

Optimal Incorporation, Structure of Debt Contracts, and Limited-Recourse Project Financing*

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Received July 12, 1994

We analyze the interrelationships among the corporate organization structure, the capital structure, and the ownership structure of a firm with multiple projects, when incumbent management derives control benefits. The choices made by firm management are: (1) Whether to set up projects as a joint firm or as separate firms (spin-off), (2) the amount of debt financing to use, (3) the structure of the debt contract (e.g., straight debt on the joint firm, limited-recourse project financing, or spin-off with straight debt), and (4) the fraction of equity to hold in each firm (ownership structure). Differences in managerial ability across projects, benefits of control, and the probability of loss of control through a takeover or through bankruptcy are driving factors in this model. We relate the project characteristics to the optimality of spin-offs and limited-recourse project financing arrangements, and derive implications for the allocation of debt and the ownership structure across projects. *Journal of Economic Literature* Classification Numbers: G32, G34, D21. © 1996 Academic Press, Inc.

* Please address all correspondence to Thomas Chemmanur at Columbia University. For helpful comments or discussions, we thank Jeffrey Callen, Upinder Dhillon, Mark Flannery, Lemma Senbet, Roy Smith, Marti Subrahmanyam, Ingo Walter, and participants in presentations at the Federal Reserve Bank of New York, Harvard Business School, MIT, Princeton University, the Wharton School, the 1992 AEA meetings, the 1993 WFA meetings, and the conference on *Optimal Security Design and Innovations in Financing* (April 1993) at Rutgers University. Special thanks to two anonymous referees and to the JFI Editors for several valuable suggestions. We alone are responsible for all errors and omissions.

1. INTRODUCTION

Issues of optimal incorporation have received little attention in financial economics. An entrepreneur with access to several projects faces the following problem: Should he structure these projects under one firm, or should he form separate corporations to run these? An ongoing firm with assets in place faces a similar question regarding a new project. Moreover, it must also ask: under what circumstances should its multiple projects be spun off into distinct corporate entities? Although senior corporate officers pay close attention to these issues, corporate finance theory has little to say about them. For example, the starting point of discussions that invoke the principle of value additivity is that the choice of incorporation of an additional project is irrelevant. However, in this paper, we study a setting in which project incorporation decisions are important for firm management.

We also consider the choices faced by an entrepreneur who is planning to use some debt financing. For concreteness, assume that he has two different projects. Here, depending on the method of incorporation and the structure of the debt contract used, the entrepreneur has three different financing possibilities: (1) Incorporate both projects separately in different firms and sell debt as well as equity in the two separate corporations (each with claim on the cash flows of only the project incorporated within that firm). (2) Incorporate both projects under one firm, selling equity and debt in the joint firm with claims on the combined cash flows. (3) Incorporate both projects as parts of a joint firm and issue two separate debt claims each entitled to cash flows from only a specified project and the equity entitled to the combined residual cash flows. Another decision to be made by the entrepreneur is the allocation of his wealth among the equity of the different corporations (if he sets up more than one). This paper provides a unified framework to study the above choices of organizational form, capital structure, and ownership structure. Our results also provide insight into restructuring activities motivated by corporate control and changes in ownership and capital structure which accompany corporate restructuring.

One of our objectives is to analyze limited-recourse project financing arrangements, often referred to simply as "project financing." This is a relatively new but increasingly popular method of financing gigantic capital projects such as power plants, oil pipelines, integrated oil refineries, automated steel mills, and chemical fertilizer factories.¹ Project financing has

¹ During the 1980s, a fairly active market developed in the private placement of limited recourse project financing. Chen *et al.* (1989) document that from January 1, 1987 through September 21, 1989, underwriters announced \$23.1 billion worth of project financing. This works out to an average of \$700 million in announced project financing per month compared to an average of \$30.2 billion per month of new securities (debt plus equity) issued by U.S. corporations over the same period. Out of a total of 168 projects financed under this

been defined as “the financing of a particular economic unit in which a lender is satisfied to look initially to the cash flows and earnings of that economic unit as the source of funds from which a loan will be repaid and to the assets of the economic unit as collateral for the loan” (Nevitt, 1979). Very often, the promoting firm also offers the lender some guarantees embedded in the covenants in addition to the collateral of the project itself.² However, the key ingredient of project financing seems to be that in project financing, the project, its assets, its contracts, and its cash flows are segregated from the promoting company in order to obtain the credit appraisal and the loan for the project, independent of the sponsoring company. Usually, the sponsoring company provides management for the project, but the project is legally distinct from the sponsors, whose balance sheets do not reflect the project debt.

Although limited-recourse project financing is gaining in importance, we know very little about it. For example, what are the characteristics of the activities which are optimally financed through a project financing arrangement? What explains the use of a very high proportion of debt to finance projects implemented under this arrangement? What is the rationale behind the notion expressed by practitioners that project financing increases the “debt-capacity” of the firm? The framework of this paper will be able to provide some answers to these questions.

We address these issues with a simple model that starts with the premise that the right to control a corporation is valuable. The benefits of control are available only to the party in control, and cannot be contracted away to other security holders.³ The other security holders receive only the cash payoffs to the corporate securities held by them, called “security benefits.” Examples of such control benefits are management perquisites, synergy with other projects run by the same management, returns to firm-specific investments in human capital, reputation effects arising from successfully managing the project, etc. The control benefits from managing a project are a function of its characteristics. For example, a project with large amounts of free cash flow (see Jensen, 1986) may generate large control benefits for incumbent management. Given such control benefits, management will seek to maximize the sum of the present values of control benefits and security benefits.

arrangement, 102 were in power production and the remaining in oil and gas development (13), real estate development (26), plant construction (12), and R&D partnerships (7). See also Kensinger and Martin (1988) for a description of the wide range of situations in which limited-recourse project financing has been used successfully.

² If no such guarantees are offered, the project financing is referred to as “nonrecourse.” Pure nonrecourse project financing is, however, somewhat rare.

³ This assumption is quite common in the corporate control literature. See, for instance, Grossman and Hart (1982) or Harris and Raviv (1988a, 1988b).

In this setting, we study the problem faced by an entrepreneur who has access to multiple projects, and who needs to raise capital by selling securities to outsiders. Selling equity to finance the projects carries with it the risk that this equity may be bought by a rival for control. If the rival accumulates enough votes from his own stock holdings plus those of the outsiders who may choose to vote with him, he can wrest control of the projects from the incumbent. We assume that the voting behavior of passive outside shareholders in a control contest for any corporation will be determined by the management ability of the entrepreneur relative to that of the rival. Selling a nonvoting security such as debt may be a way out. However, debt also reduces the expected value of management's control benefits, since it increases the probability of bankruptcy, involves restrictive covenants, and leads to monitoring by debtholders. In the event of bankruptcy, the incumbent loses control benefits totally or substantially. Restrictive debt covenants also reduce the expected benefits of control because of reduced managerial discretion.

Given such a situation, the entrepreneur's equilibrium choices of project incorporation, the structure of debt contracts, and ownership structure will be determined by the interplay of three influences. First, the entrepreneur may use firm size strategically as a deterrent to takeover by the proper allocation of projects across corporate units. Second, he may have differing management abilities for various projects (relative to the rival) and consequently may desire to calibrate his equity holdings in different firms. Third, the level of control benefits and their rate of decline with debt may differ across projects, so that the flexibility to allocate debt optimally across different corporations or different projects in the same corporation (through project financing) may be significant.⁴ The only additional feature which determines these equilibrium choices is the amount of capital available to a potential rival for financing takeover activity.

In our model, optimal capital structure, corporate structure, and ownership structure are all interrelated. Our results can be summarized as follows:

- If the incumbent can maintain control of both projects if they are financed using equity alone, no debt is issued. In this case, if incumbent's ability relative to potential rivals in managing the two projects is similar,

⁴ A prominent example of size as a deterrent to takeover is the failed takeover attempt of Time Inc. by Paramount Inc. in 1989. Despite a higher bid by Paramount, the takeover was foiled because of a friendly merger between Time Inc. and Warner Communications to become Time-Warner. The reason why Paramount could not take over the combined firm seems to be its size. According to an affidavit filed at Delaware's Chancery Court, and cited by Paramount in support of its position, "...the combined companies would cost \$31 billion at \$200 a share and few companies would have both the financial capacity and interest in buying Time-Warner" (Wall Street Journal, June 17, 1989).

then joint incorporation will dominate separate incorporation. If, however, the incumbent's ability varies across the projects relative to those of potential rivals, then, if the amount of capital available to the rival to finance a takeover is not too large, separate incorporation will dominate.

- If the incumbent cannot retain control of both projects if equity alone is used to finance them, the projects will be financed with a combination of debt and equity. In this case, if the incumbent's relative abilities are comparable across the projects and the structure of control benefits are also similar, the projects will be jointly incorporated and financed with straight debt on the joint firm. If, however, the structure of the incumbent's control benefits are vastly different across the two projects (while his relative abilities for the projects remain similar), limited-recourse project financing will be optimal.

- When debt is required to maintain control, if the incumbent's relative abilities are sufficiently different across the two projects, spin-off, with debt issued against one or more of the separate firms, is optimal.

- The optimal allocation of debt in a limited-recourse project financing arrangement across different projects depends on the structure of the incumbent management's control benefits. Under certain additional assumptions about the nature of control benefits and the distribution of project cash flows, the project with smaller control benefits per dollar of value will be allocated a higher debt ratio.

- In spin-offs, the debt allocation is also affected by the incumbent's relative abilities across projects. If the control benefits per dollar of value are the same for both projects, the firm (project) for which the incumbent has lower management ability relative to potential rivals will carry a higher debt ratio; further, other things remaining the same across the projects, incumbent management will invest more wealth in the equity of the higher relative ability firm.

Our paper is related to the seminal papers in the corporate control literature (see, for instance, Harris and Raviv, 1988a and 1988b and Grossman and Hart, 1988). In particular, it is closely related to Harris and Raviv (1988a), who study the effect of corporate control contests on the extent of debt financing of the firm in a single-project setting. We extend their analysis to a multi-project setting in order to study the optimal incorporation of projects, the optimal package of claims to be issued to finance them, and the optimal structure of the debt contracts to be used. Grossman and Hart (1986) and Hart (1987) study the optimal level of integration of a firm's activities from the point of view of minimizing distortions in managerial incentives in a setting of incomplete contracting. They, however, ignore the effects of financing.

Our paper is also related to the literature on limited-recourse project financing. The only paper prior to ours to provide a theoretical rationale for project financing arrangements is Shah and Thakor (1987). They develop a signaling model of optimal capital structure under asymmetric information, under which riskier firms adopt higher debt levels in equilibrium. An implication of their theory is that signaling costs are minimized when projects that are riskier than the parent firm are financed under the limited-recourse project financing arrangement, with the leverage ratios used greater than that of the parent firm. In contrast to their model, ours is a symmetric-information model driven by considerations of corporate control, so that our model can explain the existence of project financing arrangements even in situations where the extent of asymmetric information is not significant.⁵ In research subsequent to ours, John and John (1991) and Flannery *et al.* (1993) argue that project financing arrangements result from the firm's efforts to minimize the impact of agency problems (which may lead to underinvestment (as in Myers, 1977) or asset substitution (as in Jensen and Meckling, 1977)).⁶ There are also a number of papers (e.g., Castle, 1975, Mao, 1982, Sandler, 1982, Nevitt, 1983, Kensinger and Martin, 1988) which describe some of the institutional details of project financing arrangements.

The rest of this paper is organized as follows. In Section 2, we present the model. In Section 3, we characterize the equilibrium corporate and financial structure chosen by the incumbent in different settings. In Section 4, we discuss the testable implications of our model. In Section 5, we conclude. All proofs are in the Appendix.

2. THE MODEL

There are three types of investors, who are all risk neutral. First, there is an entrepreneur (the "incumbent") with monopoly access to two positive NPV projects. He establishes either a single corporation to run both the projects, or two separate corporations, each to run one of these projects. Second, there is a continuum of atomistic outside investors who are "pas-

⁵ Chen *et al.* (1989) point out that informational asymmetries cannot always explain limited-recourse project financing. For example, in the area of independent power generation, where limited-recourse financing is the norm, the technologies involved are well known, the licensing applications and the power purchase contracts are publicly available, and the technology is not particularly risky.

⁶ Two other related papers are Houston and Venkatraman (1994), who argue that loan commitments in conjunction with short-term debt contracts can serve to mitigate distortions in the firm's investment incentives, and John (1993), who argues that spin-offs can serve to mitigate the under-investment incentives engendered by debt.

sive” in the sense that they are not contenders for control (“passive investors”). Finally, there is the rival management (the “rival”) who has currently no equity in the firm, but who may invest in the equity of the company (or companies) set up by the incumbent in order to take over control. The probability distribution of the cash flow from each project depends only on the ability of the management team currently in control. The cash flows from the two projects are stochastically independent of each other. Denote by V_1^J and V_2^J the mean cash flows for projects 1 and 2, respectively, with management team J in control, where $J \in \{I, R\}$ with I representing incumbent management and R the rival. For simplicity, we assume that the risk-free rate is zero. If the incumbent is better at managing project i , $V_i^I > V_i^R$, while if the rival is better, $V_i^I < V_i^R$, for $i = 1, 2$. For any given project, either the incumbent or the rival could be better. All agents have symmetric information about the distribution of project cash flows. The probability distribution of project cash flows under incumbent management is characterized by an increasing “hazard rate”: i.e., if we denote the cash flow from project i by \tilde{y}_i ($i = 1, 2$), its probability density function by $f_i(\cdot)$ and the corresponding cumulative distribution function by $F_i(\cdot)$, we assume that the hazard rate function $H_i(\tilde{y}_i) \equiv f_i(\tilde{y}_i)/(1 - F_i(\tilde{y}_i))$, is increasing in \tilde{y}_i .⁷

The investment amounts required to implement projects 1 and 2 are I_1 and I_2 , respectively. Let w^I denote the total amount, inclusive of any borrowing on his personal account, that the incumbent has at hand to invest in these projects. Refer to this as the incumbent’s initial investment.⁸ The incumbent finances the total amount ($I_1 + I_2$) required for investing in his projects partly from this initial investment, and the remaining by selling securities to the passive investors. We will assume that the menu of securities that the incumbent can issue is restricted to voting equity and nonvoting debt.⁹ However, the incumbent has considerable flexibility in structuring

⁷ The assumption of an increasing hazard rate is not very restrictive, since it is satisfied by most well-known probability distributions, such as the uniform, normal, exponential, and Laplace distributions. It is also satisfied by the gamma and Weibull distribution with degrees of freedom parameter larger than 1 (see Barlow and Proschan, 1975, p. 79).

⁸ As in Harris and Raviv (1988a), we assume that the entrepreneur cannot borrow unlimited amounts on his personal account, or equivalently, that borrowing beyond a certain level will involve paying prohibitively high interest rates. If the incumbent can borrow unlimited amounts at the same terms as the firm, he will do so, using this borrowed amount to hold enough equity to maintain control, and we will not observe any firm-level debt in the setting of this model. In practice, even if such borrowing were possible, personal borrowing would not allow entrepreneurs to take advantage of the limited liability provisions available to the company. As such, risk aversion would prevent any entrepreneur from using his personal borrowing in preference to firm-level borrowing beyond a certain extent.

⁹ We thus restrict the menu of securities to the two most commonly used instruments, ruling out various other kinds of securities, such as nonvoting preferred stock. An analysis of the optimal use of such instruments is outside the scope of this paper.

these claims. Consider first the possibility of financing with equity alone. The incumbent can establish one corporation to run both his projects, selling equity claims to outsiders on the combined cash flows (“joint incorporation”). Alternatively, he can establish two separate corporations, each to run one of these projects, and sell distinct equity claims for these firms (“separate incorporation”).

Consider now the case of financing with a combination of debt and equity. In this case the incumbent has three different financing possibilities: (1) Incorporate both projects under one firm, sell equity on the joint firm, and sell debt with claims on the combined cash flows of both projects. We will refer to this as “straight debt.” (2) Incorporate both projects as parts of a joint firm and sell two distinct debt claims, each entitled to cash flows from only one specified project. The equity sold represents claims on the combined residual cash flow. We will refer to this as “limited-recourse project financing” or sometimes simply “project financing.” (3) Incorporate both projects separately in different firms and sell separate debt as well as equity claims on the individual firms. We will refer to this case as “spin-off.”¹⁰ In the spin-off case, the incumbent also chooses the optimal split x of his total equity position between the equity of the two corporations he establishes, i.e., a fraction x of his total equity position will be invested in the equity of firm 1, and the remaining fraction $(1 - x)$ invested in that of firm 2. We will refer to these decisions collectively as the “corporate and financial structure” chosen by the incumbent.

We assume that, for a given management team in control, the probability distributions of the project cash flows are unaffected by corporate and financial structure. Consequently, the value of each firm under a given management team is given by the sum of the values of the projects run by that team. Also, for a given management team in control, the value of the firm is independent of the level or the kind of debt. The level of debt and equity chosen by the incumbent thus affects the total value of each firm only through its impact on the identity of the management team in control. Let $i \in \{t, 1, 2\}$ index the mode of incorporation: here t stands for incorporation of both projects under a joint firm, while 1 and 2 indicate, respectively, the incorporation of project 1 as firm 1 and project 2 as firm 2. Thus, when the two projects are incorporated separately, the values of the two firms will be given by V_1^J and V_2^J , respectively. If they are incorporated jointly under one corporate umbrella, the firm value is given by $V_t^J = V_1^J + V_2^J$, $J \in \{I, R\}$.

¹⁰ There is yet another possibility: Structure the projects under separate firms, sell debt jointly with a claim on the sum of the cash flows from these two projects, and allocate the residual cash flows between the equity of the two firms according to some prespecified sharing rule. Although our framework is suitable for analyzing this case as well, this is a situation not encountered in practice, and we do not study it here.

When debt is issued, the value of debt and equity issued against each firm depends not only on the face value of the debt issued, but also on the specific structure of the debt contract. In the case of joint incorporation, the debt is issued either as straight debt on the joint firm (denoted by s for straight debt) or as two distinct debt contracts, each entitled to the cash flows of only one specified project (denoted by p , for limited-recourse project financing). Thus, D_i^k refers to the face value of debt with claims on the cash flows of the i th corporation, $i \in \{t, 1, 2\}$ as before, with debt structure specified by $k \in \{s, p\}$. In the case of project financing, the promised payments made against each project has to be specified: thus $D_i^p = \{D_i^p, D_i^p\}$. In the case of spin-off, the incumbent has only one way of structuring the debt contract: separate debt claims, each entitled to cash flows from a specific firm (project). We will therefore use D_1 and D_2 , respectively (without superscripts), to denote the promised payments on debt issued on the two projects in the case of spin-off.

The value of equity in each firm is the present value of the cash flows accruing to that firm from the project(s) run by the firm, residual to the payment D_i^k to debtholders according to the usual sharing rule. We will denote this equity value of $E_i^J(D_i^k)$, where $i \in \{t, 1, 2\}$, and $J \in \{I, R\}$. Thus, $E_t^I(D_t^s)$ refers to the equity value of a joint firm with straight debt under the control of the incumbent; $E_t^I(D_t^p)$ refers to the corresponding value under limited-recourse project financing. Similarly, in the spin-off case, $E_1^I(D_1)$ and $E_2^I(D_2)$ refer to the equity values of separate firms under the management of the incumbent, each with a single project. In the case of straight debt, the incumbent has to give up control of both projects if the (joint) debt on the firm is in default. On the other hand, in the case of project financing and spin-off, the incumbent gives up control of a project only if the debt on that particular project is in default. Because of this feature common to both project financing and spin-off, the equity value of the joint firm under project financing will be the same as the sum of the equity values of the two separate firms in the spin-off case, provided the two projects carry identical debt levels in both arrangements. In other words, if $D_t^p = D_1$ and $D_t^p = D_2$,

$$E_t^I(D_t^p) \equiv E_1^I(D_1) + E_2^I(D_2) = E_1^I(D_1) + E_2^I(D_2), \quad (1)$$

with $E_1^I(D_1) = E_1^I(D_1)$ and $E_2^I(D_2) = E_2^I(D_2)$. Clearly, no such relationship exists under straight debt.

We will assume limited liability, and that the absolute priority rule is satisfied in the event of bankruptcy. This implies that the value of equity in the i th firm is nonnegative, and decreasing in the face value of debt D_i^k , irrespective of the structure of the debt contract. Further, we assume that the distribution of project cash flows is such that, for the range of debt

levels required to be issued by the incumbent to maintain control, $E_i^I > E_i^R$ if $V_i^I > V_i^R$, for all firms i , the inequality being reversed if the value of the firm is higher under the rival. Denote the total amount the rival can devote to a takeover, including amounts he can generate by borrowing on his personal account, by W^R . Depending on the kinds of equity claims outstanding, the rival uses his wealth to buy up equity from the passive shareholders in the firm(s) established by the incumbent, in a bid to wrest control of his projects from the incumbent.

It is assumed to be prohibitively costly to write and enforce contracts based on the value of these control benefits that are enjoyed by the management team in charge (see Harris and Raviv, 1988a, and Grossman and Hart, 1988, for similar assumptions); the control benefits therefore do not accrue to the security holders and do not get reflected in the market value of the securities issued by the firm. The control benefits from managing a project are a function of its characteristics. Further, these benefits of control are lost if the incumbent management loses control to the rival through a takeover, or if they lose control of the firm through bankruptcy.

The expected value of the benefits of control from a project is decreasing in the face value of debt with claims to the cash flows from it. This is a consequence of the increase in the probability of bankruptcy, the reduction in managerial discretion due to the restrictiveness of additional debt covenants, the increase in the intensity of monitoring, and the decrease in the amount of free cash flow, which accompany a higher level of debt. We will use the function $K^J(D)$, $J \in \{I, R\}$, $i \in \{1, 2, t\}$ to represent the expected value of the control benefits accruing to management from a project which is supporting a promised payment D of debt against its cash flows; since this expected value of control benefits is declining in debt, $\partial K_i^J / \partial D < 0$.

We will make the following additional assumptions about the form of the incumbent's control benefit function when characterizing the equilibrium corporate and financial structure in the case where the incumbent needs to issue debt to maintain control (Section 3.2). First, we assume that the expected value of the incumbent's control benefits from project i in the solvent state (which is a constant for all debt levels) is given by k_i , $i = 1, 2$. Second, we assume that the decline in the expected value of control benefits from a firm (project) due to debt occurs only because of the increase in the probability of loss of control of the projects under it through bankruptcy, which accompanies an increase in the debt level.¹¹ Third, we

¹¹ Thus, we focus on only one of the several ways in which debt reduces the control benefits of incumbent management. Clearly, we do not need to impose this additional structure on the incumbent's control benefit function in order to derive results in the all equity case (where the incumbent can maintain control of both projects without issuing any debt). Further, even when the incumbent needs to issue debt to maintain control, several results can be derived without imposing these assumptions on the structure of the incumbent's control benefit func-

assume that, when debt is structured separately (as in project financing or spin-off), with each debt contract affecting only a single project, the expected control benefits from the two projects are additive. Given these assumptions, when straight debt of face value D_i^s is written jointly on both projects, the expected value of the incumbent's control benefits will be given by $k_t(1 - F_t(D_i^s))$, where $k_t = k_1 + k_2$, and $1 - F_t(D_i^s)$ is the probability of solvency of the joint firm. If the two projects are incorporated jointly, but separate debt is issued (project financing), then the expected value of control benefits to the incumbent is $k_1(1 - F_1(D_1^p)) + k_2(1 - F_2(D_2^p))$. Finally, if the two projects are incorporated separately and separate debt is issued as well (spin-off), then the expected value of the incumbent's control benefits is $k_1(1 - F_1(D_1)) + k_2(1 - F_2(D_2))$.¹²

We now specify the voting behavior of passive investors in a control contest. We will assume that in a control contest for the i th firm, the fraction of passive investors who vote for the incumbent is a function of the relative abilities of the incumbent and the rival in managing the firm, denoted by $\pi(V_i^I/V_i^R) \equiv \pi_i$. Further, a majority of passive investors who hold equity in the firm vote for the incumbent if $V_i^I > V_i^R$, and for the rival if $V_i^I < V_i^R$ for any $i \in \{1, 2, t\}$: i.e., $0.5 < \pi_i \leq 1$ if $V_i^I > V_i^R$, $0 \leq \pi_i < 0.5$ if $V_i^I < V_i^R$, and $\pi_i = 0.5$ if $V_i^I = V_i^R$. In addition, $\partial\pi_i/\partial(V_i^I/V_i^R) > 0$ for all corporations i , so that the greater the ratio of the firm value under the incumbent to that under the rival, the greater the fraction of passive investors who vote for him.¹³ Thus, π_i is a measure of the ability of the incumbent relative to the rival in managing firm i (i.e., the project(s) under it); we will therefore often refer to it as the "relative ability" of the incumbent with respect to firm i .

The above assumptions made about the passive investors' voting rule constitute only one of several alternative specifications which can deliver our results. The essential requirement here is that the following conditions, generally consistent with our common-sense notion of voting by passive investors in control contests, be satisfied. First, in such a contest between the incumbent and the rival, more of the passive investors vote for the

tion. However, for ease of exposition we maintain a uniform set of assumptions throughout this paper. Interested readers are referred to the working paper version for the results derived without this additional structure.

¹² Note that, in general, the equilibrium level of control benefits accruing to the incumbent under project financing and spin-off will not be the same, since the equilibrium level of debt issued against the two projects under these two alternative arrangements will not be the same.

¹³ For example, $\pi(V_i^I/V_i^R) \equiv 1/[1 + V_i^R/V_i^I]$ satisfies the properties we have assumed. To illustrate this voting function numerically, assume that $V_1^I = 200$, $V_2^I = 100$, $V_1^R = 50$, and $V_2^R = 400$. It follows that $V_t^I = 300$ and $V_t^R = 450$. Then, $\pi_1 = 0.8$, $\pi_2 = 0.2$, and $\pi_t = 0.4$. It is also easy to verify that, for a voting function satisfying these properties, $\pi_1 = \pi_2$ implies that they also equal π_t .

management team that is, in fact, better able to manage the firm. Second, the fraction of votes obtained by the incumbent in the control-contest for a given firm are increasing in his management ability relative to the rival for the project(s) run by that firm. And finally, if the incumbent obtains the same fraction of passive votes in contests for the control of each of the two firms (when the two projects are incorporated separately), he obtains an equivalent fraction of passive votes in a control-contest for the joint firm when the two projects are incorporated under a single firm, i.e., $\pi_1 = \pi_2 \Rightarrow \pi_1 = \pi_2 = \pi_t$.¹⁴

The security benefits of the two competitors for control are maximized by voting for the management team which can generate the larger present value of cash flows. However, since they also obtain benefits from control, the rival and the incumbent have an incentive to vote for themselves. A management team for which the second motivation dominates the first for all debt levels and structures of the debt contract will be called “control-driven.” Formally, we will define the incumbent and rival as control-driven if $\Delta E_i^J(D_i^k) \leq K_i^J(D_i^k)$, for $J \in \{I, R\}$, for all debt levels D_i^k , for $i \in \{1, 2\}$, and for $k \in \{s, p\}$. Here $\Delta E_i(D_i^k)$ is defined as the difference between $E_i^I(D_i^k)$ and $E_i^R(D_i^k)$. To simplify our analysis, we will assume that the

¹⁴ Since our results do not hinge on any particular specification of the π function, we have chosen not to model the details of this voting function explicitly, since doing so only serves to add complexity to our model without generating commensurate insights. However, one way to model this would be to use a variation of the general approach adopted in Harris and Raviv (1988): we provide a skeletal outline of this approach below. Assume that, while the incumbent’s ability is common knowledge, passive investors are uncertain about the management ability of the rival (i.e., they have only a prior probability assessment of his management ability for the two projects). Let information be symmetric, so that neither the incumbent nor the rival has better information about the rival’s management ability than the passive investors. In the event of a control contest, passive investors obtain additional (independent) private signals about the rival’s management ability relative to the incumbent just before voting, with the probability of a signal favorable to the incumbent in the control contest for a given firm increasing in the ratio of the true management abilities of the incumbent and the rival for the project(s) run by that firm. Investors use these signals to update their priors using Bayes’ rule, and vote according to these updated assessments of firm (and therefore equity) value (i.e., each investor votes for that management team which, he believes, will generate a greater future equity value). Under these assumptions, the voting rule of passive investors will have the properties we have assumed: First, given the large number of (atomistic) passive investors, and that the signals obtained by investors is informative, a larger fraction of passive investors will vote for the more able management team. Second, the fraction of passive investors voting for the incumbent will be monotonically increasing in the ratio of firm values under the incumbent and the rival, since (given that the investors’ prior is informative) this fraction itself will be a monotonic function of the ratio of the true management abilities of the two competing teams; further, if the incumbent obtains the same fraction of passive votes in contests for the control of each of the two firms (when the two projects are incorporated separately), he obtains an equivalent fraction of passive votes in a control contest for the joint firm when the two projects are incorporated under a single firm.

incumbent and rival are control-driven, so that they always vote for themselves. However, we briefly discuss in the conclusion the case where the incumbent is not control-driven.

The sequence of events is as follows. Initially, the incumbent has monopoly access to two positive NPV projects. The incumbent invests the amount w^I of his own wealth in these projects, financing the rest of the total investment required by selling zero NPV claims to passive outsiders. In deciding the corporate and financial structure of his projects, he takes into account the characteristics W^R , V_1^R , and V_2^R of the rival, which are common knowledge. The rival now invests his wealth in buying up equity in the firm(s) established by the incumbent, in an attempt to take over control. Finally, all stockholders vote, control of a given firm being transferred to the rival if he wins strictly more than 50% of the votes of the stockholders in that firm; the incumbent retains control of the firm otherwise. This sequence of events is known to all investors, who make rational choices, taking into account optimal choices by others. This includes pricing of all securities based on rational expectations.

DEFINITION OF EQUILIBRIUM. Equilibrium in our model is defined as a choice of corporate and financial structure by the incumbent, a set of prices for all securities of the firm(s) set up by the incumbent, an investment decision by the rival, and an outcome of the control contest, such that (a) the prices of all securities are the “correct” prices given the outcome of the control contest and (b) the choices made by the incumbent and the rival maximize the sum of the expected values of their security benefits and control benefits. Thus, neither the incumbent nor the rival would increase his expected payoff by deviating unilaterally from his equilibrium choice. Since the voting behavior of passive investors is already captured in their voting function π , they have no additional strategic choices and we need not explicitly specify their behavior in equilibrium.

In equilibrium, the total value of the securities in the firm(s) set up by the incumbent will be $V_1^I + V_2^I$, $J \in \{I, R\}$, depending on if the incumbent or the rival is expected to be in control of each project. Let us denote by W^I the amount $w^I + V_1^I + V_2^I - (I_1 + I_2)$. Then, W^I represents the value of the incumbent’s total equity position. This amount includes the initial investment w^I plus the rents accruing to the incumbent from having the monopoly access to the two projects with a combined positive NPV of $V_1^I + V_2^I - (I_1 + I_2)$. Because the incumbent sells zero NPV claims to outsiders, he is able to keep these rents himself. Since the cash flows from each project depends on the ability of the management team which controls the project in equilibrium, the prices of the securities issued by the incumbent, and consequently W^I , depend on the outcome of the control contest.

In choosing the corporate and financial structure of his projects, the incumbent's objective is therefore to maximize the sum of his security and control benefits. The incumbent's problem is given by

$$\text{Maximize } W^I + \sum_{D_i^k=0} K_i^I(D_i^k), \quad (2)$$

where the summation in (2) is taken over all firms i controlled by him. Recall that the corporate and financial structure enters the incumbent's objective through its effect on the outcome of the control contest, which determines his security benefits W^I . It also affects the incumbent's control benefits, since the expected value of the benefits from control from any firm depends on the level of debt, and the structure of the debt contract in its capital structure.

The rival's objective in allocating his wealth W^R between the equity of the firms established by the incumbent is to maximize the sum of his own security benefits and control benefits. However, since all investors have rational expectations, the rival has to pay a fair price (based on the expected outcome in equilibrium) for the equity he buys from the passive investors. Therefore, the rival's problem is given by

$$\text{Maximize } \sum K_j^R, \quad (3)$$

where the summation in (3) is taken over all firms j that the rival succeeds in taking over from the incumbent in equilibrium.¹⁵

In order to focus on the case where managerial ability matters in the control contest, we will assume that even after the incumbent and the rival have invested to the full extent of their wealth in the equity of any firm, passive investors will hold equity in the firm. This requires that $W^I > W^R$, and $W^I + W^R < \min\{E_i^I(D_i^k)\}$, for $i \in \{t, 1, 2\}$, and $k \in \{s, p\}$, for the range of debt values required by the incumbent to maintain control of both firms

¹⁵ The assumption that the rival obtains some private benefits from control does not play any important role in generating our results; all we require is that the rival has some desire (for whatever reason) to wrest control of the firm from the incumbent. Since all securities are priced here in a rational expectations equilibrium, the equilibrium price of equity incorporates the outcome of any control contest. Given that all agents have symmetric information about his management ability, the price the rival has to pay for equity would already reflect the increase in firm value under his management, thus rendering him powerless to extract any of the security benefits associated with his taking over control (the argument here is similar in spirit to that underlying the free-rider problem studied by Grossman and Hart, 1980). We have therefore assumed that, like the incumbent, the rival also obtains some private benefits from control, in order to model the rival's motivation to attempt a takeover in the simplest possible manner.

in equilibrium.¹⁶ In other words, for any possible choice of the mode of incorporation and financing contract, the combined wealth of the incumbent and the rival is not enough to buy up the entire equity in the firm, for the range of debt levels used by the incumbent to maintain control.¹⁷

3. EQUILIBRIUM CORPORATE AND FINANCIAL STRUCTURE

We will now characterize the corporate and financial structure chosen by the incumbent in equilibrium, which also determines the outcome of the control contest. Since the value of the incumbent's total equity position depends only on who is in control, and debt reduces the incumbent's control benefits, the sum of the incumbent's security and control benefits is always higher when he can maintain control without issuing any debt. Consequently, the incumbent issues only equity when he can control both projects without issuing debt. In the next section, we will characterize this all-equity case, and discuss the case where the incumbent needs to issue debt as well in the following section. We will henceforth suppress the superscript I on the firm value, equity value and control benefit functions. Unless otherwise mentioned, these will always refer to the values when under the incumbent.

3.1. *Equilibrium with Equity Alone*

The incumbent has only two choices to make in this case: (1) optimal incorporation, i.e., deciding between joint incorporation and separate incorporation, or (2) optimal allocation x of his total equity position W^I between firms' equity, in the case where he chooses separate incorporation.

¹⁶ The assumption that $W^I > W^R$ is needed to ensure that passive investors hold equity in the firm in situations where the incumbent needs to issue debt to maintain control. If this assumption is not satisfied (and $W^R > W^I$), the rival will always be able to buy up a larger fraction of the wealth in the firm than the incumbent (issuing additional debt favors the rival in this case). This implies that, in equilibrium, the incumbent will hold more than 50% of the equity in the firm on his own account since this will be the only way for him to maintain control. This will "lock-out" the rival from control and also ensure that passive investors do not have any role to play in the control contest, since, in this case, they will not hold any equity in the firm after both the incumbent and the rival have invested to the full extent of their wealth in the firm's equity.

¹⁷ Even when these assumptions are not satisfied, the basic features of the analysis remain the same, except that we now have to proceed by studying a number of special cases, depending on the magnitude of the wealth levels of the incumbent and the rival. For instance, if the joint wealth of the incumbent and the rival is sufficient to buy up the entire equity of a joint firm running both projects (with zero debt issued), then the relative ability levels π_1 , π_2 , and π_t do not matter in determining the optimal corporate and financial structure: the incumbent has to ensure control of each firm based only on his own wealth. In this case, the results developed in the paper apply by setting $\pi_1 = \pi_2 = \pi_t = 0$. Rather than enter into such a case-by-case analysis, we restrict the scope of this paper to the setting where managerial ability always matters in any control contest.

In the case where the incumbent chooses joint incorporation, he can maintain control of both projects in equilibrium only if the inequality (4) is satisfied, with W^I given by (5).

$$\frac{W^I}{E_t} + \left[1 - \frac{W^I + W^R}{E_t} \right] \pi_t \geq \frac{1}{2}, \text{ where } E_t = V_t = V_1 + V_2. \quad (4)$$

$$W^I = w^I + V_1 + V_2 - (I_1 + I_2). \quad (5)$$

On the other hand, if both projects are structured separately, both the inequalities in (6) have to be satisfied for the incumbent to maintain control in equilibrium, with W^I given, as before, by (5)

$$\frac{xW^I}{E_1} + \left[1 - \frac{xW^I + W^R}{E_1} \right] \pi_1 \geq \frac{1}{2}, \quad (6)$$

$$\frac{(1-x)W^I}{E_2} + \left[1 - \frac{(1-x)W^I + W^R}{E_2} \right] \pi_2 \geq \frac{1}{2},$$

where

$$E_1 = V_1, E_2 = V_2. \quad (7)$$

In (4), and in the two inequalities (6), the first term on the left-hand side represents the fraction of the equity held by the incumbent, while the second term represents the fraction of votes the incumbent gets from the passive investors. The incumbent has to get at least 50% of the votes from these two sources together to maintain control of a firm. Thus, wealth and ability are substitutes in the control contest. Notice that (4) and (6) incorporate the effect of optimal choices by the rival. If the incumbent chooses to incorporate his projects in two separate firms, the rival, who moves after the incumbent, can invest his entire wealth in buying up the equity of the firm which is more vulnerable to a takeover. On the other hand, if the incumbent chooses joint incorporation, the rival merely invests his entire wealth in the equity of the combined firm, giving him a smaller share of the equity than he would have in any one of the separate firms. Therefore, under joint incorporation, the size of the combined firm acts as a deterrent to takeover, neutralizing the rival's strategic advantage of moving second.

Since we have assumed that both the incumbent and the rival are control-driven, the incumbent will always choose to retain control of both projects if possible. Further, since the incumbent does not issue any debt, his objec-

tive (2) will have the same value in all cases where he is able to retain control of both firms, irrespective of the mode of incorporation which allows him to do it. Consequently, if both separate incorporation and joint incorporation allow the incumbent to maintain control, he is indifferent to the mode of incorporation. However, in many cases (depending on the relative ability and wealth levels of the incumbent and the rival), the incumbent will be able to control both projects without issuing any debt only by choosing a certain mode of incorporation, and will therefore prefer one corporate and financial structure to the other. We will characterize such situations in Proposition 1. To facilitate exposition, define a function of the relative ability of the incumbent as

$$\phi(\pi_i) \equiv \frac{(1 - \pi_i)}{\left(\frac{1}{2} - \pi_i\right)} W^I - \frac{\pi_i}{\left(\frac{1}{2} - \pi_i\right)} W^R, \quad \text{for } i = t, 1, 2. \quad (8)$$

$\phi(\pi_i)$ is increasing in π_i on $[0, 1/2)$ and $(1/2, 1]$; the function is not continuous at 0.5. For $\pi_i < 0.5$, $\phi(\pi_i)$ has a nice intuitive interpretation: it gives the size (as measured by equity value) of the largest firm in which an incumbent of relative ability π_i can maintain control against a rival of wealth W^R (without issuing any debt), by investing his entire wealth W^I in the equity of that firm.¹⁸

PROPOSITION 1 (Joint vs. Separate Incorporation). (i) *If $\pi_1 = \pi_2$, then the incumbent can control both projects without issuing any debt for a larger set of model parameters under joint incorporation than under separate incorporation. In particular, if both projects can be controlled under separate incorporation against a rival of wealth level W^R , joint incorporation maintains control against a rival of wealth level $2W^R$.*

(ii) *Assume (without loss of generality) that the incumbent has a higher relative ability for managing project 2 (i.e., $\pi_2 > \pi_1$). Then, for $\pi_1, \pi_t < 0.5$, if $\pi_2 \geq (1/2)(1 - W^R/V_2)$, $\phi(\pi_1) \geq V_1$, and $\phi(\pi_t) < V_1 + V_2$, the incumbent can control both projects without issuing any debt under separate incorporation, but cannot do so under joint incorporation.*

The key ingredients that determine the feasibility of controlling both projects under either mode of incorporation are the wealth of the incumbent

¹⁸ This intuition does not carry through to the case where $\pi_i > 1/2$. If this is the case, the incumbent can always control the firm without issuing any debt (regardless of equity value) provided his investment in that firm is larger than the rival's. Given our assumption that $W^I > W^R$, this means that, if $\pi_i > 1/2$, the incumbent can always control both projects without issuing any debt, using joint incorporation.

relative to the rival and the difference between the management abilities of the incumbent (relative to the rival) across his two projects. If the rival's wealth is significant, but the incumbent's management abilities for both the projects are of the same order, then joint incorporation is advantageous, since it prevents the rival from using his wealth strategically. However, if the rival's wealth is relatively small, and there is a great difference between the incumbent's management abilities (relative to the rival) for his two projects, then separate incorporation is the right choice, since it gives the incumbent greater flexibility in using his wealth and ability as substitutes. Since separate incorporation results in distinct equity being sold for each firm, the incumbent can allocate his wealth optimally across the equity of the two firms, taking into account the difference in his management abilities relative to the rival for the two firms. Holding firm size constant, in the all-equity case the incumbent will invest a greater proportion of his wealth in the firm for which he has lower management ability relative to the rival.¹⁹

3.2. *Equilibrium with Debt and Equity*

If the wealth and ability of the incumbent relative to the rival are such that neither the inequality (4) nor the pair of inequalities (6) hold, then the incumbent cannot maintain control by issuing equity alone. Issuing debt allows the incumbent to generate wealth for investment, without giving up his control rights. The cost of doing this is that the expected value of his control benefits decrease with debt. However, since the incumbent is control-driven, he prefers retaining control of the project to obtaining an increase in his security benefits. Consequently, the incumbent issues just enough debt in equilibrium to ensure that he is in control of both projects. Since the cash flow distribution from each project depends on the corporate and financial structure only by affecting the outcome of the control contest, the total value of all securities issued by the incumbent will equal $V_1 + V_2$ in equilibrium, and the value of the incumbent's security benefits, W^I , is given, as before, by (5). Thus, the incumbent's objective is simply to choose the corporate and financial structure that maximize the expected value of his control benefits.

In arriving at his choice of the corporate and financial structure, the incumbent first takes the incorporation choice (joint incorporation or spin-off) as given, and solves this subproblem for the debt contract structure, debt allocation across firms (projects), and the allocation of his wealth W^I

¹⁹ For a numerical illustration of Proposition 1(ii), assume that $W^R = 20$, and let $V_1 = 100$, $V_2 = 200$, so that $V_t = 300$. Then, $\pi_1 = 0.2$, $\pi_t = 0.4$, $W^I \in [42.5, 54.4]$, and $\pi_2 \in [.56, 1]$ are parameter values for which the incumbent can maintain control of both projects under separate incorporation by issuing only equity (and setting $x = 1$), but cannot do so under joint incorporation.

across the two firms which maximizes his control benefits under that mode of incorporation. We now describe each of the incumbent's subproblems.

The Incumbent's Subproblem Given Joint Incorporation

Given joint incorporation, the incumbent's objective is to choose the debt contract and debt allocation across projects (in the case where project financing is his optimal choice), that maximizes his control benefits. Therefore, he maximizes (9) subject to the constraint (10), which ensures control of both projects, and nonnegativity constraints.

$$\text{Maximize } K_t(D_t^k), \quad (9)$$

$$D_1, D_2, D_t \geq 0$$

$$\frac{W^I}{E_t(D_t^k)} + \left[1 - \frac{W^I + W^R}{E_t(D_t^k)} \right] \pi_t \geq \frac{1}{2}, \quad (10)$$

where

$$K_t(D_t^k) = k_t(1 - F_t(D_t^s)) \text{ and } E_t(D_t^k) = E_t(D_t^s) \text{ for straight debt,}$$

$$K_t(D_t^k) = k_1(1 - F_1(D_1^p)) + k_2(1 - F_2(D_2^p)) \text{ and} \quad (11)$$

$$E_t(D_t^k) = E_1(D_1^p) + E_2(D_2^p)$$

for project financing.

First, the incumbent solves the above program taking straight debt as given. Since debt is costly to the incumbent, the debt level which solves the above program is that for which (10) holds as an equality, since this is the minimum level of debt that guarantees control of both projects to the incumbent. Denote this solution by D_t^{s*} . Second, the incumbent solves the program taking project financing as the debt contract, and arrives at the optimal debt levels D_1^{p*}, D_2^{p*} . The incumbent now makes his debt contract choice: He chooses straight debt or project financing according as $k_t(1 - F_t(D_t^{s*}))$ is greater or less than $k_1(1 - F_1(D_1^{p*})) + k_2(1 - F_2(D_2^{p*}))$. We will denote this optimal choice by D_t^{k*} , with the corresponding level of control benefits denoted by $K_t(D_t^{k*})$.

The Incumbent's Subproblem Given Spin-Off

Given spin-off, the incumbent solves for the debt levels D_1 and D_2 to be issued against firms 1 and 2, respectively, and the split x of his total equity position W^I between the two firms, which will maximize his control benefits: i.e., he maximizes (12) subject to the pair of constraints (13), which ensure control of both projects, and the nonnegativity constraints.

$$\text{Maximize}_{x, D_1, D_2 \geq 0} k_1(1 - F_1(D_1)) + k_2(1 - F_2(D_2)), \quad (12)$$

$$\frac{xW^I}{E_1(D_1)} + \left[1 - \frac{xW^I + W^R}{E_1(D_1)} \right] \pi_1 \geq \frac{1}{2}, \quad (13)$$

$$\frac{(1-x)W^I}{E_1(D_1)} + \left[1 - \frac{(1-x)W^I + W^R}{E_2(D_2)} \right] \pi_2 \geq \frac{1}{2}.$$

Since debt is costly to the incumbent, he will issue the smallest amount of debt consistent with maintaining control of both firms. Thus, the optimal values of the debt levels D_1 and D_2 will either equal zero, or will be such that the corresponding control condition holds as an equality. We denote the solution to this program by x^* , D_1^* , and D_2^* .

Given the solutions to the subproblems discussed above, the incumbent chooses that mode of incorporation that gives him the highest expected value of control benefits: he chooses joint incorporation or separate incorporation (spin-off) depending on whether $K_1(D_1^{k*})$ is greater or less than $k_1(1 - F_1(D_1^*)) + k_2(1 - F_2(D_2^*))$. In each case, he chooses the debt contract, debt level(s), and the split-up of his total equity position (if he chooses spin-off) according to the solution of the corresponding subproblem. The incumbent thus chooses the "best way" to maintain control.

The prices of all securities issued by the incumbent are determined according to this equilibrium corporate and financial structure. Thus, the value of the debt and equity issued by the incumbent will depend on the equilibrium choices of debt contract structure and debt levels. However, the total value of all securities will be the same regardless of corporate and financial structure. Since the incumbent will control both projects in equilibrium, the rival will be indifferent between investing and not investing in the equity of the firm(s) set up by the incumbent, and the value of his control benefits will equal zero in equilibrium. We now characterize the incumbent's equilibrium choice of corporate and financial structure under different settings.

PROPOSITION 2 (Spin-Off vs Project Financing). (i) *If $\pi_1 = \pi_2$, the incumbent prefers project financing to spin-off.*

(ii) *Let $\pi_2 > \pi_1$, with $\pi_1, \pi_2 < 0.5$. Then, the incumbent prefers spin-off to project financing if his relative abilities across the two projects are such that $\pi_2 \geq (1/2)/(1 - W^R/V_2)$ and $\phi(\pi_2) \leq 2\phi(\pi_1)$, provided that $k_2 \geq k_1$, and the cash flows from the two projects are identically distributed under the incumbent.²⁰*

²⁰ If the cash flows from the two projects are distributed uniformly over $[0, h_i]$, $i = 1, 2$, the requirement that the cash flows from the two projects be identically distributed can be replaced by an assumption that the control benefits per dollar of value from project 2 is higher than that from project 1 (i.e., $k_2/h_2 > k_1/h_1$).

The intuition behind Proposition 2 parallels that behind Proposition 1. Unlike the all-equity case, however, here the incumbent can always maintain control by issuing a sufficiently large amount of debt. His problem now is to maintain control by incurring the least possible dissipation in control benefits. If the incumbent's abilities in managing the two projects are sufficiently close, the flexibility of allocating wealth strategically across the equity of two separate firms is not important, so that the takeover-deterrence effect of size dominates. Therefore, if the incumbent needs to issue debt to control his projects, he needs to issue less debt with both projects incorporated in a joint firm and the required debt issued under limited-recourse project financing than with a spin-off arrangement. Consequently, his choice will be project financing, since the expected value of his control benefits will be larger in this case.²¹

In contrast, if the incumbent's abilities (relative to the rival) in managing the two projects differ significantly and the rival's wealth level is relatively low, then the ability to allocate wealth strategically across the equity of two separate firms overwhelms the benefit of using firm size as a deterrent to takeover.²² Proposition 2(ii) characterizes one such situation, where the incumbent's relative ability for project 2 is large enough that, in the event of a spin-off, he can control firm 2 relying only on the votes of passive investors, i.e., without investing any of his wealth in the equity of that firm. The incumbent can therefore invest all his wealth in the equity of firm 1 for which he has lower management ability relative to the rival. This means that the incumbent can control a much larger fraction of the votes of firm 1 than would be possible if he had to invest the same amount in the equity of the much larger combined firm running both projects together (as in project financing), so that the face value of debt that the incumbent needs to issue to maintain control will be smaller in this case than under project financing, leading the incumbent to prefer spin-off over project financing.²³

We now study the conditions under which the incumbent prefers limited-

²¹ We are able to compare limited-recourse project financing and spin-off readily since, for a given level of debt issued against a project's cash flows, the control benefits from that project (firm) is the same under either arrangement.

²² Firm size is built up by incorporating both projects within the same firm. The conditions $\pi_1 = \pi_2$ for project financing to dominate spin-off, and the conditions on π_1 and π_2 specified in Proposition 2(ii) for spin-off to dominate project financing, are both sufficient (but not necessary) conditions. Thus, even if π_1 and π_2 are not equal, the incumbent is better off using project financing rather than spin-off as long as the incumbent's management abilities relative to the rival for his two projects are quite close; similarly, the difference between π_1 and π_2 required for spin-off to dominate project financing is often smaller than that required by the condition in Proposition 2(ii) (see footnotes 28 and 29 for numerical illustrations).

²³ The condition $\phi(\pi_1) \leq 2 \phi(\pi_1)$ rules out the case where the incumbent obtains an overwhelming advantage in getting the votes of passive investors in a joint firm only because he has incorporated both projects jointly.

recourse project financing to straight debt, and vice-versa. To facilitate exposition, denote by $\eta_i, i \in \{1, 2\}$, the inverse of the equity value function (under incumbent management), so that $\eta_i(E_i(D_i)) = D_i$. Since the equity value functions $E_1(\cdot)$ and $E_2(\cdot)$ are the same for both project financing and spin-off, the inverse functions $\eta_1(\cdot)$ and $\eta_2(\cdot)$ are also identical under these arrangements; $\eta_t(\cdot)$ denotes the inverse of the equity value function when straight debt is issued, $E_t(\cdot)$.²⁴

PROPOSITION 3 (Project Financing vs Straight Debt). (i) *Let π_t be such that $V_2 < \phi(\pi_t)$. Then the incumbent prefers limited-recourse project financing to straight debt if control benefits from project 2 are sufficiently larger than those from project 1, such that*

$$k_2 \geq k_1 \left[\frac{F_1(\eta_1(\phi(\pi_t) - V_2))}{F_t(\eta_t(\phi(\pi_t)))} - 1 \right]. \tag{14}$$

If, in addition, $\pi_1 = \pi_2$, then project financing is the equilibrium choice of the incumbent.

(ii) *Let the project cash flows, \tilde{y}_1 and \tilde{y}_2 , respectively, be distributed uniformly over $[0, h]$. Then, if the control benefits from the two projects are equal ($k_1 = k_2$), the incumbent prefers straight debt to project financing. If, in addition, $\pi_1 = \pi_2$, straight debt is the equilibrium choice of the incumbent.*²⁵

The advantage of limited-recourse project financing over straight debt is the flexibility to allocate debt across the two projects in a lopsided manner (if this is warranted by differences in the extent of control benefits across the two projects), thus allowing the incumbent to minimize the adverse impact of debt on his control benefits. A situation in which this feature of project financing is beneficial is characterized in Proposition 3(i), where one of the projects confers a large amount of control benefits, and generates cash flows with very low risk, while the other yields much smaller control benefits, but is highly risky. Here, project financing allows the incumbent to issue most of the debt (required to maintain control of the two projects) against the low control benefit project, leaving the high control benefit project relatively debt-free (we will discuss optimal debt allocation across projects later). Issuing straight debt with claim on the cash flows of both

²⁴ Since the equity value functions $E_i(D), i \in \{1, 2, t\}$ are monotonically decreasing in the debt level D , their inverse functions $\eta_i(D)$ are also decreasing.

²⁵ The proof of this proposition requires us to use the details of the probability distribution of project cash flows, and we work with the uniform distribution case for analytical simplicity. However, since the logic behind this result does not depend on properties specific to any particular probability distribution, we conjecture that this result will hold for other probability distributions as well.

projects in this case can only reduce the expected value of the incumbent's total control benefits, by increasing the probability of losing control of the high-control benefit, low-risk project through bankruptcy, making project financing the right choice.²⁶

However, there are also synergies from writing straight debt on the combined cash flows of the two projects. In our model, these arise from co-insurance effects, which result in a lower probability of bankruptcy when debt is written on the combined cash flows of the joint firm rather than separately on that of the individual projects as in project financing. Consequently, if the structures of control benefits are similar across the two projects (as in Proposition 3(ii)), there is little advantage to be gained from the uneven debt allocation possible under project financing. Straight debt is then the right choice, since there are significant co-insurance benefits to be obtained under a straight debt arrangement.²⁷ If $\pi_1 = \pi_2$ in this situation, then straight debt dominates spin-off as well, since (from Proposition 2), spin-off will yield an even lower level of control benefits in this case than project financing.²⁸

PROPOSITION 4 (Spin-Off vs Straight Debt). *Assume (without loss of generality) that the incumbent's relative ability for firm 2 is greater than that for firm 1 (i.e., $\pi_2 > \pi_1$), and let $\pi_1, \pi_1 < 0.5$. Then, the incumbent prefers spin-off to straight debt if $k_2 \geq k_1$ and the incumbent's relative abilities across the two projects are such that $\pi_2 \geq 1/2 / \{1 - W^R/V_2\}$, and $F_1(\eta_1(\phi(\pi_1))) <$*

²⁶ The condition $\phi(\pi_1) > V_2$ merely ensures that the high control benefit project is not too large relative to the wealth available to the incumbent, so that he is able to implement the strategy of maintaining control by issuing debt primarily on the low control benefit project.

²⁷ Of course, such co-insurance benefits would be somewhat less if the cash flows from the two projects are positively correlated rather than being stochastically independent, as is assumed here.

²⁸ The following numerical example illustrates Propositions 2(i) and 3. Let the project cash flows under the incumbent, \bar{y}_1 and \bar{y}_2 , respectively, be distributed uniformly over $[0, 100]$. Also assume that $W^I = 5$, and $W^R = 1$. Now, set $\pi_1 = \pi_2 = 0.1$, so that $\pi_1 = 0.1$ as well. Initially, let $k_1 = k_2 = 1$, in which case straight debt with face value 112.93 is the equilibrium choice of the incumbent, giving an expected control benefit value of 0.7581. If the incumbent chooses limited-recourse project financing instead, he has to issue debt of face value 66.83 on each project, yielding a control benefit value of 0.6633; spin-off, on the other hand, requires him to allocate half his wealth to the equity of each firm, with debt of face value 67.21 issued on each firm, giving an expected value of control benefits of only 0.656. Thus, the co-insurance features of straight debt make it the equilibrium choice. Now, keeping other parameters unchanged, increase k_2 in steps of one unit each. Straight debt remains the equilibrium choice as long as $k_2 < 7$, above which project financing becomes the equilibrium choice. For the project financing case with $k_2 = 7$, the incumbent needs to issue debt of face values 93.36 and 53.56 on firms 1 and 2, respectively, yielding him an expected value of control benefits of 3.3168. If he uses straight debt instead, the incumbent has to issue debt of face value 112.93, which yields him a lower expected control benefit value of 3.0324. (Since we have kept $\pi_1 = \pi_2$ throughout this example, spin-off always yields the incumbent a lower expected value of control benefits than project financing, regardless of the values of k_1 and k_2).

$2F_t(\eta_t(\phi(\pi_t)))$. If, in addition, the cash flows from the two projects under the incumbent are identically distributed, and $\phi(\pi_t) \leq 2\phi(\pi_1)$, then spin-off is the incumbent's equilibrium choice.

Because it reduces the debt to be issued to maintain control, spin-off provides the incumbent with a higher expected value of control benefits than straight debt if his relative abilities across the two projects are sufficiently different and the probability of bankruptcy of the lower-relative-ability firm under the spin-off arrangement (with the level of debt required to maintain control allocated to it) is lower than twice that of the joint firm (with the level of straight debt required to maintain control issued against it). The reason is that in this case the advantage to the incumbent of strategically allocating his wealth across the equity claims of two separate firms dominates not only the advantage straight debt offers of using size as a deterrent to takeover, but also any synergies such as co-insurance effects arising from writing debt on the combined cash flows of the two projects. If, in addition, the requirements specified in Proposition 2(ii) are also satisfied, then spin-off is preferred by the incumbent to project financing as well, making it his equilibrium choice.²⁹

PROPOSITION 5 (Debt Allocation in Project Financing). (i) *If project financing is the equilibrium choice of the incumbent, the equilibrium debt levels on the two projects are characterized by*

$$k_1 H_1(D_1^{P*}) = k_2 H_2(D_2^{P*}), \quad (15)$$

²⁹ Propositions 2(ii) and 4 are illustrated by the following numerical example. Start with the same initial conditions as in the numerical example in footnote 28, so that $k_1 = k_2 = 1$, and $\pi_1 = \pi_2 = \pi_t = 0.1$. In this case, we know that straight debt is the incumbent's equilibrium choice. Now, keeping everything else the same, increase π_2 , specifying the passive investors' voting function to be the same as that given in footnote 13 (a specific voting function is used only to ensure that the π_t values used are consistent with the values of π_1 and π_2 and the other parameters assumed). Straight debt remains the equilibrium choice of the incumbent until π_2 exceeds 0.39, at which point spin-off becomes the equilibrium choice. (Spin-off yields the incumbent expected control benefits of 0.814; alternatively, he can ensure control by issuing straight debt of face value 110.703, which gives him an expected value of control benefits of only 0.7974, so that spin-off dominates straight debt.) Since we keep $k_1 = k_2$ throughout this example, project financing always gives a lower expected value of control benefits than straight debt, regardless of values of π_1 and π_2 . Project financing gives a higher expected value of control benefits than spin-off as long as π_2 is less than 0.21, above which spin-off dominates project financing (at $\pi_2 = 0.21$, spin-off yields expected control benefits of 0.678, compared to only 0.677 for project financing). Notice that the difference in the incumbent's relative abilities across the two projects required for spin-off to dominate straight debt is larger than that required for spin-off to dominate project financing.

in the case of an interior solution (i.e., $D_1^{p*} > 0$, $D_2^{p*} > 0$). If an interior solution does not exist, zero debt is allocated to the project with a higher value of $k_i H_i(D)$ (say project 2), with all the debt required to maintain control issued against project 1 (i.e., $D_1^{p*} = \eta_1(\phi(\pi_1) - V_2)$).

(ii) In an interior equilibrium, the ratio of debt levels across the two projects, D_2^{p*}/D_1^{p*} is decreasing in the ratio of their control benefits, k_2/k_1 .

(iii) If the cash flows from the two projects are identically distributed, $k_2 > k_1$ implies that $D_1^{p*} > D_2^{p*}$.

(iv) If the project cash flows are distributed uniformly over $[0, h_i]$, $i = 1, 2$, then (in an interior equilibrium), a lower level of debt per dollar of project value is issued against the project with the larger amount of control benefits per dollar of project value.

Condition (15) requires that the product of the level of control benefits in the solvent state times the hazard rate be equalized for the two projects with the equilibrium level of debt issued against their cash flows. This product is a “sensitivity” or cost-to-benefit ratio, which measures the marginal reduction in control benefits from each project with debt relative to the marginal reduction in equity value contributed by the project with debt; recall that reducing equity value is a benefit here, since it allows the incumbent to control more votes. Thus, if a firm has two projects with widely differing sensitivity ratios, then project financing offers the flexibility of loading up with debt the project with the lower sensitivity ratio. Other things remaining the same, this means that the project with lower control benefits will carry a large amount of debt since the sensitivity ratio is increasing in the level of debt issued. This is consistent with the well-known notion among practitioners that limited-recourse project financing increases the “debt-capacity” of the firm; unlike project financing, straight debt does not allow any such adjustment of debt levels in accordance with the specific characteristics of various projects, thus limiting the debt financing that can be undertaken without a significant reduction in management’s control benefits.

PROPOSITION 6 (Debt and Wealth Allocation in a Spin-off). (i) If spin-off is the equilibrium choice, then, in an interior equilibrium ($D_1^* > 0$, $D_2^* > 0$), the optimal debt levels are characterized by

$$k_1 H_1(D_1^*) \frac{(1 - \pi_1)}{(1/2 - \pi_1)} = k_2 H_2(D_2^*) \frac{(1 - \pi_2)}{(1/2 - \pi_2)}. \quad (16)$$

(ii) In such an equilibrium, if k_2 increases (for a given k_1), D_1^* increases, D_2^* increases, and x^* decreases.

(iii) *Let the cash flows from the two projects be distributed uniformly over $[0, h_i]$, $i = 1, 2$. Then, in an interior equilibrium (with $\pi_1, \pi_2 < 0.5$):*

(a) *The ratio of debt levels issued per dollar of project value across the two projects $(D_2^*/h_2)/(D_1^*/h_1)$ is decreasing in the ratio of the incumbent's relative abilities, π_2/π_1 (for given k_1, k_2); it is decreasing in the ratio of their control benefits in the solvent state, k_2/k_1 (for given π_1, π_2).*

(b) *If $k_2 \geq k_1$, then $\pi_2 > \pi_1$ implies that a lower level of debt per dollar of project value will be issued against project 2.*

(iv) *If the project cash flows are identically distributed, and $k_2 = k_1$, then $\pi_2 > \pi_1$ implies that $D_1^* > D_2^*$; if, in addition, the project cash flows are uniformly distributed, $x^* < (1 - x^*)$.³⁰*

When the incumbent's ability relative to the rival in managing one of the two firms in a spin-off is very high, the incumbent can control that firm by relying only on the votes of passive investors. The incumbent will therefore invest all his wealth in the equity of the other firm, minimizing the amount of debt to be issued to control that firm. If, however, his management ability for neither firm is that high, he splits his wealth between the equity of the two firms, with the level of debt issued against each firm and the fraction of the incumbent's wealth invested in each firm depending on his ability levels and the structure of control benefits across the two firms. The optimality condition (16) characterizing the debt levels issued against the two firms in such an interior equilibrium is similar to the condition (15), except that the sensitivity ratio $k_i H_i(\cdot)$ of each project is now multiplied by an increasing function of the incumbent's ability (relative to the rival) for managing that project. This is because, in a spin-off (unlike in project financing), there are two distinct equity claims available to outsiders, so that, in addition to the considerations discussed under Proposition 5, the incumbent also wants to reduce the fraction of passive votes in the firm for which he has lower ability than the rival. This makes the optimal debt levels allocated to the two firms a function of these relative abilities as well as the structure of control benefits. Thus, if the control benefits from the two projects are similar, the incumbent will invest more of his wealth in the equity of the higher-relative-ability firm, but issue more debt against the lower relative ability firm. The reason is that the incumbent will obtain only a lower fraction of the votes of passive investors in the lower-

³⁰ To illustrate this proposition numerically, let $\pi_1 = 0.1$ and $\pi_2 = 0.39$, with all other parameters as in the illustration in footnote 29 ($k_1 = k_2 = 1$), so that spin-off is the incumbent's equilibrium choice. In this case, the incumbent invests 26.75% of his wealth in the equity of firm 1 (so that $x^* < (1 - x^*)$) and issues debt of face value 76.51 on firm 1 and 42.1 on firm 2 (thus firm 1 has a greater debt-ratio). Now, keeping π_1 the same, increase π_2 to 0.41 (so that π_2/π_1 increases): the incumbent now maintains control by issuing debt of face value 78.04 against firm 1 and 36.02 against firm 2 (so that $D_2^*/h_2)/(D_1^*/h_1)$ falls), and x^* falls to 23.65%.

relative-ability firm than in the higher-relative-ability firm, and issuing debt reduces the fraction of passive investors in any firm.³¹

4. EMPIRICAL IMPLICATIONS

4.1. *Implications for Corporate Structure and Spin-Offs*

When management has similar abilities, relative to potential rivals for control, across different projects or assets-in-place versus a new project, and these projects are similar in terms of their control benefits to incumbent management, they will be incorporated under one corporate umbrella, with any debt used issued in the form of straight debt on the joint firm. If, however, these relative abilities across projects are very different, then they will be spun off into separate firms or, in the case of a new project, it will be set up as a separate firm. A testable consequence of this implication is that business units that are spun-off will have considerably different operating performance than the parent firm. Assuming that management's ability will be lower in activities that are unrelated to its main activity, a related testable consequence of the above implication is that spun-off units will have industry membership different from that of the parent firm (as captured by differences in their S.I.C. codes, for instance). The empirical evidence of Schipper and Smith (1983) is consistent with this prediction: 72 out of 93 firms in their sample of spin-offs involved parents and subsidiaries with different industry membership.

Another implication deals with the capital and ownership structures of the two business units after a spin-off. Our model predicts that the allocation of debt across the spun-off units will be such that the unit for which management has lower relative ability will carry a larger debt ratio, provided the control benefits from the higher-relative-ability project are at least as high as that from the lower-relative-ability project. Further, if other things, including control benefits, are similar across the two units, the incumbent management will hold a larger proportion of their wealth as equity in the higher-relative-ability firm.³²

³¹ If, however, the control benefits from the lower-relative-ability firm are much larger than those from the higher-relative-ability firm, the objective of minimizing the amount of debt issued against the larger control benefit firm may become the overriding concern; the incumbent will therefore issue more debt on the higher-relative-ability firm and invest more wealth in the lower-relative-ability (larger control benefit) firm, so as to keep control of that firm with as little debt as possible.

³² To test this implication, we can use the performance of the business units prior to the spin-off as a proxy for the relative abilities of management for the two units. As far as we know, the empirical literature has not examined the relationship between capital and ownership structure after a spin-off and the pre-spin-off performance of the business units involved; there is, however, some anecdotal evidence supporting this prediction. One example was provided by the spin-off of Morton-Thiokol, completed on July 1, 1989, into two separate

4.2. *Implications for Limited-Recourse Project Financing*

When the incumbent's relative ability for a new project is similar to that for the projects already existing in the parent firm, but the control benefits available to management from the project are significantly different from those from the sponsoring firm, then the project should optimally be implemented under a limited-recourse project financing arrangement. To test this implication, we need to specify proxies for the magnitude of the control benefits arising from various projects. Two good proxies for the benefits of control are the extent of managerial discretion (projects with a high degree of managerial discretion will confer greater control benefits) and the extent of free cash flow (as in Jensen, 1986). Further, when an activity is governed by elaborate and explicit "rules and contracts" (Williamson, 1988), it may leave little room for managerial discretion to consume control benefits (see, e.g., Boot, Greenbaum and Thakor, 1993). Thus, the complexity and restrictiveness of the contracts associated with a project may also serve as a useful proxy for the magnitude of control benefits. Consistent with this implication, Chen *et al.* (1989) document that the most widespread use of project financing is in construction projects in the nonutility power production industry, where projects are characterized by a fairly complex set of contracts, with the product and cash flows carefully precommitted to suppliers and creditors in such a fashion as to leave the management little discretion and little free cash flow.³³

Another prediction is that in a limited-recourse financing arrangement,

companies: Morton International Inc., including Morton's chemical, salt, and fledgling automobile air-bag operations, and Thiokol Corporation, an aerospace concern (see, for instance, WSJ, July 5, 1989). Morton-Thiokol manufactured the solid rocket motors for the Challenger space shuttle, which exploded after lift-off on January 28, 1986, killing seven astronauts. The profits from the company's aerospace business fell after the shuttle crash, largely because of the costs associated with the company's own research into what happened and efforts to make future launches safer. Further, the Challenger disaster brought the aerospace division under considerable regulatory scrutiny, and raised questions about managerial competence. On the other hand, the company's specialty chemicals and air-bag businesses were thriving. While firm management has denied that the spin-off had anything to do with the shuttle disaster, we would argue that the differences in the control benefits and the relative abilities of incumbent management across the two divisions contributed to the spin-off. Consistent with our predictions, these differences were also reflected in the capital structures of the two corporations resulting from the spin-off: Thiokol Corporation had a debt-equity ratio of approximately 1, while Morton International's was only around 0.045.

³³ Also, projects financed under the limited-recourse arrangement are often those undertaken in foreign countries (relative to the sponsoring firm), and usually involve multiple sponsors (some of which may be foreign governments and companies), thus giving rise to a highly regulated and closely monitored environment. These features may further reduce the value of control benefits available from these projects to the management of the sponsoring firm.

TABLE I

SUMMARY OF IMPLICATIONS FOR FORM OF INCORPORATION AND DEBT CONTRACT STRUCTURE

		k_1 Close to k_2	k_1 and k_2 significantly different
Incumbent able to control both projects without issuing debt (all equity case)	π_1 close to π_2	Joint incorporation	Joint incorporation
	π_1 and π_2 significantly different	Separate incorporation	Separate incorporation
	π_1 close to π_2	Joint incorporation with straight debt	Joint incorporation with limited-recourse project financing
Incumbent unable to control both projects without debt			
	π_1 and π_2 significantly different	Spin-off or joint incorporation with straight debt	Spin-off

the greater the disparity in the control benefits (per dollar of value) between the projects implemented under limited-recourse financing and that of the sponsoring firm, the greater the difference between the debt-ratios of the parent firm and the project financed under this arrangement. Since in our model only projects with control benefits significantly different from those of the parent firm are financed under limited-recourse, the implication here is the following: if the project has much lower control benefits than the parent firm, then the debt ratio used to finance the project under limited-recourse financing will be much greater than that of the parent firm. Making use of the proxies for control benefits discussed earlier, this leads to the testable prediction that the debt-ratios used to finance projects under the limited-recourse arrangement will be decreasing in the levels of free cash flow from these projects and increasing in the number and complexity of covenants needed to govern project activity, as well as in the extent of regulation. Some preliminary evidence consistent with this implication is provided by Wynant (1980), who documents that the debt-ratios used in limited-recourse project financing arrangements (around 65 to 75%) are, on average, much greater than those of the sponsoring firms.

5. CONCLUSION

When a firm undertakes multiple projects and incumbent management enjoys noncontractible control benefits, the corporate and financial structure of the firm significantly affects the incumbent management's ability to maintain control. In such a setting, we have analyzed the interrelationships

among corporate structure, capital structure, and ownership structure, and derived implications for the optimal incorporation of projects, the amount of debt issued, debt contract structure, debt allocation across projects, and the ownership structure. In particular, we have characterized the situations under which limited-recourse project financing and spin-offs are optimal.

For the sake of simplicity and focus, we made two fairly strong assumptions: First, we assumed that the incumbent is control driven, and second, that the wealth and ability of the rival are known fully before incumbent management chooses the corporate and financial structure of the firm. Because of these two assumptions, no takeovers occur in equilibrium. However, it is easy to relax these assumptions to allow takeovers to occur in equilibrium, and we will now briefly discuss the implications of doing so.³⁴ To consider the simplest case, assume that the rival can be one of two possible management ability types (high and low) and that the value of both projects under the high ability rival will be higher than those under the low ability rival. Assume also that the incumbent has incomplete information about the rival's type—he knows only the probability distribution over potential rival types—when choosing the corporate and financial structure of his projects. The incumbent and outside investors come to know the true type of the rival just before voting in the control contest. Further assume that the incumbent is control driven only with respect to a low ability rival, and would want to give up control to a high ability rival since the increase in his security benefits when the projects are managed by a high ability rival would outweigh his loss of control benefits. Finally, assume that the wealth and ability levels of the incumbent are such that he needs to issue debt to maintain control against either rival type.

In this situation, the incumbent's equilibrium choice of corporate and financial structure depends in part on his prior probability assessment of the rival being of the low ability type. Consider first the case where this probability is very high. Then the incumbent issues just enough debt to ensure control against the low ability rival, and chooses the corporate and financial structure of his projects to minimize the loss in control benefits due to debt. In this case, no takeover occurs if the rival indeed turns out to be of the low ability type; on the other hand, if he turns out to be of the high ability type, a friendly takeover occurs, i.e., the incumbent will vote for the rival in the control contest. Consider now the second case where the probability of a low ability rival is very low. The incumbent would not issue any debt in this case and would therefore be indifferent to the choice of corporate and financial structure, since the expected loss in control benefits to the incumbent in the event of a takeover by a low ability

³⁴ For a detailed discussion of the case where takeovers occur in equilibrium, see Chemmanur (1990).

rival would be low enough to be outweighed by the expected decrease in his control benefits from issuing debt to prevent such a takeover. In this case, if the rival indeed turns out to be of the low ability type, a hostile takeover occurs, i.e., the incumbent will vote against the rival in the control contest, but will lose in equilibrium. If he turns out to be of the high ability type, a friendly takeover occurs. Thus, while the analysis becomes more complex when we allow for takeovers to occur in equilibrium, the basic intuition driving our results goes through even then, for the range of rival-abilities where the incumbent does not want to cede control to the rival.

APPENDIX

Proof of Proposition 1. (i) $\pi_1 = \pi_2 \Rightarrow \pi_1 = \pi_2 = \pi_t = \pi$ (say). For the incumbent to control both firms under separate incorporation, both the inequalities in (6) have to hold. Rearranging these inequalities, adding, and using $\pi_1 = \pi_2 = \pi$, we obtain

$$W^I(1 - \pi) - \pi(2W^R) \geq \left(\frac{1}{2} - \pi\right) V_t, \quad (\text{A1})$$

which is simply a rearranged version of (4), the control condition under joint incorporation against a rival of wealth ($2W_R$).

(ii) $\pi_2 \geq 1/2\{1 - W^R/V_2\}$ ensures that, under separate incorporation, the incumbent can control firm 2 relying on passive votes alone, so that $x^* = 1$. Then, $\phi(\pi_1) \geq V_1$ ensures control of firm 1 (with $x = 1$) as well. On the other hand, $\phi(\pi_t) < V_1 + V_2$ implies that (4) is violated, so that the incumbent cannot maintain control under joint incorporation with equity alone. Q.E.D.

Proof of Proposition 2. (i) $\pi_1 = \pi_2 \Rightarrow \pi_1 = \pi_2 = \pi_t$. Since the incumbent has to issue some debt to control both projects, $\pi_1 = \pi_2 = \pi_t < 0.5$ (since, if $\pi_t \geq 0.5$, it can be shown that both projects can be controlled using equity under joint incorporation). Now, the optimal allocation of the incumbent's total wealth, x^* , and the optimal debt levels, D_1^* and D_2^* , under spin-off are given by the solution to the incumbent's objective (12) subject to the control constraints (13). Rewriting these constraints and adding, we get (using $\pi_1 = \pi_2 = \pi_t$)

$$\begin{aligned} (1 - \pi_t)W^I - 2\pi_t W^R &\geq \left(\frac{1}{2} - \pi_t\right) [E_1(D_1^*) + E_2(D_2^*)] \\ &\Rightarrow (1 - \pi_t)W^I - \pi_t W^R > \left(\frac{1}{2} - \pi_t\right) [E_1(D_1^*) + E_2(D_2^*)], \end{aligned} \quad (\text{A2})$$

implying that there exists $D_1^p \leq D_1^*$ and $D_2^p \leq D_2^*$, at least one of the inequalities strict, such that

$$(1 - \pi_t)W^l - \pi_t W^R = \left(\frac{1}{2} - \pi_t\right) [E_1(D_1^p) + E_2(D_2^p)]. \quad (A3)$$

But (A3) is the condition for controlling both projects under limited-recourse project financing; thus the incumbent can control both projects under project financing with either the same or less debt on each project compared to that under spin-off (with strictly less debt on any one project), thus yielding a larger expected value of combined control benefits under project financing.

(ii) $\pi_2 \geq 1/2\{1 - W^R/V_2\}$ ensures that, in a spin-off, the incumbent can control firm 2 using the votes of passive investors alone, so that $x^* = 1$ and $D_2^* = 0$. The optimal level of debt issued on firm 1 will then be just enough to maintain control, so that $E_1(D_1^*) = \phi(\pi_1)$, with the resulting expected value of control benefits given by $k_1\sigma_1(D_1^*) + k_2$ (denoting $1 - F_i(D)$ by $\sigma_i(D)$, for $i \in \{t, 1, 2\}$ from now on). Consider now the case of project financing. Since both project cash flows are identically distributed, and using $k_2 \geq k_1$, we obtain $D_1^{p*} \geq D_2^{p*}$ (see Proposition 5(iii) $\Rightarrow E_1(D_1^{p*}) \leq E_2(D_2^{p*})$). This implies, using $E_1(D_1^{p*}) + E_2(D_2^{p*}) = \phi(\pi_t)$, and the assumption $\phi(\pi_t) \leq 2\phi(\pi_1)$, that $E_1(D_1^{p*}) \leq \phi(\pi_1)$. Since $E_1(D_1^*) = \phi(\pi_1)$, this means that $D_1^{p*} \geq D_1^* \Rightarrow \sigma_1(D_1^{p*}) \leq \sigma_1(D_1^*) \Rightarrow k_1\sigma_1(D_1^{p*}) + k_2\sigma_2(D_2^{p*}) < k_1\sigma_1(D_1^*) + k_2$, so that the incumbent prefers spin-off to project financing. Q.E.D.

Proof of Proposition 3. (i) If the incumbent chooses straight debt, the level of debt required to maintain control is given by $D_t^* = \eta_t(\phi(\pi_t))$, and the expected value of control benefits to the incumbent will be then given by $(k_1 + k_2)[1 - F_t(\eta_t(\phi(\pi_t)))]$ (since the solvency probability $\sigma_t(\cdot) = 1 - F_t(\cdot)$). Consider now project financing, with an arbitrary lop-sided allocation of debt, namely $D_2 = 0$ and $D_1 = \eta_1(\phi(\pi_t) - V_2)$: it is feasible to maintain control with such a debt-allocation since, by assumption, $\phi(\pi_t) > V_2$. The expected control benefits under this arrangement is $k_1[1 - F_1\{\eta_1(\phi(\pi_t) - V_2)\}] + k_2$, which can be verified to be higher than that under straight debt if (14) is satisfied. Thus, the expected value of control benefits under project financing with an arbitrary allocation of debt is higher than that under straight debt; an optimal allocation would confer even higher expected control benefits, so that project financing is preferred to straight debt. If, in addition, $\pi_1 = \pi_2$, project financing is preferred to spin-off as well (Proposition 2), making it the equilibrium choice.

(ii) (We provide only an outline of this lengthy proof.) For the ex-

pected control benefits under straight debt to exceed that under project financing, (A4) has to hold:

$$k_1\sigma_t(D_t^*) = (k_1 + k_2)\sigma_t(D_t^*) > k_1\sigma_1(D_1^{p*}) + k_2\sigma_2(D_2^{p*}). \quad (\text{A4})$$

Since the cash flows from both projects are identically distributed, and $k_1 = k_2$, we know that $D_1^{p*} = D_2^{p*}$, so that (A4) holds as long as $\sigma_t(D_t^*) > \sigma_1(D_1^{p*})$. Now, since both project cash flows are uniformly distributed over $[0, h]$, we can derive the probability distribution of combined project cash flows $\tilde{y}_1 + \tilde{y}_2$, using which the equity value of the combined firm when straight debt of face value D_t is issued can be shown to be

$$E_t(D_t) = h - \frac{h^2 D_t - D_t^3/6}{h^2} \text{ for } D_t \leq h, \quad (\text{A5})$$

$$E_t(D_t) = h - \frac{D_t^3 - 6D_t^2 h + 12D_t h^2 - 2h^3}{6h^2} \text{ for } D_t \geq h.$$

Then, the optimal debt level D_t^* is that at which (A5) is equal to $\phi(\pi_t)$ (note that $\pi_t < 0.5$, since the incumbent has to issue debt to maintain control). Alternatively, if the incumbent chooses project financing, $E_1(D_1^{p*}) = E_2(D_2^{p*})$, since $D_1^{p*} = D_2^{p*}$. Therefore, under project financing, the optimal debt level D_1^{p*} on project 1 is that at which the equity value of project 1, given by $E_1(D_1^p) = h/2 - D_1^p + (D_1^p)^2/(2h)$, equals $\phi(\pi_t)/2$. Making use of these two requirements which explicitly characterize the optimal debt levels in straight debt and project financing, respectively, we can show with a lot of algebra that $\sigma_t(D_t^*) > \sigma_1(D_1^{p*})$, so that (A4) holds, and consequently, straight debt is preferred to project financing. Now, if $\pi_1 = \pi_2$, spin-off confers a lower expected value of control benefits than project financing (Proposition 2), making straight debt the equilibrium choice.

Q.E.D.

Proof of Proposition 4. $\pi_2 \geq 1/2/\{1 - W^R/V_2\}$ ensures that, in a spin-off, the incumbent can control firm 2 relying on passive votes alone, so that $x^* = 1$ and $D_2^* = 0$. Then, the optimal level of debt issued on firm 1 in a spin-off will be just enough to maintain control (with $x = 1$), given by $D_1^* = \eta_1(\phi(\pi_1))$. On the other hand, if straight debt is chosen, the face value of debt issued will be that which just satisfies (11): i.e., $D_t^* = \eta_t(\phi(\pi_t))$. Therefore, spin-off is preferred to straight debt if $k_1[1 - F_1(\eta_1(\phi(\pi_1)))] + k_2 > (k_1 + k_2)[1 - F_t(\eta_t(\phi(\pi_t)))]$, which can be verified as true if $k_2 \geq k_1$ and $F_1(\eta_1(\phi(\pi_1))) < 2 F_t(\eta_t(\phi(\pi_t)))$.

Q.E.D.

Proof of Proposition 5. (i) The above condition is obtained from the

Kuhn–Tucker necessary conditions for a maximum of the program (9) to (11). Rewriting the constraint (10) similar to (A3), we can see that this optimization problem has a convex feasible set (since $E_1(D_1^p)$ and $E_2(D_2^p)$ are both convex). Further, since the constraint qualification is met, the Kuhn–Tucker conditions will be necessary and sufficient. Therefore, the problem reduces to finding λ , μ_1 , and $\mu_2 \geq 0$, to maximize

$$L = k_1\sigma_1(D_1^p) + k_2\sigma_2(D_2^p) + \lambda[\phi(\pi_t) - E_1(D_1^p) - E_2(D_2^p)] \\ + \mu_1 D_1^p + \mu_2 D_2^p. \quad (\text{A6})$$

A solution to this optimization problem is characterized by the first-order conditions, along with the control constraint (10) and the nonnegativity restrictions:

$$k_1\sigma_1' + \lambda(-E_1') + \mu_1 = 0, \quad k_2\sigma_2' + \lambda(-E_2') + \mu_2 = 0. \quad (\text{A7})$$

An interior solution is obtained by setting $\mu_1 = 0$ and $\mu_2 = 0$ and $\lambda > 0$ in the above, giving, $k_1\sigma_1'/E_1' = k_2\sigma_2'/E_2' = \lambda$. Now,

$$E_i(D) = y_i - D + \int_0^D F_i(y) dy, \Rightarrow E_i' = -1 + F_i(D); \quad (\text{A8})$$

$$\sigma_i(D) = 1 - F_i(D), \Rightarrow \sigma_i'(D) = -f_i(D),$$

so that the condition for a interior equilibrium becomes $k_1H_1(D_1^p) = k_2H_2(D_2^p)$. Now, $k_iH_i(D)$ is increasing in D , since the hazard rate H_i is assumed to be increasing in D . Therefore, if there does not exist a pair of debt levels D_1^p, D_2^p such that the above condition holds, and $k_2H_2(D_2^p) > k_1H_1(D_1^p)$ for all pairs of debt levels, we have a corner solution given by $\mu_1 = 0, D_1^p > 0; \mu_2 > 0, D_2^p = 0$, so that project 2 will have no debt issued against it, and all the debt required to maintain control is issued against project 1 (i.e., $D_1^{p*} = \eta_1\{\phi((\pi_t) - V_2)\}$).

(ii) $H_1(D_1^{p*})/H_2(D_2^{p*})$ has to increase as k_2/k_1 increases to satisfy the necessary condition $k_1H_1(D_1^{p*}) = k_2H_2(D_2^{p*})$. This implies that D_1^{p*}/D_2^{p*} increases, since the new equilibrium debt levels also have to satisfy control condition (10), and $H_i(D)$ is increasing in D .

(iii) If $F_1 \equiv F_2, k_2/k_1 = 1 \Rightarrow D_1^{p*}/D_2^{p*} = 1$. Then, as k_2/k_1 increases, $D_1^{p*}/D_2^{p*} > 1$ (using (ii)).

(iv) If \bar{y}_1 is distributed uniformly over $[0, h_1]$ and \bar{y}_2 over $[0, h_2]$, the necessary condition characterizing an interior equilibrium reduces to $k_1/(h_1 - D_1^{p*}) = k_2/(h_2 - D_2^{p*})$. Using the fact that firm 1 has lower control

benefits per dollar of value, $k_1/(h_1/2) < k_2/(h_2/2)$, in this equation yields $D_1^*/(h_1/2) > D_2^*/(h_2/2)$, i.e., debt issued per dollar of value is higher for firm 1. Q.E.D.

Proof of Proposition 6. (i) If spin-off is the equilibrium choice, an interior solution D_1^* , D_2^* , and x^* to the incumbent's optimization problem (12) to (13) is characterized (along with the control constraints (13) and the nonnegativity restrictions) by the F.O.C.

$$\begin{aligned}
 k_1\sigma'_1 - \lambda_1 \left[\frac{\left(\frac{1}{2} - \pi_1\right)}{(1 - \pi_1)} \right] E'_1 &= 0, \\
 k_2\sigma'_2 - \lambda_2 \left[\frac{\left(\frac{1}{2} - \pi_2\right)}{(1 - \pi_2)} \right] E'_2 &= 0, \\
 \lambda_1 W^I - \lambda_2 W^I &= 0,
 \end{aligned} \tag{A9}$$

where λ_1 and λ_2 are the Lagrangian multipliers corresponding to the control constraints for firms 1 and 2, respectively. The third condition in (A9) yields $\lambda_1 = \lambda_2$, which can be used in the first two along with (A8) to yield the condition characterizing the debt allocation in an interior equilibrium: $k_1 H_1(D_1^*) A(\pi_1) = k_2 H_2(D_2^*) A(\pi_2)$ (here, $A(\pi_i) \equiv (1/2 - \pi_i)/(1 - \pi_i)$; note that $A(\pi_i)$ is increasing in π_i in the open intervals $(0, 0.5)$ and $(0.5, 1)$). (From this condition, we can see that for an interior equilibrium to exist, $\pi_1, \pi_2 < 0.5$, since it is never satisfied when π_1, π_2 are on opposite sides of 0.5; if, on the other hand, $\pi_1, \pi_2 > 0.5$, then $\pi_1 > 0.5$, so that both projects can be controlled without issuing any debt.)

(ii) If k_2 increases for a given k_1 , $H_1(D_1^*)/H_2(D_2^*)$ has to increase for the condition $k_1 H_1(D_1^*) A(\pi_1) = k_2 H_2(D_2^*) A(\pi_2)$ to hold (since π_1 , and π_2 are fixed). This can occur only if D_1^* increases and D_2^* decreases, since $H_i(\cdot)$ is increasing in D , and using the fact that the new equilibrium levels should continue to satisfy the control conditions (13) as equalities. Now, from the control constraint (13) for firm 1 at the optimum allocation of wealth, x^* is given by

$$x^*(\pi_1) = \frac{E_1(D_1^*)}{A(\pi_1)W^I} + \frac{\pi_1 W^R}{(1 - \pi_1)W^I}. \tag{A10}$$

Partially differentiating w.r.t. k_2 yields

$$\frac{\partial x^*}{\partial k_2} = \frac{1}{A(\pi_1)W^1} \frac{\partial E_1}{\partial D_1^*} \frac{dD_1^*}{dk_2}, \quad (\text{A11})$$

which gives $\partial x^*/\partial k_2 < 0$, since $\partial E_1/\partial D_1^* < 0$ and $dD_1^*/dk_2 > 0$.

(iii) If \bar{y}_1 is distributed uniformly over $[0, h_1]$ and \bar{y}_2 over $[0, h_2]$, the condition $k_1 H_1(D_1^*) A(\pi_1) = k_2 H_2(D_2^*) A(\pi_2)$ becomes (substituting the hazard rate function), $\{(k_1/h_1)A(\pi_1)\}/\{1 - D_1^*/h_1\} = \{(k_2/h_2)A(\pi_2)\}/\{1 - D_2^*/h_2\}$. This yields the results (a) and (b) as follows:

(a) If π_2/π_1 increases, $A(\pi_2)/A(\pi_1)$ increases (for a given k_1, k_2), so that $(1 - D_2^*/h_2)/(1 - D_1^*/h_1)$, has to increase to satisfy this equilibrium condition, so that $(D_2^*/h_2)/(D_1^*/h_1)$ decreases. The second part of this result is obtained using a similar argument.

(b) $\pi_1 > \pi_2 \Rightarrow A(\pi_2) > A(\pi_1)$ (since $\pi_1, \pi_2 < 0.5$). Using this and the fact that $k_2/(h_2/2) \geq k_1/(h_1/2)$ in this equilibrium condition yields $D_1^*/(h_1/2) > D_2^*/(h_2/2)$, the required result.

(iv) If $\pi_2 > \pi_1$, $A(\pi_2) \geq A(\pi_1)$. Further, since $F_1 \equiv F_2$, $H_1(\cdot) \equiv H_2(\cdot) \equiv H(\cdot)$ (say). Then, since $k_2 = k_1$, and the condition $k_1 H(D_1^*) A(\pi_1) = k_2 H(D_2^*) A(\pi_2)$ has to hold at the equilibrium allocation of debt levels, $H(D_1^*) > H(D_2^*) \Rightarrow D_1^* > D_2^*$. Finally, if $\pi_1 = \pi_2$, $D_1^* = D_2^* = \bar{D}$ (say), and $x^* = (1 - x^*)$. Now, if $\pi_2 > \pi_1$, $A(\pi_2)/A(\pi_1) = H(D_1^*)/H(D_2^*) = (h - D_2^*)/(h - D_1^*)$ if \bar{y}_1, \bar{y}_2 follow $U[0, h]$, which allows us to compute D_2^* as a function of D_1^* . Using this in the equation obtained by adding the control conditions (13) for the two firms, and making use of the equity value function for a uniform distribution, yields $D_1^* > \bar{D} > D_2^*$. Therefore, using (A10), and the analogous equation for $(1 - x^*)$ (obtained by rearranging from 2's control condition (13)), we see that $x^* < (1 - x^*)$. Q.E.D.

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