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RESEARCH ARTICLE

Anil Arya · Jonathan Glover

The use of debt to prevent short-term managerial exploitation

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Abstract This paper emphasizes the versatility of debt by presenting a setting in which debt is used to assuage a manager. Our result is driven by the option-like feature of shareholder ownership in the presence of debt and the detrimental effect of diversification (reduced volatility) on option value. The diversification effect is introduced in our model when the shareholders use a "portfolio of managers" over the firm's life. In contrast, retaining the existing manager is a riskier strategy. Debt makes this risky strategy desirable for the shareholders and, thus, serves to commit them to be more patient in firing decisions. Viewed broadly, the paper stresses the interaction between capital structure, information system design, and control systems.

Keywords and Phrases Commitment · Debt · Information system

JEL Classification Numbers D81 · G32

1 Introduction

A firm's choice of financing instruments is often explained by its desire to minimize agency costs. For example, a firm might use debt to reduce costs associated

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A. Arya (✉)
Fisher College of Business, Ohio State University, Columbus, OH 43210, USA
E-mail: arya@cob.osu.edu

J. Glover
Tepper School of Business, Carnegie Mellon University, Pittsburgh, PA 15213, USA
E-mail: jglover@cmu.edu

with shareholder-manager conflicts. Increasing the fraction of the firm financed by debt increases the managers' share of the equity and better aligns their goals with those of the shareholders (Jensen and Meckling 1976). Also, debt reduces free cash flow and, hence, opportunities for managerial slack consumption (Stulz 1990). Further, if bankruptcy is costly for managers, perhaps because of job loss and reputation damage, debt can create incentives for the managers to work harder, consume fewer perquisites, make better investment decisions, etc. (Grossman and Hart 1982).

Broadly stated, the idea in the above papers is that debt can discipline managerial actions. We emphasize the versatility of debt by studying a setting in which debt is used to assuage the managers. In our model, debt disciplines the shareholders' opportunistic behavior. Our result is driven by the option-like feature of shareholder ownership in the presence of debt and the detrimental effect of diversification (reduced volatility) on option value. The diversification effect is introduced in our model when the shareholders use a "portfolio of managers" over the life of the firm. In contrast, retaining the existing manager is a riskier (more volatile) strategy. Debt makes this risky strategy desirable for the shareholders and, thus, serves to commit them to be more patient in their firing decisions. This reduces the cost of hiring the manager in the first place.

We study a two-period model in which an owner (shareholder) makes a decision to fire or retain the period-one manager for period two. The analysis focuses on the effect of debt on this decision. The firm's total cash flow (sum of period-one and period-two cash flows) is used to make a debt payment. In period one, the firm hires a versatile manager who is capable of both initiating as well as implementing projects. After the project is up and running, the owner has the option of replacing the versatile manager with another manager who specializes in implementing projects.

Replacing the period-one manager impacts the firm's performance in two ways. First, because of specialization, the expected period-two cash flow is higher under the new manager. Second, the firm's cash flows across periods is more likely to be similar if the period-one manager is retained than if a different manager is hired in each period. To capture this effect, we assume if the period-one manager is retained, cash flows across periods are perfectly correlated–there is a "fit" between the firm and the manager that stays the same over time. If a new manager is hired, cash flows across periods are uncorrelated.

We assume the owner cannot commit to a policy regarding firing/retention of the manager. Also, the manager cannot commit to staying with the firm.[1] The "at-will" nature of the contract provides the owner with incentives to exploit the versatile manager's talent in initiating projects but then replace him with a more specialized manager. However, there is a cost to such short-run exploitation. The threat of firing increases the compensation needed to attract the versatile manager to the firm in the first place. In our model, this cost of increased compensation exceeds the benefit of improved expected cash flows. Firing is excessive from an ex ante (before the manager is hired) efficiency perspective.

[1] Observed employment contracts often specify broad terms and objectives but rarely specify the exact circumstances under which the employee can quit or be dismissed (Milgrom and Roberts 1992, p 330).

The question is: can capital structure substitute for the owner's commitment? That is, can the owner choose a debt level under which it is self enforcing for her to not fire the period-one manager? At the time the owner makes her firing decision, she cares about the firm's residual cash flows. The residual can be viewed as a (European) call on the total cash flow of the firm with an exercise price equal to the debt obligation. The bondholders write and sell this call to the shareholders.

The standard arguments from option theory apply. An increase in volatility of the underlying security (here, total cash flows) increases the value of the option. The owner gains dollar for dollar when the firm's cash flows exceed its debt obligation. However, she suffers no increase in damage if cash flows fall just short or way short of the debt obligation; owner losses are capped at zero. The correlation in cash flows across periods affects the volatility in total cash flow.[2] The volatility in total cash flow is lower if a new manager is hired in period two than if the existing manager is retained. Since hiring a new manager results in cash flows being uncorrelated across periods, a diversification effect is introduced.

From the preceding arguments it follows that, for any non-zero debt level, retaining the existing manager provides the owner with the advantage of increased volatility of the cash flows. We show that by choosing a sufficiently large debt level, the benefit of increased volatility can offset the cost of lower expected cash flows. This makes it self enforcing for the owner to retain the period-one manager. Without debt, the option feature and the critical volatility effect disappear–in an all equity firm, the shareholders bear both upside and downside risk.

The model studied in this paper is similar to that presented in Berkovitch and Israel (1996). They study the role of debt in motivating managerial effort. Berkovitch and Israel assume that the owner observes the realization of period-one cash flow when she makes her firing decision. In this regime, total cash flow is more volatile with a new manager; with an existing manager the volatility is zero. Hence, debt makes it *harder* for an existing manager to keep his job.

In contrast, in our model we assume the principal receives no information regarding period-one cash flows at the time she makes her firing decision. We do this for two reasons. First, if either perfect information or no information is to be taken as a starting point, we are not sure that one is more realistic than the other. In practice, financial information of a firm is conveyed by accounting reports, which can be manipulated in the short-run but are more difficult to manipulate in the long-run. Our modeling in this paper of no information being revealed at the end of period one and the total cash flow being revealed at the end of period two is intended to capture accounting practice in a simplified way.[3]

Second, our intent is to highlight the interaction between debt, available information, and the owner's firing decision. In our model, increased debt makes it *easier* for an existing manager to keep his job. With our modeling of information, what matters is volatility in cash flows over the firm's life, not just the volatility in

[2] Recall, at the time the shareholders make their firing decision, it is the volatility in cash flows over the life of the loan (not just period-two cash flow) that is used to value the option created by debt. Cash flows from the first period can be used to make debt payments at the end of the second period.

[3] Bagnoli and Watts (2000) argue that little may be needed for earnings management to emerge as part of a Nash equilibrium: firms may exaggerate their earnings in a world driven by multi-firm comparisons simply because they expect other firms to do so.

the second period's cash flow. Capital structure, in conjunction with information systems, can be a powerful control tool.

We also study some extensions of our basic model. We show the results continue to apply when cash flows produced by different managers are imperfectly correlated (rather than uncorrelated). Also, we relax the assumption that the owner can identify and hire a specialist with certainty. Finally, we consider contingent firing decisions by considering a middle ground wherein the owner learns some but not precise information about the period-one cash flow prior to making her firing/retention decision. A concluding section discusses limitations of our work (e.g., the cost of issuing debt, the role of other commitment devices such as severance pay), which we think might be worthwhile to pursue in future work.

2 The model

Consider a three date (two-period) model of a firm with risk-neutral participants. At date 0, the principal (owner, shareholder, entrepreneur) makes a financing and an operating decision. One, she issues debt with face value d to be repaid at date 2. Two, she hires a versatile agent (manager). The agent is versatile in that he is capable of initiating and implementing a project. At date 1, the principal makes a firing/retention decision; she either retains the versatile agent or replaces him with a specialist.

The firm's period-one and period-two cash flows are denoted by x_1 and x_2, respectively. It is common knowledge that x_1 is uniformly distributed over the interval [0,1]. If the principal retains the versatile agent, $x_2 = x_1$. This is intended to capture the idea of there being a "fit" between the firm and the agent. While neither the principal nor the agent knows how good the fit will be at the time the agent is hired, the fit determines both x_1 and x_2. If the principal hires a specialist, $x_2 = x + \alpha$, where x is uniformly distributed over [0,1] and is independent of x_1, and $\alpha \geq 0$. In other words, the new agent is associated with a new fit, and α is the benefit of specialization.[4]

It is assumed that each party can terminate the contractual relationship at the end of period one without owing explanation–the employment contract is "at will." If the period-one agent is fired, he is assumed to incur a disutility of K, $K > 0$.K can be interpreted as the cost of finding (or the decreased desirability of) a new job. The agent's reservation utility is normalized to 0 in each period.

We assume K is sufficiently large that if the principal could commit to the firing/retention decision, she prefers to hire the versatile agent for both periods.[5]

[4] The specialized agent is not hired in period one because, unlike the versatile agent, he is not capable of (or, at least not as competent in) initiating projects. For example, the specialist may excel at marketing (critical during growth stage) but may lack the technical know how needed for start-up.

[5] If the principal commits to hiring the versatile agent for both periods, the expected cash flow is 0.5+0.5. If she commits to hiring the versatile agent in only the first period, the expected cash flow is $0.5+0.5+\alpha - K$; in this case, a wage of K is needed to satisfy the period-one agent's reservation utility. $K > \alpha$ implies cash flows are higher if the firm commits to retaining the period-one agent. This ordering may be satisfied if the new agent is only slightly better at implementing projects than the existing agent (small α) and/or if the period-one agent is invested heavily in firm-specific human capital for which there is only a thin market in subsequent periods (large K).

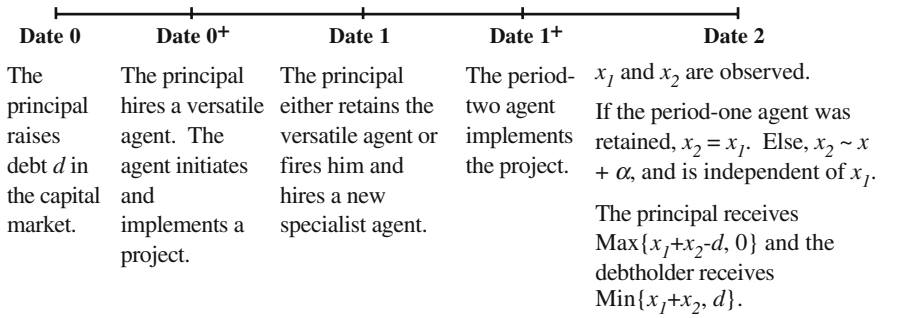

Fig. 1 Timeline

The question is: can the principal adhere to this retention decision, given the at-will nature of the employment relationship?

x_1 and x_2 are publicly observed by all parties at date 2.[6] Debt is restricted to be less than or equal to the maximum total cash flow, $0 \leq d \leq 2$. If $x_1 + x_2 < d$, the firm defaults on its loan. In the event of a default, the payment to the debtholder is $x_1 + x_2$ and the principal receives 0. If $x_1 + x_2 \geq d$, the debtholder is paid d and the principal retains the residual $x_1 + x_2 - d$. Figure 1 summarizes the sequence of events.

3 Results

Debt impacts the principal's firing/retention decision because (1) retaining the period-one agent in period two is a riskier alternative (in terms of the volatility in total cash flows) than firing him and using a portfolio of agents and (2) with debt, the principal prefers riskier alternatives because she bears only one-sided risk. In this section, we show that by using sufficient levels of debt, the principal can exploit the gains of increased volatility to credibly commit to retaining the period-one agent.

Retaining the period-one agent implies x_1 and x_2 will be perfectly correlated, and this lack of diversification implies $x_1 + x_2$ will be more volatile than if a different agent is used in each period. Increased volatility increases the value of a call option. And, in the presence of debt, the principal's residual, $\text{Max}\{x_1 + x_2 - d, 0\}$, is a call option on total cash flows with exercise price d.

Formally, denote the value of the call option (expected residual at date 1) if the period-one (existing) agent is retained by C_E, $C_E = \int_d^2 (y - d) f(y) dy$, where $y = x_1 + x_2$ and $f(y)$ is the pdf of y if x_1 and x_2 are perfectly correlated. The call value if a new agent is hired in period two is C_N, $C_N = \int_d^{2+\alpha} (y - d) g(y; \alpha) dy$, where $g(y; \alpha)$ is the pdf of y if x_1 and x_2 are uncorrelated (and α is the benefit

[6] Debt covenants are assumed to prevent the principal and the agent from "milking" the firm at date 1.

parameter). The following proposition presents closed form expressions for the value of the call options.

Proposition 1 *The principal's expected residual, as a function of α, d, and her firing decision, is as follows:*

$$\begin{aligned}
C_E &= C_E^1 = 1 - d + d^2/4, && if\, 0 \le d \le 2,\\
&= 0, && otherwise.\\
C_N &= C_N^1 = 1 + \alpha - d, && if\, 0 \le d \le \alpha,\\
&= C_N^2 = 1 + \alpha - d + (d-\alpha)^3/6, && if\, \alpha < d \le 1 + \alpha,\\
&= C_N^3 = (2 + \alpha - d)^3/6, && if\, 1 + \alpha < d \le 2 + \alpha,\\
&= 0, && otherwise.
\end{aligned}$$

Proof If the period-one agent is retained, $x_2 = x_1$. In this case, $y = 2x_1$ is uniformly distributed: $f(y) = 1/2$ if $0 \le d \le 2$ and 0, otherwise. If a new agent is hired in period two, x_1 and x_2 are uncorrelated. In this case, the pdf of y is:

$$\begin{aligned}
g(y;\alpha) &= y - \alpha, && if\, \alpha \le y \le 1 + \alpha,\\
&= 2 + \alpha - y, && if\, 1 + \alpha < y \le 2 + \alpha,\\
&= 0, && \text{otherwise.}
\end{aligned}$$

Plugging these values for the pdf in C_E and C_N, and simplifying, yields the call values. □

The following observations follow from Proposition 1.

1. The value of the call can be written as comprising of two parts. The first part is the expected residual if the principal bore both upside and downside risk. In the case of C_E, this is $1 - d$. In the case of C_N, this is $1 + \alpha - d$. If two-sided risk was the only force in effect (as is case when all equity financing is used), the period-one agent would be fired for all $\alpha > 0$. However, because debt financing results in the principal bearing only upside risk, the value of the call is increased by the second term. In the case of C_E this is $d^2/4$. In the case of C_N, the increase depends on the value of d and α. If d is small (less than α), the principal bears two-sided risk, and so the second term is 0. For $d \ge \alpha$, the value of the call is again increased by the second term.
2. It is the upside risk term discussed above that can make it credible for the principal to commit to retaining the period-one agent. To see this crisply, set $\alpha = 0$. Now if the principal bore two-sided risk she would be indifferent between retaining or firing the period-one agent. However, the principal strictly prefers retaining the period-one agent because the upside risk term under C_E is greater than under C_N:

$$\text{if } 0 < d \le 1,\ C_E - C_N = \frac{d^2}{4} - \frac{d^3}{6} > 0,$$

$$\text{if } 1 < d < 2,\ C_E - C_N = \frac{(2-d)^2}{4} - \frac{(2-d)^3}{6} > 0.$$

Intuitively, when $\alpha = 0$, the only difference between retaining the period-one agent or firing him is that, in the former case, there is a lack of diversification.

If the existing agent is retained, the volatility (variance) of $x_1 + x_2$ is $4\sigma^2$ while it is $2\sigma^2$ with a new agent, where $\sigma^2 = 1/12$ is the variance of a uniform [0,1] variable. The higher volatility in $x_1 + x_2$ is the reason C_E is greater than C_N; the value of a call option increases when the volatility of the underlying stock increases.

3. As debt increases, the value of the calls C_E and C_N decrease for the same reason that the value of a stock option decreases as the exercise price increases. For example, $\mathrm{d}C_E/\mathrm{d}d = -1 + d/2 < 0$. Also, as α increases, the value of C_N increases for the same reason the value of an option increases when the underlying stock price increases, i.e., $\mathrm{d}C_N/\mathrm{d}\alpha > 0$.

To summarize, if $\alpha > 0$ and $d = 0$, the principal strictly prefers to fire the period-one agent. In this case, the benefit of increased cash flow obtained by hiring a specialized agent is key. On the other hand, if $\alpha = 0$ and $d > 0$, the principal strictly prefers to retain the period-one agent. In this case, the benefit of increased volatility provided by the existing agent is key. When α and d are nonzero, both forces are simultaneously present. The next proposition summarizes how these forces compete. In the proposition, and the remainder of the paper, we use d^* to denote the minimum level of debt that is needed to guarantee retention.

Proposition 2 *For $0 \le \alpha \le 2/9$, debt can be used by the principal to assure the period-one agent that he will not be fired, and*

$$
\begin{aligned}
d^* &= 1/2 + \alpha + (1/2)\,\mathrm{Re}\Big[(1 + i\sqrt{3})\big(-1 + 18\alpha - 6\alpha^2 \\
&\qquad + 2\sqrt{\alpha(-12 + 72\alpha - 70\alpha^2 + 9\alpha^3)}\big)^{1/3}\Big] \; if\, 0 \le \alpha \le 1 - \sqrt{2/3}, \\
&= 3/2 + \alpha - (1/2)\,\mathrm{Re}\Big[(1 - i\sqrt{3})\big(-1 + 6\alpha - 6\alpha^2 \\
&\qquad + 2\sqrt{\alpha^3(-2 + 9\alpha)}\big)^{1/3}\Big] \; if\, 1 - \sqrt{2/3} < \alpha \le 2/9.
\end{aligned}
$$

Proof The proof makes use of the expressions for C_E and C_N derived in Proposition 1. For $\alpha > 0$, there is no d-value that satisfies $C_E^1 \ge C_N^1$, $0 \le d \le 2$ and $0 \le d \le \alpha$.Note $C_E^1 \ge C_N^1$ implies $d \ge 2\sqrt{\alpha}$, and $\alpha = 0$ is the only solution to $2\sqrt{\alpha} \le 2$ and $2\sqrt{\alpha} \le \alpha$.

Using standard formulas for solving cubic equations,$C_E^1 = C_N^2$ yields three d-values, only one of which lies in the valid range ($0 \le d \le 2$ and $\alpha < d \le 1 + \alpha$) for $0 \le \alpha \le 1 - \sqrt{2/3}$. This is the first expression for d^* in the proposition. Note, the upper bound on α, $\alpha = 1 - \sqrt{2/3}$, is the value at which $d^* = 1+\alpha = 2 - \sqrt{2/3}$.

For higher α-values, d^* is obtained by solving $C_E^1 = C_N^3$ such that $0 \le d \le 2$ and $1+\alpha < d \le 2 + \alpha$. This yields the second expression for d^* in the proposition.The upper bound on α, $\alpha = 2/9$, arises because for all greater α-values $C_N^3 - C_E^1 > 0$ for all d. In particular, at $\alpha = 2/9$,

$$
C_N^3 - C_E^1 = \frac{(14 - 9d)^2(37 - 18d)}{8748} \ge 0 \quad \text{for all } 0 \le d \le 2.
$$

The result then follows from the fact that as α increases C_N increases while C_E is unchanged. □

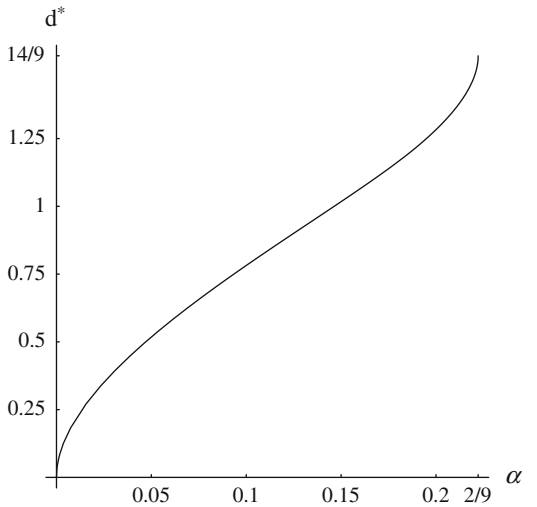

Fig. 2 d^* versus α

Intuitively, in the presence of debt, the principal's residual is a call option on total cash flows. This makes it in the principal's own best interest to not use a portfolio of agents. This explanation also suggests that as the benefit to specialization from hiring a new agent increases, higher levels of debt will be needed to convince the period-one agent that he will be retained. The next proposition shows this conjecture is correct.

Proposition 3 *The level of debt d^* is increasing in the degree of specialization α.*

Proof One way to derive the result is to differentiate the equations used in Proposition 2 ($C_E^1 - C_N^2 = 0$ and $C_E^1 - C_N^3 = 0$) w.r.t. α and solve for $\mathrm{d}d^*/\mathrm{d}\alpha$. A simpler (equivalent) approach is to plot d^* versus α using the closed form expressions for d^* presented in Proposition 2. This graph is presented in Figure 2, and proves the relationship is monotonic.

4 Extensions[7]

4.1 The effect of correlation

In our model, if a new agent is hired in period-two, cash flows across periods are uncorrelated. While the assumption helps with conducting a crisp analysis, from a practical standpoint, it may seem too stark. Presumably, both agents employ the same assets, making it natural that the cash flows would be correlated. Moreover, the paper's intuition suggests it is the difference in correlation (cash flows are more correlated if the same agent is employed) that is key to the use of debt. This subsection shows that this intuition is correct.

[7] We thank the referees for suggesting the issues in this and the next section.

As before, assume cash flows are perfectly correlated if the period-one agent is retained. However, if a new agent is hired, let r, $0 \leq r \leq 1$, denote the correlation in the cash flows. In particular, with the new agent, $y = x_1 + x_2 = x_1 + rx_1 + (1-r)x + \alpha$. So, if $r = 0$, the problem is identical to the one we solved in the previous section. At the other extreme, if $r = 1$, the new hire provides not just the α-advantage but also provides the same volatility as the existing agent.

The results can now be derived in much the same way as before. The counterpart to Proposition 1 is as follows. C_E is unchanged, and C_N is:

$$\begin{aligned}
C_N &= 1 + \alpha - d, && if\, 0 \leq d \leq \alpha,\\
&= 1 + \alpha - d + \tfrac{(d-\alpha)^3}{6(1-r^2)}, && if\, \alpha < d \leq 1 + \alpha - r,\\
&= \tfrac{(1-r)^2 + 3(2+\alpha-d)(1+\alpha+r-d)}{6(1+r)}, && if\, 1 + \alpha - r < d \leq 1 + \alpha + r,\\
&= \tfrac{(2+\alpha-d)^3}{6(1-r^2)}, && if\, 1 + \alpha + r < d \leq 2 + \alpha,\\
&= 0, && \text{otherwise.}
\end{aligned}$$

Note, with $r = 0$, the above expressions reduce to those presented in Proposition 1. Clearly, as r increases, the volatility advantage associated with retaining the existing agent is cut. We show the implications of this on the use of debt in two (related) two ways. First, for a given α-value, more debt is needed to retain the existing agent at higher r values; the left panel in Figure 3 illustrates this result. Second, as r increases, debt is effective in retaining the existing agent for a smaller set of α-values. More precisely, tedious calculations can be used to verify that debt can be used by the principal to assure the period-one agent he will be retained for $0 \leq \alpha \leq \alpha^*$ (r), where:

$$\alpha^*(r) = \text{Max}\left\{ \frac{2(1-r^2)}{9}, \frac{(1-r)\left(3(1+r) - \sqrt{3(1-r^2)}\right)}{6(1+r)} \right\}.$$

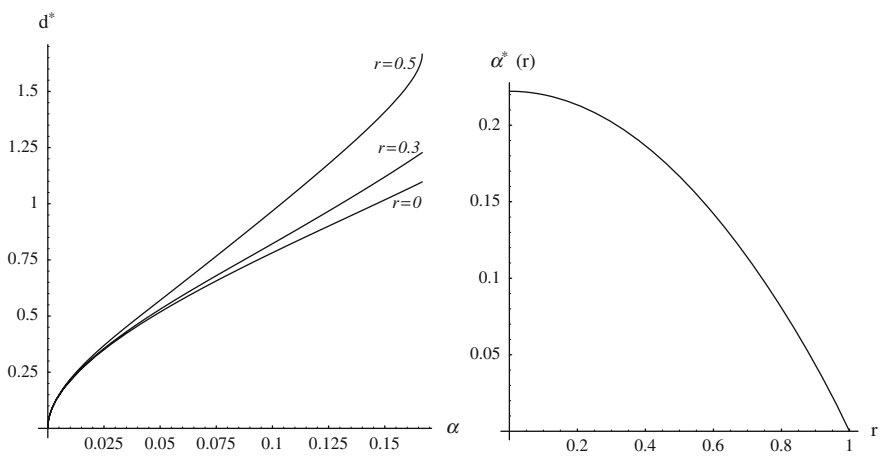

Fig. 3 The effect of correlation on the results

The right panel in Figure 3 illustrates that α^* (r) is decreasing in r.[8] And, as expected, α^* (0) = 2/9 (the result in Proposition 2) and α^* (1) = 0 (with perfect correlation, the new agent is surely preferred).

4.2 Uncertainty in hiring

The paper's model also assumes that there is no uncertainty associated with the principal's hiring in period two–the principal can identify a specialist agent with probability 1. But what if the principal could identify a specialist only with probability p, $0 \leq p \leq 1$? In this case, while the new hire yields uncorrelated cash flows (the disadvantage associated with a new hire), he provides the α-benefit only with probability p.

Formally, with the new hire, $y = x_1 + p(x+\alpha) + (1-p)x = x_1 + x + p\alpha$, and denote the smallest debt level that ensures retention by d'. This is the same setting as in Section 3 except that α is replaced by $p\alpha$. Hence, $d'(\alpha) = d^*(p\alpha)$, and the principal can retain the agent for $\alpha \leq 2/9p$. In other words, as might be expected, the lower the p-value, the easier it is to keep the existing manager. This translates into: (1) less debt being needed to commit to retention ($d'(\alpha) = d^*(p\alpha) < d^*(\alpha)$) and (2) the principal being able retain the agent for a larger set of α-values.

4.3 Contingent firing decisions

Given that the conventional discussion of debt in corporate governance focuses on its role in disciplining managers, the paper's model takes the opposite tact. It focuses on a setting where the goal is to assure the agent he will not be excessively disciplined (fired). However, this is not to say that debt cannot be used so that both firing and retention are part of the equilibrium. In this subsection, we consider such an example. The example also reminds of the delicate interaction between capital structure, information system design, and the control problem.

Return to the paper's model with one change. Suppose the information system in place reveals some information about period-one cash flow at the end of the first period, thus, permitting the principal to make contingent firing/retention decisions. In particular, say the information system reveals whether x_1 is in [0,1/10) or [1/10,1], and K (the agent's disutility of being fired) is such that the principal's goal is to retain the period-one agent if and only if the high cash flow partition is obtained. To complete the example, suppose α, the specialization benefit, is 1/10.

Now the principal chooses d so that she is indifferent between retaining and firing the period-one agent when the partition [1/10,1] is realized. This also implies she strictly prefers to fire when [0,1/10) is observed. Given x_1 in [1/10,1], the principal's expected residual if she retains the existing agent is:

$$\begin{aligned} C_E &= 11/10 - d, && if\ 0 \leq d \leq 0.2, \\ &= (5/18)(2-d)^2, && if\ 0.2 < d \leq 2, \\ &= 0, && \text{otherwise.} \end{aligned}$$

[8] The two terms in $\alpha^*(r)$ correspond to whether or not d^* exceeds $1+\alpha+r$ for some α-value. If $r < 1/2$, then d^* is greater than $1+\alpha+r$ for sufficiently large α, and the first term in $\alpha^*(r)$ applies; if $r \geq 1/2$, d^* is less than $1+\alpha+r$, and the second term applies.

Given x_1 in [1/10,1], the principal's expected residual if she hires a new agent is:

$$\begin{aligned} C_N &= 23/20 - d, && if\ 0 \le d \le 0.2, \\ &= (1/2700)(3101 - 2640d - 300d^2 + 500d^3), && if\ 0.2 < d \le 1.1, \\ &= (1/200)(279 - 330d + 100d^2), && if\ 1.1 < d \le 1.2, \\ &= (5/27)((21/10) - d)^3, && if\ 1.2 < d \le 2.1, \\ &= 0, && \text{otherwise.} \end{aligned}$$

Using the above values of the options, it follows that the smallest d-value at which $C_E = C_N$ is $d = 0.7267$. From Proposition 2, in the absence of partition information, $d^* = 0.7819$. Consistent with intuition, proving x_1 exceeds at least 1/10 gives the existing agent an extra edge which translates into lower debt being needed to retain him. At the same time, the chosen debt level is small enough that when the lower cash flow partition is realized, the principal prefers hiring the new agent. Debt, in conjunction with judicious information release, is a versatile control instrument.

5 Discussion

This paper highlights the versatility of capital structure as a control instrument by showing it can serve as a substitute for the shareholders' commitment. We relate the firm's debt level to the shareholders' firing/retention decision by building on (1) the option-like feature of shareholder ownership in the presence of debt and (2) the diversification effect introduced by using a portfolio of managers.

While the focus on the shareholder-manager relationship allows us to crisply make our point, the analysis is partial in that the pricing of debt is left out of the equation. There are two potential effects. On the one hand, increased risk taking by the firm makes debt less attractive since it makes it more expensive to borrow. On the other hand, the fact that increased debt can induce the firm to take more desirable actions (exhibit more patience in firing, for example) may leave it with a greater likelihood of being in a position to pay. Another way to see this point is that the model does not include how the firm makes use of the money raised from issuing debt. A direction for future work is to include debtholders in the analysis. We conjecture that doing so may reduce but not eliminate the ability of debt to induce commitment. And, more broadly, our point is not that an increased ability to commit is the only consequence of issuing debt. Just that the standard arguments used to justify an optimal mix of debt and equity for a firm may shift slightly more towards debt when capital structure and information system are viewed as design variables.

Another related extension would be to study the role of debt covenants. In our model, debt covenants are implicitly used to prevent shareholders from milking the firm at the end of the first period. Without such covenants, the shareholders would benefit ex post at the expense of the debtholders. If shareholders could extract period-one cash flow at the time they make firing decisions, they would care only about the volatility in period-two cash flow. The benefit to the period-one manager of adding more volatility to total cash flow is lost. It might be interesting to derive

conditions under which shareholders are better off with debt covenants: the benefit of being able to commit to not exploiting the manager in the short-run might sometimes offset the cost of not being able to milk the firm.

Finally, in our model, debt substitutes for the principal's commitment. There are, of course, other substitutes when it comes to managerial retention. If payments could be conditioned on firing decisions (severance pay), the owner could credibly commit to not firing the manager at the end of period one. If a board of directors were introduced into our model, it might be optimal to have the board include some friendly directors who would collude with management and not fire the manager too soon (from an ex ante perspective). Our intention is not to argue that one of these commitment mechanisms is best but instead to illustrate the role of capital structure as one of many commitment mechanisms.

Nevertheless, it is interesting to speculate about the conditions under which the use of debt might be less costly than other mechanisms. Consider the case of severance pay in a world in which the owner receives private information about the desirability of a given manager and that information is obtained during the manager's employment. In this setting, while severance pay may be effective as a way of committing to retain good managers, it may also attract undesirable managers. Moreover, getting rid of undesirable managers involves making severance payments on the equilibrium path and, hence, is costly. In such a setting debt may be a less costly way to achieve commitment. Moreover, with an appropriately designed information system, debt provides the added advantage of allowing for contingent firing/retention decisions. As an aside, we note the use of debt may also be appropriate for the firm in committing to pursue other strategic goals (e.g., aggressive investment in R&D activities).

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