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Source: *The Journal of Finance*, Vol. 37, No. 2, Papers and Proceedings of the Fortieth Annual Meeting of the American Finance Association, Washington, D.C., December 28-30, 1981 (May, 1982), pp. 457-470
Published by: Blackwell Publishing for the American Finance Association
Stable URL: http://www.jstor.org/stable/2327348
Accessed: 27/11/2009 08:16

Costly Contracting and Optimal Payout Constraints

KOSE JOHN and AVNER KALAY*

I. Introduction

MOTIVATED BY THE ASSUMPTION of perfect capital markets, the firm has been traditionally viewed as a homogeneous unit whose clear objective is to maximize its market value. However, in an environment of costly contracting, some recent research [1, 3, 4, 6–10, 12, 15] has portrayed the firm as a collection of competing groups whose interests can conflict. This paper concentrates on the conflict between the two major groups—the stockholders and the bondholders—and derives an optimal set of contractual arrangements which minimize the costs of this conflict. In our model, these contracts will determine endogenously the optimal investment levels and the dividend policy of a levered firm.

Myers [12] has argued that stockholders, who control the firm, could attempt to transfer wealth from the bondholders even by rejecting profitable investment projects. In other words they can choose policies which reduce the market value of the firm. He has indicated that constraints on dividend payouts[1], self-imposed by stockholders, are a possible solution to the problem of underinvestment. The details of such constraints are documented and anlayzed by Kalay [8, 9], who examines a large random sample of bond indentures. Kalay models the choice of the "tightness" of the effective dividend constraint and finds it to depend on the investment opportunities facing the firm and its leverage ratio. His analysis provides a possible explanation for dividend payments even when they involve transaction and tax related costs.

This paper presents a rigorous theoretical analysis of the form and optimality[2] of constraints on dividend payouts to be self-imposed by the shareholders of a levered firm in debt contracts. These optimal contracts are derived endogenously in a multiperiod model which allows for divergence of interests between stockholders and bondholders. In our environment of costly contracting a precise

* New York University. We wish to thank Sudipto Bhattacharya, Ernest Bloch, Han Kim, Jan Mossin, Sang Park, Ron Singer and Marti Subrahmanyam, for helpful discussions. We are also grateful to the participants of the Finance Seminar at New York University. This work was supported by a faculty research grant from the Graduate School of Business Administration, New York University.

[1] Throughout the paper we define dividends to include share repurchases and all other cash payments to the stockholders. Hence the words "payout" and "dividends" are used interchangeable.

[2] The optimality of the constraints is from the point of view of the shareholders (who control the firm and take investment and financing decisions which maximize their own wealth). When combined with the assumption that bondholders accurately incorporate into their pricing of bonds (at contracting time) any possible deviations of stockholders from optimal investments, the optimal constraints will be seen to be those that induce ex post investments that maximize the combined wealth of stockholders and bondholders.

measure of residual agency costs is also characterized. The cost of contracting is introduced in our model by requiring that all contracts offered by the stockholders have to be measurable with respect to the coarser information structure of the bondholders. As uncertainty resolves the bondholders have less information than stockholders (except at the terminal date) since they simply observe the cash flows and do not undertake the prohibitively costly verification of the precise realized state. In such an environment of contracting the optimal dividend constraints written on observable cash flows take two forms—to be called "flexible" constraints and "point" constraints. Flexible constraints rely heavily on stockholders' ex post incentives to maximize their own wealth. In other words, under these constraints stockholders retain most of their freedom of choice and would in general choose to invest more than the required minimum investment. While the flexible constraints are typically operational in the good states of the world, the point constraints become effective in the bad states. The point constraints usually require a predetermined level of minimum investment and in general stockholders would invest no more. The empirical evidence presented previously by Kalay is found to be consistent with the predictions of the theory developed here.

II. The Optimal Contracts

II.1 *The Market Setting*

The economy is described by the following set of assumptions:

A.1 The economy extends through three dates, $t = 0$, $t = 1$, and $t = 2$.

A.2 The agents in the economy are divided into the stockholders of a given firm and the market participants (including the prospective bondholders).

A.3 The uncertainty in the economy is described by an Arrow-Debreu state preference model; $\Omega = \{\omega_1, \cdots, \omega_n\}$ indexes the states of the world.

A.4 The information structure in the economy is represented by a sequence of refining partitions of Ω, $\{F_t : t = 0, 1, 2\}$ (cf., Radner [13]). $\{F_t^s : t = 0, 1, 2\}$ will denote the information structure of the stockholders and $\{F_t^B : t = 0, 1, 2\}$ that of the bond market. At contracting time ($t = 0$) the bondholders and the stockholders have the same information; without loss of generality, $F_0^s = F_0^B = \{\{\Omega\}\}$ the trivial partition. However, at $t = 1$, there is a partial resolution of uncertainty and the stockholders' information is better than that of the bondholders, i.e., F_1^s is strictly finer than F_1^B. We will find it convenient to denote by θ the generic element of $F_1^s = \{\theta_1, \theta_2, \theta_3, \cdots, \theta_n\}$ and by ϕ the generic element of $F_1^B = \{\phi_1, \phi_2, \phi_3, \cdots, \phi_m\}$. Each ϕ_i may be thought of as a meta state (lumpy state) containing many θ's. One interpretation of the coarser information structure of the bondholders is that the bondholders observe the true level of aggregate cash flows, say X_1, at time $t = 1$ and identify the meta state, say ϕ_i of θ's which could have generated it. But it is prohibitively costly[3] for them to resolve ϕ_i any finer. On the other hand,

[3] Townsend [14] explicitly models a cost of verifying the realized state. In our model we choose to introduce costs of contracting by making the information structure of the bondholders coarser than that of the stockholders, and requiring that all admissible contracts be measurable with respect to F_1^B.

stockholders know exactly what $\theta \in \phi_i$ is realized (i.e., $\theta \in F_1^s$) and can take their θ-contingent investment decisions appropriately. Finally, the true state of the environment is known to all agents at $t = 2$. That is, $F_2^s = F_2^B =$ the discrete partition of Ω. We will use ω to denote realized state at $t = 2$.

A.5 Corporations are subject to income tax, τ_c, and their payments to the bondholders are fully tax deductible. Personal income taxes are assumed to be zero for all agents in the economy.[4]

A.6 The corporation is assumed to have a finite number of positive NPV projects. In equilibrium, investment in financial claims which are traded in a perfect capital market provides the investor zero NPV. In our economy, however, given assumption A.5 investment in the financial markets by the corporation for its claimholders would provide a negative NPV. Thus, our firm has a limited supply of projects with nonnegative NPV.[5]

A.7 The agents in the economy behave as if they are risk neutral and the risk free rate is assumed to be zero.

A.8 There are no other taxes, transaction costs or bankruptcy costs, however, unless mentioned otherwise, renegotiation between the bondholders and the stockholders is prohibitively costly. Hence, any contract between the bondholders and the stockholders is written at time 0 and expires at time 2. Possible market mechanisms (like take overs and recapitalizations at $t = 1$) which might resolve an effective conflict between stockholders and bondholders are also assumed to be too costly.

[4] This assumption details a tax structure which is consistent with the equilibrium described in DeAngelo and Masulis (1980), i.e., the marginal tax the bondholders are paying on income is less than the corporate tax rate. For simplicity (and without loss of generality) we choose the case where personal taxes are zero. We realize that this structure is incomplete in that it abstracts from equilibrium considerations (e.g. Miller [11]). But as indicated in footnote 6 the details of the tax structure is not crucial to our analysis; it provides one convenient leverage related benefit. Alternatively, agency cost of equity and signalling value of debt could have been modelled.

[5] Suppose the corporation faces a decision whether to invest funds in the financial markets or to pay them out as a dividend to the stockholders. Let τ_p be the personal tax stockholders pay on any form of income. Assume further that corporation has E dollars to invest. If E is invested in the financial market at time $t = 0$, and its after tax revenues are paid to the stockholders, they are expected to get: $R_1 = E(1 + r)(1 - \tau_c)(1 - \tau_p)$

where; r is the expected rate of return on the investment chosen.

If, on the other hand, the corporation pays E as dividends and stockholders invest the proceeds in the same investment, they are expected to get, at time $t = 1$, $R_2 = E(1 - \tau_p)(1 + r)(1 - \tau_p)$ clearly $R_2 > R_1$ if $\tau_c > \tau_p$. The assumption, that the supply of non-negative NPV projects is limited, has some additional real world basis. The tax on "Improper Profit Accumulation" (See Bittker and Eustice (1971, pp. 8–3, 8–18)) can affect the supply of zero net present value projects. By retaining earnings beyond the "reasonable needs of business" the corporation is providing evidence of its intent to avoid income tax paid by its stockholders. Among the major elements determining whether the tax avoidance purpose is present, are the corporation's dividend history and investment of undistributed earnings in assets unrelated to the corporation's business. Investment in the financial market is viewed as investment not related to the purpose of the business. Hence, including the expected costs due to the accumulated earnings' tax, those projects can have negative net present value. Admittedly, very few publicly held corporations have been prosecuted under this law. However, this can be an equilibrium result; firms can avoid this cost by paying dividends. Moreover, investing in assets having no reasonable connection with the purpose of the business can bring on a searching inquiry. Thus, costs can be imposed even without actual prosecution.

A.9 For a given set of constraints which are included in the debt indentures (if there are any), stockholders, who control the firm, take investment and financing decisions which maximize their own wealth. The investment opportunities facing their firm at time $t = 0$ are represented by $f(I_0, \theta)$ and at time $t = 1$ by $\bar{f}(I_1, \omega:\theta)$. $f(I_0, \theta)$ represents the total payoffs at time $t = 1$ in state θ from investment I_0 made at $t = 0$. Similarly, $\bar{f}(I_1, \omega:\theta)$ represent the total terminal payoffs at time 2 in state ω resulting from investment of $I_1(\theta)$ in time $t = 1$ and state θ. Both f and $\bar{f}$ have the usual properties of production functions, that is:

$$\frac{\partial f}{\partial I_0}, \ \frac{\partial \bar{f}}{\partial I_1} > 0 \quad \text{and} \quad \frac{\partial^2 f}{\partial I_0^2}, \ \frac{\partial^2 \bar{f}}{\partial I_1^2} < 0.$$

Further

$$f(0, \theta) = 0, \quad \bar{f}(0, \omega:\theta) = 0, \quad \text{for all} \quad \theta, \omega;$$

$$f(I_0, \theta) \geq 0, \quad \bar{f}(I_1, \omega:\theta) \geq 0, \quad \text{for all} \quad \theta, \omega, I_0, I_1.$$

Stockholders invest at times $t = 0, 1$ and liquidation takes place at $t = 2$. The value of stockholders' claims on the firm can, therefore, be represented as the present value of their expected dividend stream; D_t, $t = 0, 1, 2$. Where D_2, is a liquidating dividend. Hence stockholders would choose the investment policy which maximizes

$$\bar{D} = E_\theta E_{\omega/\theta}[D_0 + D_1(\theta) + D_2(\omega:\theta)].$$

II.2 *The Stockholders' Problem*

Suppose at time $t = 0$ the stockholders have raised equity funds of value E. They issue a pure discount bond with promised payment F, at maturity $t = 2$, and for which bondholders pay B at time $t = 0$. The price of this debt is determined by the time $t = 0$ valuation of its payoffs at time $t = 2$; $\min\{\bar{f}(I_1, \omega:\theta), F\}$. Clearly the value of this bond depends on stockholder's financial and investment decisions. Stockholders' decisions can, therefore, be formulated as: (Problem P1);

$$\begin{aligned} &\mathrm{Max}_{I_0 \in K_0}[E + B - I_0(1 - \tau_c)] + E_\theta \, \mathrm{Max}_{I_1(\theta) \in K_1(\theta)} \\ &\qquad \cdot [\{f(I_0, \theta)(1 - \tau_c) - I_1(\theta)(1 - \tau_c)\} \\ &\qquad\quad + E_{\omega/\theta}\{\bar{f}(I_1, \omega:\theta) - \min[F, \bar{f}(I_1, \omega:\theta)]\}(1 - \tau_c)], \end{aligned} \tag{1}$$

s.t.

$$B = E_\theta E_{\omega/\theta} \min\{\bar{f}(I_1, \omega:\theta), F\}, \tag{2}$$

where

K_0 is the feasible set of I_0 as stipulated by any dividend constraint.

$K_1(\theta)$ is the feasible set of $I_1(\theta)$ as stipulated by any dividend constraint relevant for time $t = 1$.

E_θ is the expectation operator over θ. $E_{\omega/\theta}$ is the expectation operator over ω conditional on θ.

The tax structure is such that in bankruptcy the firm pays no corporate tax and it gets tax credit at the time the investment is made.[4,6]

The problem facing the stockholders is to solve for the optimal constraints (specifying feasible sets K_0 and $K_1(\theta)$) such that the resulting investments and the bondholder's pricing of the bonds (as in equation (2)) results in the maximal value for the stockholder's claims as specified in equation (1).

Clearly a straightforward solution to the problem would have been for the stockholders to offer constraints pointedly committing to undertake investment levels I_0^c and $I_1^c(\theta)$ for all θ, which maximize the combined wealth of stockholders and bondholders.[7] (For details, see equations 3–7 of footnotes 6 and 7.) If such θ-contingent contracts can be written and enforced, bondholders would price these correctly in B and the value of the stockholder's claims would be maximized. But given the asymmetry of information between bondholders and stockholders, the admissible contracts are limited to those enforceable under the common information structure.

The question we address is as follows: what constraints[8] can the stockholders

[6] As it will be clear to the reader, we could have demonstrated the features of optimal contracts without explicitly modelling the tax structure. But the tax shields provide one rationale for the stockholders to issue debt in spite of the concomitant residual agency costs. For any level of investments I_0 and $I_1(\theta)$ that is undertaken by the stockholders and if they can somehow convince the bondholders so that it is correctly priced in B, then the objective function in (P1) will be (as seen by substituting (2) into (1)).

$$\text{Max}_{I_0 \in K_0} E - I_0(1-\tau_c) + E_\theta \text{Max}_{I_1(\theta)\in K_1(\theta)}[\{(f(I_0,\theta) - I_1(\theta))(1-\tau_c)\} + E_{\omega/\theta}\{\bar{f}(I_1,\omega:\theta)(1-\tau_c) + \tau_c \min[F, \bar{f}(I_1,\omega:\theta)]\}] \tag{3}$$

This value of combined wealth of stockholders and bondholders is higher than the value of the objective function in the all equity case (for a particular level of investments I_0 and $I_1(\theta)$) by

$$E_\theta E_{\omega/\theta}\{\tau_c \min[F, \bar{f}(I_1(\theta), \omega:\theta)]\}. \tag{4}$$

This difference is the present value of the tax shields provided by the payment to the bondholders. Since this tax shield is positive it provides an incentive for stockholders to issue debt. Of course these benefits have to be traded off against the residual agency costs of debt under the optimal contracts. It should be noted that the specific assumptions of the tax structure is made for convenience and its relaxation will not change the results of the paper.

[7] The investment levels I_0^c and $I_1^c(\theta)$ which maximize the combined wealth as given in (3) are given by the first order conditions,

$$-1 + E_\theta f'(I_0^c, \theta) = 0 \tag{5}$$

$$-1 + E_{\omega/\theta}\bar{f}'(I_1^c, \omega:\theta) + \frac{\tau_c}{(1-\tau_c)} E_{\omega\in\Delta(I_1^c)}\bar{f}'(I_1^c, \omega:\theta) = 0 \quad \text{for all} \quad \theta. \tag{6}$$

where: $E_{\omega\in\Delta(I_1)}$ denotes integration over the insolvency states, i.e.,

$$\Delta(I_1) \equiv \Delta(I_1(\theta)) = \{\omega : \bar{f}(I_1(\theta), \omega:\theta) \leqq F\}, \quad \text{for any value} \quad I_1(\theta). \tag{7}$$

Since the objective in (3) is concave, the first order conditions are also sufficient.

[8] Note that the first order condition determining the optimal value of $t = 0$ investment I_0^* in (P1) is the same as that in (5) maximizing combined wealth. (The stage-1 objective function of the stockholders problem (P1) is the same as in (3)). Thus the specification of optimal K_0 is not affected by the informational asymmetry. In fact, in our problem, there need not be any contraints on I_0. The stockholders will invest up to $I_0^c = I_0^*$ on their own initiative.

offer which are measurable with respect to F_1^B (i.e., which are based on the information set of the bondholders) such that the costs of the conflict are minimized? In other words, given that the constraints can only be contingent on the cash flows, what optimal constraints can be written? In contrast to the θ-contingent contracts of the previous paragraph, the restriction now is that there should be a single constraint for all $\theta \in \phi_i$. In general it is clear that a constraint pointedly specified for a particular state θ_j can lead to suboptimal investments in other states θ_k, $k \neq j$ in ϕ_i. For example, say $\phi_i = \{\theta_1, \theta_2, \theta_3\}$ and the optimal investments $I^c(\theta_1) > I^c(\theta_2) > I^c(\theta_3)$ would maximize the combined wealth. A constraint for the metastate ϕ_i stipulating an investment of $I^c(\theta_2)$ would lead to underinvestment in true state θ_1, and over-investment if the realized state is θ_3. In the following subsection we formulate a scheme of specifying "flexible constraints" for a meta state such that the stockholders own ex post maximizing initiatives (combined with minimal constraints on their freedom of choice) would minimize the costs of the conflict.

II.3 *Flexible Constraints*

In specifying a common constraint for a multitude of states clearly the problem is to constrain the stockholder action by just the right amount—not too loose, leaving room for ex post initiatives to underinvest too much, at the same time not too tight, involving overinvestment in many states. A strategy for stipulating these type of flexible constraints is suggested by the behavior of the second stage θ-contingent objective of the stockholders $S(I_1(\theta))$ specified below:

$$\begin{aligned} S(I_1(\theta)) &= -(1-\tau_c)I_1(\theta) + E_{\omega/\theta}\{\bar{f}(I_1, \omega:\theta) - \min[F, \bar{f}(I_1, \omega:\theta)]\}(1-\tau_c) \\ &= (1-\tau_c)[-I_1(\theta) + E_{\omega/\theta}\{\bar{f}(I_1, \omega:\theta) - \min[F, \bar{f}(I_1, \omega:\theta)]\}] \end{aligned} \tag{8}$$

Let us examine the behavior of $S(I_1(\theta))$ when $I_1(\theta)$ is unconstrained, i.e. $K_1(\theta) = R_+$. It is readily checked that $S'(0) < 0$ denoting a corner (local) maximum at $I_1(\theta) = 0$ for any θ. If, in addition, $S(I_1(\theta)) < 0$ for all other values of $I_1(\theta) \in R_+$ then clearly we have $I_1^s(\theta) = 0$. In other words, zero investment is the stockholders' global optimum investment for state θ. On the other hand, it is possible that there is an interior maximum $I_1^s(\theta)$ such that $S(I_1^s(\theta)) > 0$ in which case $I_1^s(\theta)$ will be the optimum level of investment undertaken. Figure 1 illustrates these two possibilities for states θ_1 and θ_2. For θ_1, $S(I_1(\theta))$ is at a maximum such that $S(I_1^s(\theta_1)) > 0$, i.e., $I_1^s(\theta_1) > 0$. But, $I_1^s(\theta_2) = 0$ because $S(I_1(\theta_2)) \leqq 0$ for all $I_1(\theta_2) \in R_+$. For θ_2 even though the optimum investment $I_1^s(\theta_2) = 0$, it would be useful to characterize the interior (local) maximum such that $S'(I_1(\theta)) = 0$. We will denote the interior local optimum of $S(I_1(\theta))$ as $\hat{I}_1^s(\theta)$, which satisfies the first-order condition,

$$S'(\hat{I}_1(\theta)) = (1-\tau_c)[-1 + E_{\omega/\theta}\bar{f}'(\hat{I}_1^s, \omega:\theta) - E_{\omega\in\Delta(\hat{I}_1^s)}\bar{f}'(\hat{I}_1^s, \omega:\theta)] = 0 \tag{9}$$

for all θ, again $E_{\omega\in\Delta(I_1)}$ is as defined in equation (7).

The behavior of $S(I_1(\theta))$ can, generically, be categorized into three types (See Figure 2). The first type (T1) is such that for small levels of investments the function value is negative, it comes to a local minimum and then increases to a

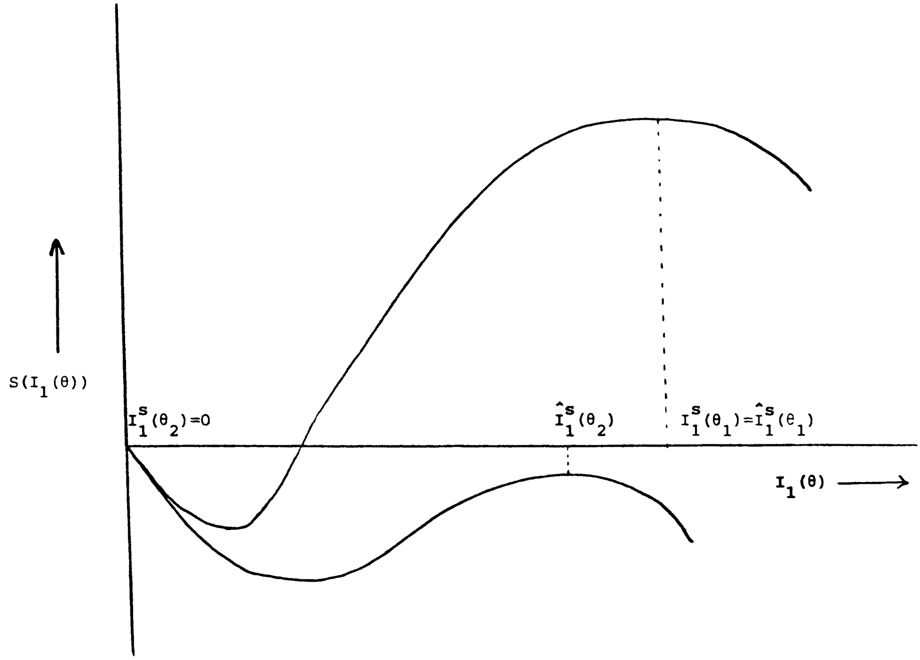

Figure 1. Behavior of $S(I_1(\theta))$

maximum of $I_1^s(\theta)$ such that $S'(I_1^s(\theta)) = 0$ and $S(I_1^s(\theta)) > 0$.[9] The second type (T2) is similar to (T1) except that the function value at its interior maximum $\hat{I}_1^s(\theta)$ is negative, $S(\hat{I}_1^s(\theta)) < 0$. The third type (T3) is such that it stays negative for all relevant investment levels (say all I_1 such that $E_{\omega/\theta}\bar{f}'(I_1, \omega{:}\theta) \geq 0$).

It is clear that the value of F is critical in determining the behavior of $S(I_1(\theta))$ for any θ. Ceteris paribus, a larger value of F would push a given $S(I_1(\theta))$ into a "worse" type. Similarly decreasing the value of F would tend to push an $S(I_1(\theta))$ into a "better" type (say T3 to T2).

Now we focus on the design of constraints on investment to be offered by stockholders at time $t = 0$. As argued earlier, they have to specify a single constraint for all $\theta \in \phi_i$, $\phi_i \in F_1^B$ (where ϕ_i is the metastates in the bondholder's information structure, possibly conditioned on the cash flows $f(I_0, \theta)(1 - \tau_c)$ to be observed.[10])

Even though a single constraint has to be specified for an entire metastate (to be discussed in section II.5) it will be useful to focus on the nature of flexible constraints applicable for metastates where certain types of $S(I_1(\theta))$ dominates. Especially interesting are the constraint specification for metastates containing θ's of Type 1 or Type 2 behavior of $S(I_1(\theta))$.

For any ϕ_i, partition ϕ_i into three groups ϕ_{i1}, ϕ_{i2} and ϕ_{i3} as follows $\phi_{ij} = \{\theta \in$

[9] It should be noted that $\hat{I}_1^s(\theta) \neq I_1^s(\theta)$, in general. Only in the special case of (T1) where $\Delta(\hat{I}_1^s(\theta)) = \square$ (empty set) will $\hat{I}_1^s(\theta)$ be equal to $I_1^s(\theta)$. Δ is as defined in equation (7).

[10] If the metastates are conditioned on cash flows then clearly $f(I_0, \theta)$ is the same for all $\theta \in \phi_i$, to be denoted as $f(I_0, \phi_i)$ for convenience.

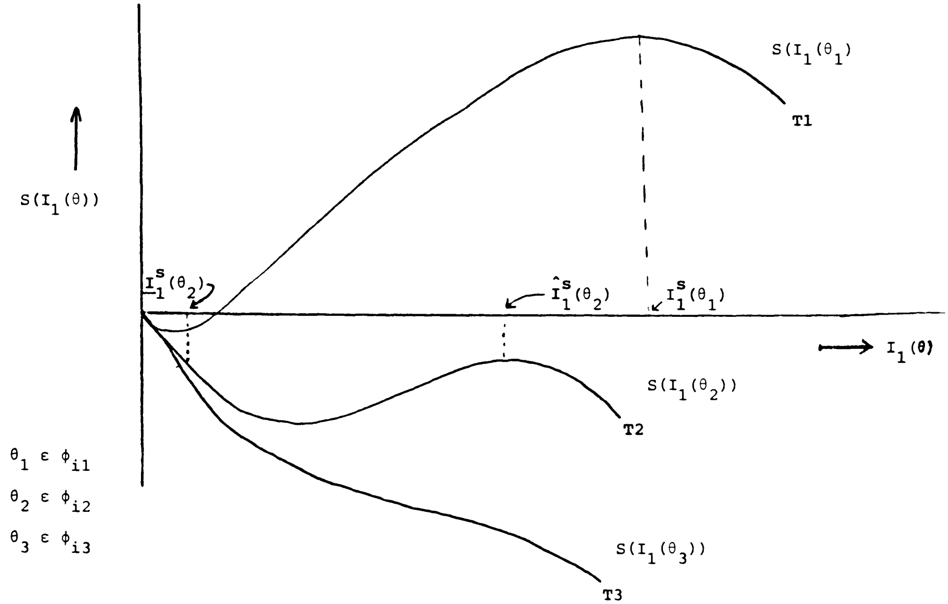

Figure 2. Different Types of S(I₁(θ))-Behavior

ϕ_i:$S(I_1(\theta))$ is of type $T_j\}$ for $j = 1, 2, 3$.

Now let us take the case of metastate ϕ_i such that $\phi_{i2} \cup \phi_{i3} = \square$, (empty set), i.e., it is characterized by only type T1 behavior. Then clearly the relevant constraint for that metastate is $K_1^{\phi_i} = R_+$, i.e., effectively no constraint need be imposed (except non-negativity). The idea is that the stockholders will invest up to $I_1^s(\theta) = \hat{I}_1^s(\theta)$ for any realized $\theta \in \phi_i$ on their own initiative.[11]

Now let us take the case of a metastate ϕ_i such that $\phi_{i3} = \square$; i.e., it is characterized by types T1 and T2. For each $\theta \in \phi_{i2}$, define the point $\underline{I}_1^s(\theta)$ by the equation, $S(\underline{I}_1^s(\theta)) = S(\hat{I}_1^s(\theta))$ where $S'(\underline{I}_1^s(\theta)) < 0$. For $S(I_1(\theta))$ in type T2 such a point is well defined. Clearly if the stockholders are constrained to invest more than $\underline{I}_1^s(\theta)$ (away from zero) they will invest up to $\hat{I}_1^s(\theta)$ on their own initiative. Thus all that is required to make the stockholders invest up to $\hat{I}_1^s(\theta)$ is to prohibit them from being in the interval $[0, \underline{I}_1^s(\theta)]$. By chopping off a suitable region of the feasible set around the undesirable local maximum of zero investment, the stockholders still retain the option of investing up to the other local maximum $\hat{I}_1^s(\theta)$. It is easy to specify a single constraint for the entire metastate ϕ_i (recall $\phi_i = \phi_{i1} \cup \phi_{i2}$) such that in each state $\theta \in \phi_i$ the stockholders will invest up to $\hat{I}_1^s(\theta)$ on their own initiative. Choose $I^{\phi_i} = \max_{\theta \in \phi_{i2}} \underline{I}_1^s(\theta)$. The relevant constraint $K_1^{\phi_i}$ would simply be $K_1^{\phi_i} = (I^{\phi_i}, \infty)$ i.e., $K_1^{\phi_i}$ would simply stipulate that the minimum investment should be at least I^{ϕ_i}. It is clear that in each realized state $\theta \in \phi_i$, the stockholders would invest up to $\hat{I}_1^s(\theta)$ on their own initiative,[12] based

[11] Recall that $\hat{I}_1^s$ (θ) is the interior (local) maximum of $S(I_1(\theta))$. For all $\theta \in \phi_{i1}$, clearly $\hat{I}_1^s(\theta) = I_1^s(\theta)$, the global maximum.

[12] If, for a particular $\theta \in \phi_i$, $\underline{I}_1^s(\theta) < \hat{I}_1^s(\theta) < I^{\phi_i}$, then the stockholders would be constrained to invest up to I^{ϕ_i}, more than $\hat{I}_1^s(\theta)$. But this is an exceptional case which is subsumed under the general characterization in (13).

on the single constraint $I_1 > I^{\phi_i}$. These constraints are referred to as "flexible" constraints to suggest the freedom of choice retained by the stockholders. Clearly a minimum investment constraint is equivalent to a maximum dividend constraint. At time $t = 1$ the realized cash flows $f(I_0, \phi_i)(1 - \tau_c) \equiv f(I_0, \theta)(1 - \tau_c)$ are known to the bondholders and $K_1^{\phi_i}$ can be written as an equivalent dividend constraint as,

$$D_1^{\phi_i} \leqq f(I_0, \phi_i)(1 - \tau_c) - I^{\phi_i}(1 - \tau_c) \tag{10}$$

where I^{ϕ_i} is the specified minimum investment. This implies that the after tax cash flows minus the minimum investment is available for dividend payments. Stockholders would choose to pay, in general,[13] less dividends than they are allowed to, because their optimal investment $\hat{I}_1^s(\theta)$ exceeds I^{ϕ_i}. It is interesting to note that, if their incentives are described by types T1 and T2, stockholders would choose to maintain a reservoir of funds available for investment financed dividends. These incentives stem from the possibilities of overinvestment and are known to the bondholders and to other market participants, therefore, the bonds are priced based on the expectation that this reservoir will be maintained. Thus, the losses to the stockholders resulting from the conflicts are limited to the expected deviations from the combined optimality i.e., to the difference between $\hat{I}_1^s(\theta)$ and $I_1^c(\theta)$. Of course, the extent to which these flexible constraints are optimal will be judged by the deviations between $\hat{I}_1^s(\theta)$ and $I_1^c(\theta)$ they would allow.[14]

II.4 *Binding Constraints*

In the previous two sections we discussed some interesting features of specifying "flexible" type of contraints on minimum investments when $\phi_{i3} = \square$ for a particular ϕ_i. Now we consider the other side of the picture, when an entire ϕ_i consists of type T3 states, i.e., $\phi_{i1} \cup \phi_{i2} = \square$. Here since $S(I_1(\theta))$ for all $\theta \in \phi_i$ belongs to type T3 we cannot rely on ex post initiative of stockholders to invest any more than they are constrained to. In other words, if they are to invest $I_1^c(\theta)$ they have to be pointedly constrained to do so. Thus for any $\theta \in \phi_{i3}$ the ideal constraint would be $K_1(\theta) = (I_1^c(\theta), \infty)$. But that would be a θ-contingent constraint which is not admissible. For a given $\phi_i = \phi_{i3}$ a point constraint can be specified as follows. Choose an investment level I^{ϕ_i} such that I^{ϕ_i} minimizes,

$$E_{\theta/\phi}C(I_1^c(\theta) - C(I^{\phi}, \theta) \equiv E_{\theta/\phi_i}C(I_1^c(\theta)) - E_{\theta/\phi_i}C(I^{\phi_i}, \theta) \tag{11}$$

where $C(I_1(\theta))$ is the θ-contingent objective which maximizes combined wealth.[6, 7] the objective in (11) is convex in I^{ϕ_i} and a well defined global minimum exists. Specifying $K^{\phi_i} = (I^{\phi_i}, \infty)$ is an optimal constraint, i.e., the total expected loss from using this point constraint is minimized. Clearly an equivalent dividend constraint

[13] If our environment of contracting allows the stockholders to default on the contracts at $t = 1$, then this statement has to be somewhat qualified. In any particular state $\theta \in \phi_{i2}$, if $\underline{I}_1^s(\theta) > f(I_0, \phi_i)(1 - \tau_c)$ the available cash flow then the stockholders have an incentive to default on the contract and walk away from the firm leaving behind the cash $f(I_0, \phi_i)(1 - \tau_c)$. But we rule out this possibility in this section by making the weak assumption that I^{ϕ_i} is less than $f(I_0, \phi_i)(1 - \tau_c)$ for all $\phi_i \in F_1^B$.

[14] Detailed computations of the deviations $I_1^c - \hat{I}_1^s$ and the resulting residual costs have been carried out for a large class of production functions $\bar{f}(I_1, \omega{:}\theta)$ where the uncertainty is multiplicative i.e., let $\bar{f}(I_1, \omega : \theta) = \bar{f}(I_1 : \theta)g(\omega)$. See John and Kalay [7] for details.

could be written as,

$$D_1^{\phi_i} \leqq [f(I_0, \phi_i) - I^{\phi_i}](1 - \tau_c) \tag{12}$$

It is clear that the minimum investment constraints would be restrictive and less flexible in "poor" metastates where type T3 behavior is common. This is consistent with the observed constraints on payout (and, therefore, investments) imposing stringent requirements when the firm is in a poor metastate.

II.5 *General Specification of Constraints*

In sections II.3 and II.4 we examined the properties of minimum investment constraints (maximum payout constraints) as applicable to metastates which are characterized by the different types of $S(I_1(\theta))$ behavior. Specifically we saw how these constraints act as "flexible" constraints when the relevant state θ is a type T1 or type T2 state and as a "point" constraint otherwise. These ideas are incorporated in specifying an optimal minimum investment constraint for a general[15] metastate ϕ_i in this section.

It is clear that for a specified minimum investment I^{ϕ_i}, the effective investment that the stockholders actually undertake depends on the realized state $\theta \in \phi_i$ and the behavior of the relevant $S(I_1(\theta))$. It will be useful to characterize the effective investment I_e for a given metastate ϕ_i as a function of I^{ϕ_i} the specified level of minimum investment and the realized state $\theta \in \phi_i$. Since we allow the stockholders to default on these constraints (when it is in their interest to do so) the realized cash flow $X_1 = f(I_0, \phi)(1 - \tau_c)$ also plays a role in determining the effective investment undertaken by the stockholders. The specification of the function $I_e(I^{\phi_i}, \theta)$ is given below:

$$I_e(I^{\phi_i}, \theta) = \begin{cases} \max(\hat{I}_1^s(\theta), I^{\phi_i}) & \text{when } \theta \in \phi_{i1} \\ \max(\hat{I}_1^s(\theta), I^{\phi_i}) & \theta \in \phi_{i2} \text{ and } \min(X_1, I^{\phi_i}) > \underline{I}_1^s(\theta) \\ I^{\phi_i} & \theta \in \phi_{i2} \text{ and } X_1 > \underline{I}_1^s(\theta) > I^{\phi_i} \\ X_1 & \theta \in \phi_{i2} \text{ and } I^{\phi_i} > \underline{I}_1^s(\theta) > X_1 \\ \min(X_1, I^{\phi_i}) & \theta \in \phi_{i2} \text{ and } \underline{I}_1^s(\theta) > \max(X_1, I^{\phi_i}) \\ \min(X_1, I^{\phi_i}) & \theta \in \phi_{i3} \end{cases} \tag{13}$$

It is clear that in the first two cases the stockholders will invest up to $\hat{I}_1^s$ on their own initiative raising equity if they have to. In the last three cases, if the effective investment is X_1, it implies that the stockholders have chosen to default on the contract. The reasons for the decisions can be easily argued based on the behavior of the relevant $S(I_1(\theta))$ function.

For any contract of the form $K_1^{\phi_i} = (I^{\phi_i}, \infty)$ the effective investments which will be undertaken by the stockholders (and correctly priced in B) is $I_e(I^{\phi_i}, \theta)$ for all $\theta \in \phi_i$. The residual loss from the conflict costs is due to the deviations of $I_e(I^{\phi_i}, \theta)$ from the combined optimum $I_1^c(\theta)$. Thus choosing the "optimal" minimum investment constraint is choosing a level I^{ϕ_i} such that it minimizes the

[15] In general a given metastate ϕ_i may contain states whose $S(I_1(\theta))$ display type (T1), (T2) or (T3) behavior. Recall the partition of $\phi_i = \{\phi_{i1}, \phi_{i2}, \phi_{i3}\}$ where $\phi_{ij} = \{\theta : S(I_1(\theta))$ is of type $T_j\}$, $j = 1, 2, 3$.

[16] In these studies also dividends are defined to include all forms of cash payments to the stockholders.

expected residual cost, $R(I^{\phi_i})$, i.e.,

$$\min \mathrm{I}^{\phi_i}\ R(I^{\phi_i}) = E_{\theta/\phi_i}[C(I_1^c(\theta)) - C(I_e(I^{\phi_i}, \theta))]. \tag{14}$$

The optimal value of $\overset{*}{I}{}^{\phi_i}$ specifies the optimal constraint $K^{\phi_i} = (\overset{*}{I}{}^{\phi_i}, \infty)$ and the resulting $R(\overset{*}{I}{}^{\phi_i})$ is a measure of residual loss due to conflict costs.

It is easy to verify that the determination of the optimal constraint for $\phi_i = \phi_{i1} \cup \phi_{i2}$ (i.e., when there are no type (T3) states) will proceed along the lines indicated in sections II.3. The optimal constraint will display the "flexible" nature discussed. When $\phi_i = \phi_{i3}$, clearly the optimal constraint will act as a restrictive binding constraint. It is also apparent that the residual loss is larger when the type (T3) behavior is predominant. From the behavior of $S(I_1(\theta))$ (and the discussions of section II.3) we can see that a higher value of F corresponds to larger incidence of the "poorer" states and bigger deviation between $I_1^c(\theta)$ and $I_e(\overset{*}{I}{}^{\phi_i}, \theta)$. In other words the residual cost $R(\overset{*}{I}{}^{\phi_i})$ under the optimal constraint is increasing in F. But of course a larger F contributes to a larger combined wealth through the present value of the tax shields. This suggests that instead of taking the value of F as given, we should jointly determine the optimal value of F and an optimal package of constraints for a given set of investment opportunities f, $\bar{f}$ and the tax environment. The solution to this problem is pursued in a companion paper.

IV. Empirical Implications and Evidence

From the theory, we conclude that one should observe dividend constraints which take the form of both point constraints and flexible constraints. This section demonstrates that the evidence contained in Kalay [8, 9] is consistent with these predictions.

Kalay examines the limitation on dividend payments included in a large randomly chosen sample of bond indentures.[16] In his documentation and analysis of these constraints he grouped them into two categories, direct and indirect dividend constraints. Interestingly, the direct dividend constraints and the indirect dividend constraints act as flexible constraints in the "good" states while the indirect dividend constraints can act as binding ("pointed") constrained in the "bad" states.

An example of a direct dividend constraint is the following:

"Company may not pay cash dividends or acquire capital stocks in excess of consolidated net income after 12.31.1968 plus net proceeds from sale of stock after such date plus $9,000,000".

This is a flexible constraint in that, while it does not allow for dividends to be paid in bad periods, it does not force stockholders to issue equity and invest up to a predetermined level.

Dividend payments are constrained indirectly as well—for example, through stockholders' pre-commitment to maintain a minimum level of working capital or a minimum ratio of assets to liabilities. The indirect dividend constraints differ from the direct constraint in one important aspect—they can force the firm to issue new equity, (i.e., to pay negative dividends) in the "bad" states of the world. For example, if net worth falls below the promised minimum, stockholders are required to issue new equity to meet their obligations. To that extent the indirect constraint can act as a point constraint in bad states. Interestingly enough, the indirect dividend constraint becomes flexible in the good states.

The evidence presented in Kalay [8, 9] indicates that stockholders do not pay themselves all the allowed amount of investment financed dividends. Moreover, the reservoir of funds available for dividends under the most restrictive constraint is smaller for firms with higher leverage ratios. The predictions of our analysis are consistent with this empirical regularity.

In general the flexible version of the constraints rely on stockholders ex post initiative to maximize their own wealth. These constraints will be written for meta states in which most of the various θ-dependent objective functions of the stockholders at time 1 are of types T1 and T2. In these cases stockholders would invest more than they are required to by the payout constraints. In other words, they will pay less dividends than they are allowed to. Hence, they would maintain on average, a large reservoir of payable funds. This is consistent with the large magnitude of reservoir maintained by firms. The average reservoir is 11.2% of the firm value and it can be as high as 40%.

The binding "point" version of the constraint, on the other hand, could force stockholders to invest more than they would want to. This would happen in states in which the minimum investment which is implied by the payout constraint exceeds stockholders' optimal investment level. In these cases stockholders would pay all that they are allowed to and, therefore, maintain no reservoir. In the other states in which their own optimum exceeds the minimum investment level which is implied by the constraint they would invest more and then maintain a small reservoir. But, on average, the reservoir maintained under an effective point constraint would be smaller than the one maintained under the flexible version of the constraint.

Now recall that, other things constant, the bigger the promised payment to the debt holders, F, the bigger the difference between the combined optimum and stockholders optimum. In other words, the bigger F, the more likely is the $t = 1$ objective of the stockholders to be of type T3 (in figure 2). At the extreme if $F = \infty$ (or higher than all the possible values of $\bar{f}(I_1, \omega{:}\theta)$), stockholders objective is described as a line of slope $= -1$, see Figure 2. In these cases only the point constraint is effective. In general, the higher F the more likely is the effective role of the dividend constraint to be a point constraint. Thus higher F (other things constant) would be associated with low reservoir and lower F with a higher reservoir. This prediction, as mentioned above, is consistent with the empirical evidence.

V. Conclusion

The optimal constraints to be offered in the debt contract by the stockholders of a levered firm are derived endogenously in our model. The technology underlying these constraints is consistent with our intuition of "optimal" contracts. That is, they should constrain stockholders' ex post choices enough, but not too much. In this sense, except in states with extremely bad future prospects, the optimal constraints offers a large degree of flexibility. A suitable minimal neighborhood of zero investment is chopped off the feasible set by these constraints, but a large measure of flexibility is retained by the stockholders for ex post optimization. Thus, the constrained minimum levels of investments (implied by the maximum dividends under the most restrictive dividend constraints) are set at a much lower level than the stockholder's optimum for the realized state. This would induce the stockholders to invest more than the specified minimum, resulting in payouts less than the allowed maximum. An immediate implication is that the stockholders would build reservoirs of payable funds under these flexible optimal constraints. Further, it is shown that the incidence and the flexibility of these constraints are greater, the smaller the leverage ratio. In other words, the reservoir of payable funds should be larger for firms with low leverage ratios. In "bad" states of the world, the optimal constraints assume a binding and restrictive form pointedly specifying the minimum level of investments to be undertaken.

The incidence of flexible and restrictive constraints on payout and the maintenance of reservoirs of payable funds (and its relation to leverage ratio) predicted by our theory of optimal contracting is supported by the evidence documented in Kalay [8, 9]. The importance of agency costs and the optimality of the flexible constraints developed here is also highlighted by the large magnitude of reservoirs maintained by firms. These are found to be 11.2% of the firm value and can be as high as 40%.

Finally, in the environment of asymmetric information and costly contracting, we have developed a measure of residual agency costs under a package of optimal constraints. This immediately suggests that a joint solution (for the optimal amount of debt and an optimal package of constraints) could be developed where benefits of debt would be traded off against the concomitant residual agency costs. Such a solution for a particular tax environment is attempted in a companion paper.

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DISCUSSION

G. M. CONSTANTINIDES*: The paper provides a rigorous discussion of the welfare aspects of dividends at a high level of generality. As Professor Hakansson states in his paper, at the technical level the analysis extends the results in Hakansson, Kunkel and Ohlson (1981) by incorporating personal taxes; Proposition V, however, is a new result.

The first set of conclusions is that informative dividends are a matter of irrelevance only under a set of strong assumptions which describe a pathological case (Proposition II). If there are also deadweight costs associated with dividends, dividends lead to a Pareto inferior allocation (Proposition III). The immediate corollary is that informative dividends almost invariably have welfare implications, and we are led to a discussion of the welfare implications of dividends. It is hard to argue against this set of conclusions. Even if one were to disagree with the specific assumptions of the model, one would probably reach a similar conclusion in a wide variety of models that *informative dividends do have welfare implications.*

In the second set of conclusions, Hakansson provides sufficient conditions which guarantee that dividend declarations are Pareto-improving (Proposition IV and necessary conditions for dividends to yield a Pareto improvement Proposition VI). The *key* assumption for (Proposition IV) is that endowments are efficient in the absence of dividend declarations. The proof then proceeds on the following lines: those consumers who refuse to trade after the dividend declaration do not become worse off. Those consumers who choose to trade after the dividend declaration become better off. Thus, as long as our set of sufficient conditions implies trading by some investors after the dividend declaration, a Pareto improvement does occur.

The final set of conclusions is that a policy of informative dividends can bring a market that is less than fully allocationally efficient in the absence of dividends to the equivalent of full allocational efficiency (Proposition V).

My specific comments below should be interpreted not as a criticism of the paper but as a call for further research in this important area of finance.

1. *Are investors rational and are equilibrium prices informative?*

A casual reading of the paper may give the impression that investors are irrational because they learn nothing from the equilibrium prices although they

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