there is indeed a positive link between managerial compensation and the firm's discretionary payout.

2.3 The costs of external equity financing

We now investigate the sources of the costs of equity financing. To do that, we need to better understand the first-best contract.

Proposition 3. *Suppose that the realization of x is public information and that $U''(W) < 0$. Then at the optimum, $W(x)$ is a constant and $P(x)$ equals x minus a constant.*

The result shows that the first-best payout schedule in the complete information case is a residual payout policy: making payment only after all the positive NPV projects and spending (including the optimal amount of on-the-job consumption) are funded. When the investors know what the true x is and when the manager is risk averse, it is optimal and feasible to give him *constant* compensation and *constant* on-the-job consumption and to ask him to pay out the residual (x minus the optimal amount of on-the-job consumption).

If the realization of x is publicly verifiable, there will be no need for the truth-telling constraint (5). This case can be regarded as one in which $\delta(x) = 0$ for all x. Therefore, the first-best solution is the one that satisfies (7) with $\delta(x) = 0$ for all x.

When x is privately observed, $\delta(x)$ will be positive with probability 1 (see Lemma 2 of the Appendix). If $V''(x - P(x)) < 0$, the marginal benefit of increasing on-the-job consumption due to the incentive effect, $-\delta(x)V''$, will be positive. Thus, given the manager's utility level at x, the optimal contract will involve more on-the-job consumption relative to the first best.

If $V''(x - P(x)) = 0$, the manager is neutral toward the risk of on-the-job consumption. The interpretation of this condition is that the manager is much more averse to the risk of his income than to the risk of on-the-job consumption. This is likely to be the case for x in the range where the manager is very wealthy in terms of on-the-job consumption and not as wealthy in terms of his personal income. The next proposition shows that even in this case the residual payout policy will be not be followed. In fact, the payout will be smooth relative to x.

Proposition 4. *Suppose that $V(\cdot)$ is linear and $U''(W) < 0$. Then the optimal payout schedule $P(x)$ satisfies $P'(x) < 1$.*

The result is equivalent to on-the-job consumption $x - P(x)$ increasing in x. The intuition is as follows. Due to the incentive effect, the more sensitive the payout P is to x, the more sensitive must be the compensation W to x. Making P less sensitive to x will reduce the sensitivity, or the risk, of W. It will, however, raise the sensitivity (risk) of $x - P$. Thus, there is a trade-off between bearing income risk and bearing on-the-job consumption risk. When the manager is averse to the income risk and neutral to on-the-job consumption risk, it is efficient to make him bear more risk in $x - P$ (i.e., make P less sensitive to x). That will reduce the compensation paid to the manager and hence increase the firm's value.

The fact that the optimal payout schedule has a slope of less than **1** means that the actual payout is smooth relative to the optimal payout. The payout smoothing here is not necessarily the same as dividend smoothing relative to earnings. In our model, payout smoothing is due to agency considerations and asymmetric information. Without the agency problem or information asymmetry, there would be no need to smooth the payout even when the manager is averse to his income risk. He could be relied on to pay out the true residual even when his compensation is a constant.

We have shown that when information is asymmetric, inefficiency will occur in the form of excessive on-the-job consumption. This is one source of the cost of public equity financing. There is another source. When the manager's reservation utility level u is small relative to the expected optimal payout, it is possible that the manager may be overcompensated. That is, the manager's expected utility at the optimum can exceed his reservation level, u. The reason the manager may be overcompensated is that upside incentives are needed to induce payout when the extent to which the manager can be punished is limited due to the existence of the lower bound on his utility, u_0.[10] This overcompensation reduces the investors' payoff.

It is instructive to compare this model to the standard principal-agent models. In those models, the true optimal payout x is publicly verifiable, and the contract is designed to motivate the manager to exert unobservable effort. Here the true x is privately observed by the manager, and he has incentives to overretain funds. Thus, the managerial compensation scheme will have to be related to the actual payout, and there is a natural link between financial policy and managerial compensation. In this model, as in principal-agent models, managerial risk aversion and the minimum utility constraint limit the effectiveness of compensation schemes in dealing with incentive problems.

3. The Debt Contract

In this section we introduce an alternative mechanism-bankruptcy-to deal with the managerial incentive problem. The optimal bankruptcy schedule is studied. It is shown that a bankruptcy schedule that prevents the manager from misrepresenting the true x is "left-tailed." That is, bankruptcy occurs when the reported x is below a constant. The term $P(x)$ is interpreted as a combination of a promised debt payment and a discretionary payment.

3.1 The bankruptcy mechanism

Bankruptcy in this model is viewed as an event in which new information about the true x is generated and in which the control over the firm's payout and spending decisions is transferred from the manager to the investors. The view of bankruptcy here incorporates the ideas of Harris and Raviv (1990a) and of Aghion and Bolton (1988) and Zender (1991). In Harris and Raviv, bankruptcy also generates new information. Our model proves that the new information will be generated when a fixed payment is not made. Aghion, Bolton, and Zender view bankruptcy as a transfer of control from the owner to the creditor. In our model the transfer is from managers to creditors.[11]

In bankruptcy the investors incur a cost $b(x)$ and observe a signal about true realization of x. It is assumed that the signal they observe

[10] An example of overcompensation is presented in the Appendix.

[11] In some countries, managers in bankruptcy lose all control to court-appointed trustees (England, Germany, and Italy, for examples). Under the current U.S. Bankruptcy Code, managers retain control of day-to-day operations. The major spending decisions, however. have to be approved by creditors.

is not verifiable by the court. The cost of obtaining a signal about x is presumably much lower than the cost of verifying the signal for a court, because a court would have to learn everything about the firm from scratch. Our assumption that the signal is unverifiable is an extreme case of this disparity. For simplicity, we assume that the signal is perfect; that is, the investors learn the true realization of x after spending $b(x)$.[12]

By "a transfer of control," we mean that in bankruptcy the investors are given the right to choose the payout level p and the compensation level w to maxmize their expected payoff subject to the constraint that the manager's utility level cannot be below u_0, the manager's minimum acceptable utility level (note that we use the lowercase w and p to denote the compensation and the payout in bankruptcy).

For a given x, the investors' maximization problem in bankruptcy is

$$\max_{w,\,p}\; p + k(x - p) - w + E[y]$$

$$\text{s.t.} \qquad U(w) + V(x - p) \geq u_0. \tag{8}$$

It can be shown that there exists a unique solution to program (8).[13] We denote the optimal solution by $w(x)$ and $p(x)$.

The optimal contract in the absence of bankruptcy can involve excessive on-the-job consumption relative to the first-best solution. Using new information about x and recontracting by choosing new w and p can improve efficiency. This efficiency gain is the benefit of the bankruptcy in our model. The cost of bankruptcy is $b(x)$.

Since the information signal generated in bankruptcy is unverifiable by a court, the outcome of recontracting cannot be prespecified in a date 0 contract as a function of the signal. Recontracting will actually take place ex post after a control transfer. Of course, a control transfer and recontracting do not have to be called bankruptcy. As we will see shortly, however, the fact that a control change and recontracting occur after the firm fails to make a promised payment makes the interpretation of bankruptcy quite natural.

3.2 Characterization of the problem

In addition to $P(X)$ and $W(x)$, a date 0 contract now also includes $s(x)$, the bankruptcy schedule. This schedule specifies the probability of bankruptcy when the manager reports x. Initially, it is assumed that the investors can precommit to impose bankruptcy according to

[12] This assumption can be relaxed without affecting the key result, Proposition 5.

[13] It is easy to see that the constraint is binding at the optimum. With the constraint, w can be expressed as a function of p. Differentiating the constraint twice with respect top, we can check that $w_{pp} \geq 0$. Now the second-order condition of the maximization problem becomes $k''(x - p) - w_{pp}(p) < 0$. Thus, the optimal solution is unique.

the schedule $s(x)$, and only deterministic bankruptcy strategies will be used. The latter assumption means that $s(x)$ can be 0 or 1. When $s(x) = 1$, bankruptcy will take place. These two assumptions will be relaxed in the next section.

Suppose that S is the region in which bankruptcy will take place. That is, $S = (x \mid s(x) = 1)$. Then the truth-telling constraint (2) of Section 2 only applies to all x's that are in S^c, the complement of S. More truth-telling constraints are needed here: no misrepresentation within S and no misrepresentation between S and S^c.

It is easy to see that the constraint in (8) will be binding at the optimum (w can always be reduced). Therefore, in bankruptcy the manager will receive the constant utility u_0. This implies that the manager has no incentive to misrepresent x within S.

Two other constraints are used: when the true x is in S, the manager should have no incentive to say that it is in S^c, and vice versa:

$$u_0 \geq U(W(x_2)) + V(x_1 - P(x_2)) \qquad \forall\, x_1 \in S\ \forall\, x_2 \notin S; \qquad (9)$$

$$U(W(x_2)) + V(x_2 + P(x_2)) \geq u_0 \qquad \forall\, x_2 \notin S. \qquad (10)$$

It is shown in Proposition 5 that these two constraints imply that bankruptcy occurs whenever the reported x is below a constant.

Proposition 5. *The bankruptcy schedule $s(x)$ of a truth-telling contract is "left-tailed": $s(x_1) = 1$ implies $s(x) = 1$ for all x in $[L, x_1]$.*

The proof is simple. The idea is that if there existed a bankruptcy region to the right of a nonbankruptcy region, the manager's utility level would be *increasing* in x in the nonbankruptcy region (to provide the manager with incentives to report truthfully) and then become u_0 in the bankruptcy region. Since the manager's utility in the nonbankruptcy region is rising, it must at some point be higher than u_0, the manager's minimum utility level. Therefore, there would be no way to prevent the manager who is in the bankruptcy region from reporting a lower x in the nonbankruptcy region, where he receives higher utility.

The "left-tailedness" of the bankruptcy schedule in this model is implied by incentive compatibility alone. In the models of costly state verification, the optimality (not merely incentive compatibility) is needed to derive this property, and the driving forces of this property are subtle and delicate [see Gale and Hellwig (1985, p. 648)].

Like constraint (2), both (9) and (10) represent a continuum of constraints. They are difficult to handle directly in an optimization problem. Some simplifications are necessary.

Let m be the infimum (lower bound) of S^c, the nonbankruptcy region. That is, $m = \inf\{x \mid s(x) = 0\}$. Without loss of generality, it is assumed that $m \in S$. Proposition 5 states that $s(x) = 0$ for $x \geq m$ and $s(x) = 1$ otherwise.

It is shown in Lemma 4 of the Appendix that, given Proposition 5, constraints (9) and (10) are equivalent to

$$U(W(m)) + V(m - P(m)) = u_0. \tag{11}$$

Equation (11) says that at the boundary point between the bankruptcy region and the nonbankruptcy region, m, the manager's utility function is continuous. The idea is that if the manager's utility were not continuous at m, he would have incentive to misrepresent when x is around m.

Due to Proposition 5 and Lemma 4, the optimization problem for the investors in this case can be significantly simplified:

$$\begin{aligned} \max_{W(\ ),\, P(\ ),\, m} \quad & E\{s(x)[p(x) + k(x - p(x)) - w(x) - b(x)] \\ & \quad + (1 - s(x))[P(x) + k(x - P(x)) - W(x)] + y\} \\ \text{s.t.} \quad & E\{s(x)u_0 + (1 - s(x)) \\ & \quad \times [U(W(x) + V(x) - P(x))]\} \geq u, \text{ (5), and (11).} \end{aligned} \tag{12}$$

In program (12), $s(x)$ is determined by m, the boundary point between the bankruptcy and nonbankruptcy regions. The relevant range of the schedules $W(x)$ and $P(x)$ is $x \geq$ m. It is not difficult to see that the characterization of the optimal contract for $x \geq m$ will not be different from that of Section 2, and the optimal $W(x)$ and $P(x)$ will still satisfy the properties derived in Section 2.

The first-order necessary condition for m to be optimal is

$$\begin{aligned} & p(m) + k(m - p(m)) - w(m) \\ & \quad - [P(m) + k(m - P(m)) - W(m)] \\ & \quad + \sigma V'(m - P(m)) = b(m), \end{aligned} \tag{13}$$

where σ is the multiplier for the constraint (11). Note that capital P and W denote the contract in the nonbankruptcy region, and small p and w in the bankruptcy region. In Equation (13), $p(m) + k(m - p(m)) - w(m) - [P(m) + k(m - P(m)) - W(m)]$ is the efficiency gain from recontracting at $x = m$ When m increases at the margin, the bankruptcy region in which the manager's utility is u_0 will expand toward the right, and the manager's utility level as a function of x in the nonbankruptcy region will also be shifted to the right. Since the manager's utility function is an increasing function of x in the nonbankruptcy region (Lemma 1 in the Appendix), his utility level in the nonbankruptcy interval will be reduced as m increases. This marginal benefit (or cost, depending on the sign of σ) to the investors is represented by $\sigma V'(m - P(m))$. The cost of bankruptcy at m is $b(m)$.[14]

3.3 The interpretation of the optimal contract

The optimal payment schedule $P(x)$ derived here can be interpreted as a combination of a debt payment and a discretionary payment. To see this, define $D = P(m)$. That is, D is the payout level when $x =$ m. For $x \geq m$, reporting x is equivalent to paying $P(x)$. Reporting an x that is below m can be viewed as failing to pay D. The firm has to pay at least D to avoid bankruptcy. Thus, the optimal contract consists of two securities: a security that promises to pay D, where a failure to pay D triggers bankruptcy, and a security that pays $P(x) - D$ when the firm is not in bankruptcy.

The first security can be interpreted as debt. The amount D can be interpreted as the promised payment on debt. The second security can be interpreted as equity.[15] Note that the payment to equity holders, $P(x) - D$, is at the manager's discretion. The manager could pay less than $P(x) - D$ to the equity holders without risking bankruptcy. However, his monetary compensation would be reduced accordingly.

4. Incentives to Impose Bankruptcy and Other Qualifications

Haugen and Senbet (1978) have forcefully argued that in a well-functioning market, bankruptcy costs can largely be avoided. In our model, it is not clear that the cost of imposing bankruptcy is less than the benefit, ex post. If the investors can precommit to the bankruptcy schedule ex ante, the set of feasible contracts will be enlarged. Thus, if the investors can precommit, it is ex ante optimal to do so. Most existing contracting models make the precommitment assumption. In this section, it is shown that the investors ex post can still have incentives to impose bankruptcy on the firm despite the cost $b(x)$ because the new information obtained in bankruptcy induces a more efficient allocation.

When the firm defaults, the investors know that $x < m$. The investors can impose bankruptcy (i.e., obtain new information) at the cost $b(x)$ and achieve the recontracting outcome. Alternatively, they can obtain no new information and save the cost $b(x)$. In the latter case, they

[14] Even when $b(x)$ is very small, the optimal bankruptcy region will not be the whole interval $[L, H]$. If that were the case, we could redefine $s(H)$ to be 0. Then $P(H)$ and $W(H)$ could be set at the first-best level and still be incentive compatible since no x higher than H will mimic H. Thus, there would be no gain from recontracting at $x = H$. By redefining the contract in this way. we could avoid the cost $b(H)$.

[15] We ignore the conflicts of interests between bondholders and shareholders analyzed by Myers (1977) and Green (1984). Bankruptcy may also involve recontracting between bondholders and shareholders.

can still impose payout P^* and compensation W^* that are optimal on average subject to the constraint that the manager will receive at least u_0 even when $x = L$, the lowest realization of x. That is, P^* and W^* solve the following problem:

$$\begin{aligned} &\operatorname*{Max}_{W,\,P} E[P + k(x - P) - W + y \mid x < m] \\ &\text{s.t.} \qquad U(W) + V(L - P) \geq u_0. \end{aligned} \tag{14}$$

For the investors to have incentives to impose bankruptcy on the firm according to the optimal bankruptcy schedule $s(x)$, their expected payoff of doing so must be no lower than that of not doing so (i.e., using the contract P^* and W^*). That is,

$$\begin{aligned} &E[p(x) + k(x - p(x)) - w(x) - b(x) + y \mid x < m] \\ &\quad \geq E[P^* + k(x - P^*) - W^* + y \mid x < m]. \end{aligned} \tag{15}$$

Inequality (14) is equivalent to

$$\begin{aligned} &E[p(x) + k(x - p(x)) - w(x) - [P^* + k(x - P^*) - W^*] \mid x < m] \\ &\quad \geq E(b(x) \mid x < m]. \end{aligned} \tag{16}$$

Inequality (16) states that, given default $(x < m)$, the investor's expected gain from recontracting is higher than the expected bankruptcy cost. It is easy to see that (16) is likely to hold when $b(x)$ is relatively low. Due to space considerations, the conditions under which inequality (16) is likely to hold will not be analyzed in detail here.

When inequality (16) is met, it is optimal for investors to impose bankruptcy on the firm ex post. The precommitment assumption is thus not needed. When (16) is not met, ex post the investors have no incentive to impose bankruptcy. We are back to the case of Section 2 in which the bankruptcy mechanism does not exist. Thus, if the investors cannot precommit to the bankruptcy schedule, in order to implement the bankruptcy mechanism, inequality (16) needs to be added as a constraint to the contracting problem. Only an m that meets (16) will be chosen at date 0.

Given that it is better for the investors to impose bankruptcy when the firm is in default, they will not randomize even when randomized bankruptcy strategies are allowed. That is because without the assumption of precommitment the investors will always choose the action that benefits them the most ex post. Randomized strategies are implementable only when the investors are precommitted to carry them out.

We have assumed that the manager's utility depends on overspending rather than total spending because a large part of the total spending is not at the manager's discretion. The manager may not be able to use all of funds spent to pursue his own objectives. It might be argued, however, that in some cases, the manager's utility can depend on total spending, not just on overspending. Let R be the firm's revenue and Z the optimal spending. Then the optimal payout x becomes $R - Z$, and total spending can be written as $Z + x - P = R - P$. If R is verifiable, P and w can be made contingent on R and on the reported x (or equivalently Z). Our analysis could be extended to this case. Basically, the manager will be provided insurance against the risk in R. When both Rand Zare unverifiable, we have two sources of asymmetric information. The problem becomes much more difficult. Whether R is verifiable or not, the mathematical techniques required to analyze the problem when the schedules depend on two variables are very complex (the standard techniques dealing with optimal control problems do not apply). We will not pursue this analysis here.[16]

5. Conclusion

We model contractal arrangements between modern corporations and their investors. We present a formal model of public equity financing and argue that when managers have incentives to overretain funds and overspend, public equity is only a claim on the payout that is at the managers' discretion. To motivate managers to make this payout, their compensation should be linked to it. This model enables us to identify the costs of public equity financing and to analyze the properties of the firm's discretionary payout policy. We show that when the managers are risk averse, a residual payout policy is not optimal and on-the-job consumption can be excessive relative to the first-best solution.

Investors can obtain new information about the firm's optimal pay out level ex post. The new information allows the firm to achieve a more efficient allocation through recontracting. When it is impossible for a court to obtain the same information, the information can be utilized by transferring the control of the firm from management to investors. We show that the information will be obtained if and only if the firm's payout falls below a promised level. This property allows us to interpret part of the optimal contract as as debt contract and the recontracting as bankruptcy. The new information is not generated

[16]For tractability, contracts contingent on the firm's value. $P + k(x - P) + y$, are ruled out. The firm's value is a poorer measure of overspending in the current period than the payout is because the marginal change in the firm's value is $1 - k'(x - P) < 1$ when the payout changes one unit. The firm's value will be a still poorer measure when y represents the sum of all future payouts and when the current manager when y represents the sum of all future payouts and when the current manager may not be responsible for all of them. As a result, making managerial compensation depend on the firm's value will exacerbate the overcompensation problem. See the working paper version of this article for mote discussion on this point.

when the optimal payout is high because the discretionary payout (public equity) arrangement works more efficiently for high optimal payout levels.

Appendix

We obtain the first-order necessary conditions for the maximization problem (6) and derive condition (7). Propositions 1-5 are proved, and four lemmas are stated and proved.

Derivation of condition (7)

Let λ, $\delta(x)$, $\tau(x)$ be the multipliers of (1), (5), and (3), respectively; m_1 is the costate variable for $W(x)$ and m_2 that for $P(x)$. The Hamiltonian is

$$\{P(x) + k(x - P(x)) - W(x) + \lambda[U(W(x)) + V(x - P(x)) - u]$$
$$+ \delta[U'(W(x))b_1 - V'(x - P(x))b_2]$$
$$+ \tau[U(W(x)) + V(x - P(x)) - u_0]\}f(x) + m_1 b_1 + m_2 b_2 + E[y].$$

By Pontryagin's maximum principle [see Hestenes (1966)], we have

$$-m_1' = \{-1 + \lambda U'(W) + \delta U''(W)b_1 + \tau U'(W)\} f(x), \tag{A1}$$

$$-m_2' = \{1 - k'(x - P) - \lambda V'(x - P) + \delta V''(x - P)b_2 - \tau V'(x - P)\} f(x), \tag{A2}$$

$$m_1 + \delta U'(W) f(x) = 0, \tag{A3}$$

$$m_2 - \delta V'(x - P) f(x) = 0. \tag{A4}$$

By totally differentiating (A3) and (A4) with respect to x and by substituting the results into (A1) and (A2), respectively, we have

$$\{1 + (\lambda + \tau - \delta')U'(W)\}f(x) - \delta U'(W)f'(x) = 0, \tag{A5}$$

$$\{1 - k'(x - P) - (\lambda + \tau - \delta')V'(x - P) + \delta V''(x - P)\}f(x) + \delta V'(x - P)f'(x) = 0. \tag{A6}$$

Equation (A5) implies that $(\lambda + \tau - \delta')f(x) - \delta f'(x) = f(x)/U'(W)$. Substituting this into (A6), we get condition (7):

$$U'(W(x))[1 - k'(x - P(x)) + \delta(x)V''(x - P(x))] = V'(x - P(x)).$$

Lemma 1. *$U(W(x)) + V(x - P(x))$ strictly increases with x.*

Proof. Since $'(x - P > 0$, $U'(W)W' + V'(x - P)(1 - P') > U'(W)W' - V'(x - P)P'$. By (5), $U'(W)W' - V'(x - P)P' = 0$. Thus, the derivative of $U(W) + V(x - P)$ is positive. Therefore, $U(W) + V(x - P)$ is strictly increasing in x. Q.E.D.

Lemma 2. *$\delta(x) > 0$ with probability 1.*

Proof. If the truth-telling constraint (5) is relaxed to an inequality,

$$U'(W(x))W'(x) - V'(x - P(x))P'(x) \geq 0, \tag{A7}$$

then $\delta(x) \geq 0$ is ensured and (A1)-(A6) will not be changed. We only need to show that, at the optimum, (A7) is binding. Suppose that (A7) is not binding. Then it must be nonbinding in an interval I by continuity. Thus, $\delta = 0$ in I. Equations (A3) and (A4) imply that $m_1 = m_2 = 0$. Hence, $m'_1 = m'_2: = 0$. With $m'_1 = 0$ and d = 0, (Al) implies that $(\lambda + \tau)U'(W) = 1$. Substituting this and m'_2 = d = 0 into (A2), we have $k'(x - P) + (\lambda + \tau)V'(x - P) = 1$.

By Lemma 1, constraint (3) can only be binding at one point at most. When (3) is not binding, $\tau = 0$. Without loss of generality, we assume that $\tau = 0$ in I.

Since λ is a constant in (l + t) U'(W) = 1, t = 0 implies that $W(x)$ is a constant or $W' = 0$ in I. Equation (7) becomes $1 - k'(x - P) = V'(x - P)/U'(W)$, which implies that $x - P(x)$ = constant or $P' = 1$ in I. Substituting $W' = 0$ and $P' = 1$ into (A7), we have a contradiction.

Since $\delta(x)[U'W' + V'(1 - P')] = 0$, piecewise continuity of W' and P' implies that $\delta(x)$ is piecewise continuous. Since $\delta(x) \geq 0$, if $\delta(x) > 0$ with probability less than 1, there must exist an interval I in which $\delta(x) \geq 0$. As we have seen, this will lead a contradition with (A7). Q.E.D.

***Proof of Proposition* 2.** Suppose that $x - P(x) < 0$. Then $1 - k'(x - P) + \delta V''(x - P) < 0$, since, by definition, $k'(x - P)x)) > 1$ and $V'' \leq 0$. On the other hand, $V' > 0$ and $U' > 0$, so (7) is violated.

Q.E.D.

Proof of Proposition 2. We divide the proof into two cases. The first case is $V'' < 0$. Suppose that for $x_2 > x_1$, $P(x_2) < P(x_1)$. Then $V'(x - P(x_1)) - V'(x - P(x_2)) > 0$, since $V'' < 0$ and $x - P(x_1) < x - P(x_2)$. That is, $V(x - P(x_1)) - V(x - P(x_2))$ is an increasing function of x. Thus, the truth-telling constraint (2) implies that

$$U(W(x_1)) + V(x_2 - P(x_1)) - U(W(x_2)) - V(x_2 - P(x_2)) > 0.$$

This means that when the true realization is x_2, the manager will prefer to report x_1. Thus, an incentive compatible $P(x)$ cannot be decreasing.

The second is $V'' = 0$. Condition (7) then becomes $U'(W)[1 - k'(x - P)] = V'$, where V' is a constant. By differentiating, we have $U''W'(1 - k') - (1 - P')U'k'' = 0$. Suppose that $P' < 0$; then $W' < 0$ by (5). By Proposition 1, $x - P(x) \geq 0$. Thus, $1 - k'(x - P) \geq 0$ by the definition of $k(\cdot)$. Since $U'' \leq 0$ and $W' < 0$, $U''W'(1 - k') \geq 0$. Since $k'' < 0$ and $1 - P' > 0$, $-(1 - P')U'k'' > 0$. Therefore, $U''W'(1 - k') - (1 - P')U'k'' = 0$ cannot hold. Q.E.D.

Lemma 3. *Constraint (5) is equivalent to constraint (2).*

Proof. For any x and x_1,

$$U(W(x)) + V(x - P(x)) - U(W(x_1)) - V(x - P(x_1))$$

$$= \int_{x1}^{x} [U'(W(\xi)W'(\xi) - V'(x - P(\xi))P'(\xi)\, d\xi$$

$$\geq \int_{x1}^{x} [U'(W(\xi)W'(\xi) - V'(\xi - P(\xi))P'(\xi)]\, d\xi = 0. \quad \text{(A8)}$$

The inequality in (A8) obtains because $-V'(x - P(\xi))$ is nondecreasing in x and $P' \geq 0$ by Proposition 2. The last equality obtains via *(5)*. Thus, *(5)* implies (2). That (2) implies *(5)* is shown in the text. Q.E.D.

Proof of Proposition 3. When the information is symmetric, there is no need for the truth-telling constraint. This is the same as assuming that $\delta(x) = 0$ for all x. When $\delta(x) = 0$ in (A5), $U'(W(x)) = 1/\lambda$. (Note that $\tau(x)$ has to be zero for $x = L$ by Lemma 1; since $x = L$ is a zero-probability event, we can assume that $\tau(x) = 0$ for all x.) This implies that $W(x)$ = constant. Equation (7) becomes $U'(W)[1 - k'(x - P(x))] = V'(x - P(x))$, and $W =$ constant implies that $x - P(x)$ is a constant or $P'(x) = 1$. Q.E.D.

Proof of Proposition 4. When $V' = v$, (7) becomes $U'(W)[1 - k'(x - P] = v$. This implies that $1 - k'(x - P) > 0$. By differentiating, we have

Suppose that $P' \leq 1$. Then $W' > 0$ by (5). Since $U'' < 0$, we have $U''W'[1 - k'] < 0$. On the other hand, $-(1 - P') \geq 0$, $U' > 0$, and $k'' < 0$. Thus, $-(1 - P')U'k'' \leq 0$. Therefore, (A9) cannot hold, contradiction. Q.E.D.

Proof of Proposition 5. Suppose that for some $x_2 < x_1$, $s(x_1) = 1$ and $s(x_2) = 0$. Then (9) implies $u_0 \geq U(W(x_2)) + V(x_1 - P(x_2))$, and

(10) implies $U(W(x_2)) + V(x_2 - P(x_2)) \geq u_0$. Since $V(x_1 - P(x_2)) > V(x_2 - P(x_2))$ when $x_1 > x_2$, we have $u_0 > u_0$, a contradiction.

Lemma 4. *Given Proposition 5, constraints (9) and (10) are equivalent to (11).*

Proof. Inequality (9) implies that the manager (weakly) prefers reporting any x_1 in S to reporting m: $u_0 \geq U(W(m)) + V(x_1 - P(m))$. As x_1 approaches m, we have $u_0 \geq U(W(m)) + V(m - P(m))$. On the other hand, by (11), he prefers reporting m to any x_1 in S: $u_0 \leq U(W(m)) + V(m - P(m))$. Thus, (9) and (10) imply (11).

We now show that (11) also implies (9) and (10). For any x_1 in S and any x_2 in S^c,

$$u_0 = U(W(m)) + V(m - P(m)) \geq U(W(x_2)) + V(m - P(x_2)) > U(W(x_2)) + V(x_1 - P(x_2)).$$

The first inequality obtains because both m and x_2 are in S^c and they should satisfy (2). The second inequality obtains because $m > x_1$ by Proposition 5. Thus, (11) implies (9). Since

$$U(W(x_2)) + V(x_2 - P(x_2)) \geq U(W(m)) + V(x_2 - P(m)) > U(W(m)) + V(m - P(m)) = u_0,$$

(11) also implies (10). The first inequality obtains via (2), and the second obtains because $x_2 > m$ by the definition of m. Q.E.D.

An example of overcompensation

Suppose that $U(W) = W$ and $V(x - P) = v_0 + v(x - P)$ with $v < 1$. It is shown in the Appendix that the optimal contract becomes $P(x) = x - z_0$, and $W(x) = vx + w_0$, where z_0 and w_0, are constants. Therefore, when the manager is risk neutral, the compensation schedule should be structured to motivate him to pay out x net of the optimal amount of on-the-job consumption, z_0– that is, to adopt the residual payout policy. When $u_0 = \infty$), the first-best payout can be achieved. We will show that when the expected optimal payout $E[x]$ and the manager's minimum utility level u_0, are high relative to his reservation expected utility level u (when $v\{E[x] - L\} + u_0 > u$), the manager will be overcompensated. That is, constraint (1) will not be binding.

Computation of the example

When $U' = 1$ and $V' = v$, Equation (7) becomes $1 - k'(x - P(x)) = v$. Then $k'' < 0$ implies that $x - P(x) = z_0$, where z_0 is a constant.

By (5), $P'(x) = 1$ implies that $W'(x) = v$. Thus, $W(x) = vx + w_0$, where w_0 is a constant.

Substituting $P(x)$ and $W(x)$ into (3) when $x = L$, we have $vL + w_0 + v_0 + vz_0 \geq u_0$, or $w_0 + v_0 + vz_0, \geq u_0 - vL$. The manager's expected utility is

If $v\{E[x] - L\} + u_0 > u$, then constraint (1) will not be binding.

Q.E.D.

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