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Independent Directors and Board Control in Venture Finance

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Abstract

The financial contracting literature treats control as an indivisible right held either by a firm's entrepreneurs or by its investors. In contrast, data from VC-backed firms shows that board control is typically shared, with a third-party independent director holding the tie-breaking board seat ('ID-arbitration'). In this article I use a bargaining game similar to final offer arbitration to model a firm's choice of action under ID-arbitration. I show that ID-arbitration can reduce holdup by moderating each party's ex post threat position. Consequently, ID-arbitration can lead to the efficient outcome in circumstances where alternative governance arrangements – entrepreneur control, investor control, or state-contingent control – are either unavailable or likely to lead to suboptimal results. This project has implications for the literature on financial contracting and the theory of the firm.

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1. INTRODUCTION

The financing contract between an entrepreneur and investor must address the parties' divergent interests. Ideally the contract could align their interests across all contingencies. Due to bounded rationality, transaction costs, and non-verifiable information, however, a complete financing contract is not possible (Aghion and Bolton, 1992). Instead, the allocation of board seats and other control rights determines who gets to decide future investment and operating decisions left out of the contract. If one party holds a majority of the board seats it can use this position opportunistically, causing the firm to pursue actions which benefit it at the expense of the firm's aggregate welfare.

The financial contracting literature suggests two partial, but imperfect, solutions to this problem: renegotiation (Coase, 1960; Grossman and Hart, 1986), and state-contingent control (Aghion and Bolton, 1992; Dewatripont and Tirole, 1994). While there is evidence that private firms sometimes use renegotiation (Broughman and Fried, 2007) and state-contingent control (Kaplan and Strömberg, 2003), both solutions are limited in various respects and neither can fully remove the risk of holdup.[1]

In this article, I model an alternative solution to this problem, based on a governance arrangement frequently used in firms financed by venture capital ('VC'). In a study documenting over 200 rounds of VC financing, Kaplan and Strömberg (2003) find that a firm's VC investors control the board 25% of the time, and the entrepreneurs control the board only 14% of the time. In the remaining firms, 61% of their sample, neither the entrepreneurs nor the investors control the firm. Instead, control of the board is shared with third-party independent directors holding the tie-breaking vote(s). I focus on the incentives created by this form of shared control. To model this arrangement, I consider a board with three directors: one entrepreneur, one investor, and one independent director (a configuration I label 'ID-arbitration').[2]

ID-arbitration has been overlooked by the financial contracting literature. The literature treats control as "an indivisible right that can be held at any given time by only one party" (Kirilenko, 2001). Consequently economic models cannot explain the most commonly observed startup board configuration. The closest analogy to ID-arbitration in the literature is state-contingent control;[3] however, these are conceptually distinct. State-

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[1] While it may improve ex post efficiency, renegotiation cannot ensure efficient investment ex ante and it may be limited by the entrepreneur's wealth (Aghion and Bolton, 1992). State-contingent control is limited in two ways. First, it depends on the existence of a verifiable signal correlated with the state of nature. Second, even if such a signal is available, state-contingent control is an imperfect solution if there are many future actions to choose from, since the efficient outcome may not be preferred by either party.

[2] Not all of the firms that share control with an independent director are exactly the same as ID-arbitration. The board may have more than three directors or multiple representatives from each group. I focus on ID-arbitration, however, because it is the simplest form of shared control. ID-arbitration applies to firms with multiple entrepreneurs or VC investors sitting on the board, provided the entrepreneurs have similar interests and the investors have similar interests. While this assumption generally makes sense, there are some reasons why the interests of early investors may diverge from later round investors (Bartlett, 2006).

[3] Kaplan and Strömberg (2003) explicitly characterize ID-arbitration as a type of state-contingent control:

contingent control determines *who* gets to decide the firm's action, whereas ID-arbitration is a *three-party* decision-making structure. This distinction is particularly relevant whenever the independent director prefers an action that neither the entrepreneur nor the investor would select if given control. Under this scenario ID-arbitration creates an incentive for compromise that is not present under state-contingent control.

I compare the incentives created by entrepreneur control, investor control, and ID-arbitration. My analysis applies to a variety of important decisions frequently faced by startup firms – whether or when to sell the firm or hire a new CEO, how much to invest in a new technology, etc. In my model, consistent with empirical data (Kaplan and Strömberg, 2003), the allocation of board seats is endogenous to the financing contract (Hermalin and Weisbach, 1998; 2003). The basic model setup, informational assumptions, and conflict between private benefits and monetary returns follow Aghion and Bolton (1992).

The primary innovation of this article is to model the firm's decision-making under ID-arbitration, where the choice of action is the result of deliberation and voting among three directors. I assume a bargaining process similar to final offer arbitration (Stevens, 1966). The entrepreneur and investor will each propose an action. If they propose the same action the firm will pursue this strategy. However, if they propose different actions, the independent director must choose between the two proposals.

I find that ID-arbitration can lead to the efficient outcome in some circumstances where entrepreneur control is unavailable and investor control would be inefficient. Because of the risk of holdup, entrepreneur control may fail to satisfy the investor's ex ante participation constraint. Moving to investor control increases the monetary returns that the firm can pledge to the investor, but compromises the project's overall value. The controlling investor will ignore the entrepreneur's private interests, and the parties may be unable to renegotiate to the efficient outcome because the entrepreneur is wealth constrained (Aghion and Bolton, 1992).

By contrast, under ID-arbitration neither the entrepreneur nor the investor can unilaterally threaten to pursue their preferred action. Instead, they must propose actions that would be endorsed by the independent director. I show, similar to analysis of final offer arbitration (Crawford, 1979), that the entrepreneur and investor have an incentive to

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"We interpret the situation where neither the VC nor the founder is in control as similar to state-contingent control. For example, in boards where [independent] board members are pivotal, it seems plausible that these members will vote with the VC as founder performance declines."

This characterization treats the independent director's endorsement as an ex post signal that effectively gives control to the entrepreneur when the firm is performing well, and to the investor when it is not. This account may make sense if, as in Aghion and Bolton (1992), there are only two actions to choose from. In which case either the entrepreneur or the investor's preferred outcome will be selected. However, if there are more than two possible actions to consider, ID-arbitration can behave differently, since the independent director may prefer an action that neither the entrepreneur nor the investor would select if given control. To further emphasize this distinction, note that firms can use both ID-arbitration and state-contingent control at the same time. For example, a firm could use ID-arbitration, but specify in the contract that the VCs will acquire additional board seats if the firm fails to meet certain performance targets, effectively giving the VCs control if the firm performs poorly. Kaplan and Strömberg (2003) find evidence supporting this dual usage.

converge towards the action most preferred by the independent director.[4] Convergence to the independent director's preferred outcome can reduce holdup by moderating each party's ex post threat position. Consequently, ID-arbitration can generate greater monetary returns than entrepreneur control, without exposing the entrepreneur to holdup by the investor.

My analysis suggests a hierarchy of control rights. Firms should use entrepreneur control whenever possible. In some cases, however, entrepreneur control may not provide enough verifiable revenues to give the investor his required rate of return. When this is the case, firms should first try to use ID-arbitration rather than investor control. However, in some instances investor control may be necessary, as it may be the only way to pledge sufficient monetary returns to ensure the investor's participation.

These predictions are consistent with empirical evidence from VC contracts. Kaplan and Strömberg (2003), for example, find that VC-backed firms are more (less) likely to use ID-arbitration relative to entrepreneur control (investor control) when there is greater uncertainty regarding the project's financial viability, and as additional funds are invested. This data is consistent with my model if we assume, as Kaplan and Stromberg do, that greater uncertainty increases the likelihood and magnitude of conflicts between the entrepreneur and the investor. Furthermore, data on the appointment of independent directors shows that they are mutually selected by 'unanimous consent' of the firm's entrepreneurs and VC investors (Kaplan and Strömberg, 2003; Broughman, 2008), helping to ensure that an independent director's interests are not captured by either party.

This study relates to the incomplete contracting literature on the optimal allocation of control rights. Grossman and Hart (1986) show that decision rights can affect relation-specific investments and should be allocated to minimize underinvestment. Emphasizing a tradeoff between cash flows and private benefits, Aghion and Bolton (1992) find that control should be awarded to the entrepreneur whenever possible; however, investor control may be necessary to satisfy the investor's financing constraint. The above papers are complimented by a number studies, including Berglof (1994), Hellmann (1998, 2006), Dessein (2005), Kirilenko (2001), Black and Gilson (1998), Marx (1998), Schmidt (2003), Yerramilli (2006), and Gompers (1995), which focus on the allocation of control in VC-backed firms. These studies generally treat control as an indivisible right that can be held at any given time by only one party – either the entrepreneur or the VC investor.[5] My study is similar to Aghion and Bolton (1992), in that the investor's financing constraint determines the optimal allocation of control. However, unlike the existing literature I do not treat control as an indivisible right, but rather I model the incentives created by a form of shared control with a third-party independent director holding the tie-breaking vote.

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[4] This result occurs for similar reasons to the convergence of political platforms as predicted by the median voter theorem (Downs, 1957). The entrepreneur and investor effectively *create* a median voter by adding an independent director to the board.

[5] One notable exception is Kirilenko (2001), who treats control as a continuous variable that entitles the entrepreneur to private benefits. Kirilenko's model, however, does not apply to the form of shared control addressed in this article.

My study also contributes to the literature on the theory of the firm. Williamson (1984, 1985) argues that a firm's authority structure can be used to minimize ex post opportunism; however, opportunistic conduct can also occur within a firm. The literature suggests that monitoring and the allocation of residual control within a firm can address intra-firm opportunism (Alchian and Demsetz, 1972; Grossman and Hart, 1986; Hart, 1995). My study emphasizes how a firm's board structure, which may include third-party independent directors, can prevent intra-firm opportunism. For a variety of reasons, this shared control governance arrangement may be difficult (though not necessarily impossible) to contractually recreate outside the firm.

The remainder of this paper is organized as follows. Section 2 describes the model and its underlying assumptions. Section 3 models entrepreneur and investor control, extending the results from Aghion and Bolton (1992) to a continuous action space. Section 4 describes and models bargaining under ID-arbitration. This section also expands the model to consider the effect of uncertainty on ID-arbitration. With uncertainty the parties no longer converge to the independent director's preferred outcome; however, ID-arbitration can still lead to the efficient outcome in circumstances where entrepreneur and investor control fail to do so. Section 5 considers data on board configurations and independent director appointment rights in startup firms. Section 6 concludes.

2. MODEL SETUP

Consider the following financial contracting problem. A risk-neutral entrepreneur (E) with no initial wealth needs funds $K > 0$ to start a new venture. Financing can be obtained from a risk neutral investor (V) who has unlimited resources. Consistent with the VC-contracting literature, the number of other entrepreneurs with worthwhile projects is limited, but there are many parties competing to finance such projects (Aghion and Bolton, 1992). Consequently E has all the bargaining power and can make a take-it-or-leave-it offer to V. The contract, however, must promise an expected return of at least K to satisfy V's individual rationality (i.e. participation) constraint. I assume that investment is socially desirable and feasible for at least some allocation of cash-flow and control rights.

After investment the parties must choose an action, a, from a compact action set, $A = [a_b, a_y]$. The optimal choice of action depends on the state of nature, θ, which is realized after investment. Following Grossman and Hart (1986) I model contractual incompleteness by assuming that the state of nature is impossible to describe in the ex ante contract, but can be observed by the parties after realization. The choice of action cannot be contracted over ex ante.[6] Instead, the allocation of control rights (i.e. board seats) determines who gets to select a. The parties can, however, renegotiate the choice of action

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[6] As noted by Maskin and Tirole (1999) this type of contractual incompleteness could in theory by circumvented by ex post message games. While I acknowledge this limitation of the incomplete contracting literature, the structured bargaining game that I model in Section 4 generates the first-best under various parameter values, removing any need for ex post messaging.

after the state of nature has been realized. Similar to the ex ante contract, I assume that E has all the bargaining power in any ex post renegotiation.[7]

The basic setup for my model is similar to Aghion and Bolton (1992) except for two important distinctions. First, my model, similar to Grossman and Hart (1986), does not allow for state-contingent control. I am effectively assuming that there are no verifiable signals that correlate with θ. Second, whereas Aghion and Bolton (1992) consider only two possible actions, my model uses a continuous action space.

To emphasize the importance of board control, I assume the parties must form a corporation (the 'Firm') to pursue the project, and that each action in A – whether or when to sell the firm or hire a new CEO, etc. – requires majority rule board authorization to be implemented. Furthermore, as is the practice in VC-backed firms (Kaplan and Stromberg, 2003), the composition of the Firm's board is endogenous to the initial financing contract (Hermalin and Weisbach, 2003).

The project yields two types of benefits: a monetary benefit $y(a, \theta)$, which can be verified and contractually allocated between the parties; and a private benefit $b(a, \theta)$, which goes exclusively to E and is non-verifiable and non-transferable. Both benefits depend on the state of nature θ and the choice of action a. The investor cares only about the project's monetary returns, while the entrepreneur cares about monetary returns as well as private benefits, such as personal satisfaction, the joy of running a family business, or being her own boss, etc. I assume that the parties can contractually divide the monetary returns, by giving $\pi y(a, \theta)$ to E and giving $(1 - \pi)y(a, \theta)$ to V, where $\pi \in [0, 1]$. The parties' respective utility functions can be expressed as:

$$U_E(a, \theta, \pi) = \pi y(a, \theta) + b(a, \theta) \tag{1}$$

$$U_V(a, \theta, \pi) = (1 - \pi)y(a, \theta) \tag{2}$$

The project's aggregate social utility is the sum of y and b, and can be expressed as:

$$U(a, \theta) = y(a, \theta) + b(a, \theta) \tag{3}$$

To illustrate the conflict between the parties I assume that y is increasing in a while b is decreasing in a for all $a \in A$. As a result the endpoints of the action set, a_b and a_y, represent maximum values for b and y respectively. To ensure a unique interior-optimum I also assume that b and y are both continuous and concave in a and $\frac{\partial y}{\partial a}(a_y) = 0 = \frac{\partial b}{\partial a}(a_b)$. The efficient action, denoted by a^*, depends on the state of nature, and can be expressed as

$$a^*(\theta) = \text{argmax}_{a \in A}\{y(a, \theta) + b(a, \theta)\} \tag{4}$$

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[7] This assumption, also used in Aghion and Bolton (1992), can affect the ex ante feasibility of each governance arrangement; however, this paper's main results do not depend on the distribution of bargaining power or even the availability of renegotiation. In fact, if renegotiation were unavailable or costly, the benefits of ID-arbitration would be increased relative to E-control and V-control (see discussion in Section 4).

The allocation of control rights is important here, since it can affect the choice of action. If E has control she has incentive to pick $\bar{a}_E$ such that:[8]

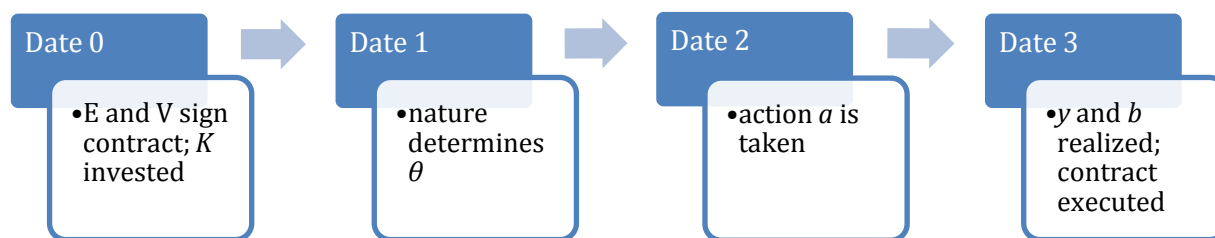$$\bar{a}_E(\theta, \pi) = \text{argmax}_{a \in A}\{\pi y(a, \theta) + b(a, \theta)\} \qquad (5)$$

If V has control he has incentive to pick $\bar{a}_V$ such that:

$$\bar{a}_V(\theta) = \text{argmax}_{a \in A}\ (1 - \pi)y(a, \theta) \qquad (6)$$

Given that y is increasing in a while b is decreasing in a, it follows that $\bar{a}_E < a^* < \bar{a}_V$.[9] Absent renegotiation, neither party has an incentive to pursue the efficient action.

The timing of events is as follows. At date 0 the parties enter a contract specifying the division of cash-flow rights π and the allocation of board control. At date 1 the state of nature θ is revealed. The parties can 'renegotiate' the choice of action between date 1 and date 2.[10] At date 2 the firm implements the selected action a. At date 3 monetary returns and private benefits are realized and the contract is executed. The time structure of the model is summarized in Figure 1.

Figure 1: Timeline

Date 0
- E and V sign contract; K invested

Date 1
- nature determines θ

Date 2
- action a is taken

Date 3
- y and b realized; contract executed

At the time of investment the parties contract over only two parameters: the allocation of cash-flow rights (represented by π), and the allocation of board control. To simplify the analysis of cash-flows I assume that the parties share monetary returns in a linear manner, πy to E and $(1 - \pi)y$ to V. Nothing significant depends on this assumption, since the conflict between E and V is driven by non-transferable private benefits rather than cash-flows. The investor, for example, could hold convertible preferred stock, a type

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[8] My analysis throughout this paper assumes that each director will act in the interests of the constituency – investor or entrepreneur – that he represents. This view is potentially at odds with corporate law, under which directors have a fiduciary obligation to serve the best interests of the corporation and its stockholders. In VC-backed firms, however, fiduciary obligations place little constraint on opportunistic behavior (Fried and Ganor, 2006), suggesting it is reasonable to ignore this legal constraint. Alternatively, the action set A can be thought of as the set of actions consistent with these legal obligations.

[9] If E were allocated all of the monetary returns (i.e. if $\pi = 1$) then $\bar{a}_E = a^*$ and E would choose the optimal action; however, this would necessarily violate V's individual rationality constraint.

[10] The parties cannot contract over future actions at date 0. Thus technically, they are negotiating the choice of action for the first time after date 1. However, I refer to this as 'renegotiation' throughout the paper to emphasize that this bargaining occurs after the original contract and after the state of nature is revealed.

of investment frequently used in VC-backed firms (Kaplan and Stromberg, 2003), and a similar analysis would apply.

The parties contract over three possible allocations of board control: (i) E-control, (ii) V-control, and (iii) ID-arbitration. In the first two cases either the entrepreneur or the investor respectively controls a strict majority of the board seats and can use this position to unilaterally select the firm's action, which can be renegotiated immediately prior to implementation.

Under ID-arbitration the choice of action is the result of deliberation and voting among the three directors. To specify the result of such deliberation, I assume a structured bargaining process similar to final offer arbitration (Stevens, 1966). Section 4 provides a detailed description of the structured bargaining game and its underlying assumptions.

3. ALLOCATIONS OF BOARD CONTROL WITHOUT AN INDEPENDENT DIRECTOR[11]

Before considering ID-arbitration in more detail, however, I first describe the benefits and, more importantly, the limitations of E-control and V-control. This section extends the basic model in Aghion and Bolton (1992) to a continuous action space.

3.1. E-control

From the investor's perspective E-control is undesirable. The controlling entrepreneur will select actions that sacrifice the Firm's monetary returns. Consequently, for some θ, the investor may not receive sufficient returns to justify his investment. Anticipating this problem, the investor may – depending on the expected distribution of θ – refuse to invest under E-control.

Under E-control the entrepreneur has an incentive to select $\bar{a}_E$, even though $U(\bar{a}_E) < U(a^*)$. To solve this problem, the parties will renegotiate. E will offer to choose a^* instead of $\bar{a}_E$ in exchange for a payment equal to $(1 - \pi)[y(a^*) - y(\bar{a}_E)]$. After renegotiation E's payoff can be expressed as:

$$U_E = \pi y(a^*) + b(a^*) + (1 - \pi)[y(a^*) - y(\bar{a}_E)] \tag{7}$$

$$= U(a^*) - U_V(\bar{a}_E) > U(\bar{a}_E) - U_V(\bar{a}_E) = U_E(\bar{a}_E) \tag{8}$$

E's payoff after renegotiation (7) is greater than her payoff pre-renegotiation (8), since $U(a^*) > U(\bar{a}_E)$. V will accept E's renegotiation offer since the change in action benefits V enough to justify the payment, leaving V indifferent between the two alternatives:

$$U_V = (1 - \pi)y(a^*) - (1 - \pi)[y(a^*) - y(\bar{a}_E)] \tag{9}$$

$$= (1 - \pi)y(\bar{a}_E) = U_V(\bar{a}_E) \tag{10}$$

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[11] For ease of presentation I drop most references to θ and π from the notation in the following sections, except where needed for clarification.

As a consequence of renegotiation, E-control will always lead to the efficient outcome.

The problem, however, is that under E-control the Firm may be unable to pledge sufficient monetary returns to V. To satisfy V's participation constraint the following relationship must hold for some $\pi \in [0,1]$:

$$EU_V(\bar{a}_E) \geq K \tag{11}$$

When the inequality in equation (11) does not hold for any $\pi \in [0,1]$, V will be unwilling to invest under E-control. An alternative governance arrangement, either V-control or ID-arbitration, may be necessary to satisfy V's participation constraint. The above analysis can be summarized in the following proposition.

> Proposition 1: *E-control will always lead to the first-best outcome, a^*, through renegotiation; however, E-control is not feasible unless $EU_V(\bar{a}_E) \geq K$ for some $\pi \in [0,1]$.*

3.2. V-Control

Under V-control the firm is able to pledge additional monetary returns to V. This follows since $y(\bar{a}_V) > y(\bar{a}_E)$ for any allocation of cash-flow rights. Provided V is given sufficient cash-flow rights, V-control will satisfy the investor's participation constraint, since $K \leq Ey(\bar{a}_V)$ by assumption.[12]

The controlling investor, however, will ignore the entrepreneur's private benefits. V has an incentive to select $\bar{a}_V$, an inefficient outcome. Renegotiation could improve the result, but renegotiation under V-control is problematic, since E has zero wealth and may be unable to bribe V into selecting an alternative action. Technically E could give up her share, π, of the Firm's monetary returns. Depending on the realization of θ, however, this may be insufficient to induce V to pursue the optimal action. To reach the first-best E must pay V at least $(1-\pi)[y(\bar{a}_V) - y(a^*)]$. This payment is only possible if, after realizing θ, the following relationship holds:

$$y(a^*) \geq (1-\pi)y(\bar{a}_V) \tag{12}$$

If renegotiation to the first-best is possible, E's payoff after renegotiation would be $U(a^*) - U_V(\bar{a}_V)$. Similar to the previous section, V's payoff will remain the same before and after renegotiation.

When (12) does not hold, E cannot pay V enough to induce the first-best; however, provided $\pi \neq 0$, the parties can still renegotiate to an intermediate action, between a^* and $\bar{a}_V$. Since A is a compact set and y is continuous and increasing in a, there exists $\tilde{a}$ such that $a^* < \tilde{a} < \bar{a}_V$ and $y(\tilde{a}) = (1-\pi)y(\bar{a}_V)$. E will propose $\tilde{a}$ in the renegotiation game and offer to pay $(1-\pi)[y(\bar{a}_V) - y(\tilde{a})]$. V will accept this offer, since E's payment fully compensates him for the change in action. This limited form of renegotiation makes E better off than no renegotiation, but it does not lead to the efficient outcome. The magnitude of expected inefficiency under V-control depends on the distribution of θ. The above analysis can be summarized in the following proposition.

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[12] We assume that investment is feasible for at least some allocation of cash-flow and control rights. Since $\bar{a}_V$ maximizes the Firm's monetary returns it is equivalent to say that $K < Ey(\bar{a}_V)$.

<u>Proposition 2</u>: *V-control is always feasible, since $K \leq Ey(\bar{a}_V)$ by assumption. However, for some θ, V-control will not lead to the first-best outcome since renegotiation is limited by E's wealth constraint.*

3.3. Limitations of E-control and V-control

Propositions 1 and 2 illustrate a tradeoff between ex post efficiency and pledgeable income. E-control ensures an ex post efficient outcome; however, the Firm can only pledge to the investor expected monetary returns equal to $Ey(\bar{a}_E)$. When the amount invested is greater than this, investment under E-control would violate V's participation constraint. Moving to V-control increases the monetary returns that the firm can pledge to the investor, but compromises the project's overall value. Under V-control the investor will ignore the entrepreneur's private benefits, and the parties may be unable to renegotiate to a^* due to E's wealth constraint.

Limiting our analysis to E-control and V-control, this tradeoff suggests a natural pecking order. Use E-control whenever equation (11) holds, and use V-control when it does not. The problem is that this may lead to a suboptimal outcome whenever V-control is needed. The question is whether ID-arbitration can improve ex post efficiency without violating V's participation constraint.

4. INDEPENDENT DIRECTOR ARBITRATION

I model decision-making under ID-arbitration with a structured bargaining process similar to final offer arbitration. E and V will each propose an action, denoted by a_E and a_V respectively. If $a_E = a_V$ there is no disagreement and the Firm will pursue this action; however, if $a_E \neq a_V$ the independent director must choose between the two proposals. Similar to final offer arbitration, the independent director (i.e. the arbitrator) cannot introduce a compromise, but must simply pick between a_E and a_V. This bargaining process ensures that the Firm's action is supported by at least two out of the three board members.

If asked to arbitrate, ID will select her preferred proposal. IDs are motivated, at least in part, by reputation. An independent director obtains some benefit – either financial or otherwise – from serving on a firm's board. I assume IDs would like to be appointed to the board of other firms in the future to continue receiving such benefits. To protect this stream of future benefits, the ID must consider her reputation among both entrepreneurs and investors.

The appointment process for IDs emphasizes this concern. In VC-backed firms, independent directors are selected by 'unanimous consent' of the firm's entrepreneurs and VC investors (Kaplan and Strömberg, 2003; Broughman, 2008). Consequently, IDs who develop a bad reputation among either group can be vetoed and are less likely to be appointed in the future. This point is confirmed by data on arbitrator selection in other contexts. Arbitrators who consistently favor one side to a dispute are more likely to be vetoed by the disfavored side, and thus less likely to serve as an arbitrator in the future (Bloom and Cavanagh, 1986). Independent directors have an incentive to resolve disputes

in an impartial manner. Other considerations, however, such as business norms or a significant relationship with one of the two parties or, may cause an ID to favor one side over the other. In any event, an independent director's choice between a_E and a_V is influenced by the importance of maintaining her reputation among entrepreneurs as opposed to investors.

To model this, I assume that an ID considers the interests of E and V, with relative weight $\tau \in [0, 1]$ assigned to E and $(1 - \tau)$ to V. We can describe ID's preference ordering as a linear combination of E and V's respective utility. Let $g(\tau, a, \theta) = \tau U_E(a, \theta) + (1 - \tau)U_V(a, \theta)$. ID's preferred outcome, $\bar{a}_{ID} \in A$, can be expressed as:

$$\bar{a}_{ID}(\tau, \theta) = \text{argmax}_{a \in A} \ g(\tau, a, \theta) \tag{13}$$

If asked to arbitrate, ID will select the proposal, $a_{ID} \in \{a_E, a_V\}$, which maximizes g:

$$a_{ID}(a_E, a_V, \tau) = \begin{cases} a_E & if \ \ g(\tau, a_E) > g(\tau, a_V) \\ a_V & if \ \ g(\tau, a_E) < g(\tau, a_V) \end{cases} \tag{14}$$

If $g(\tau, a_E) = g(\tau, a_V)$ the independent director is indifferent between the two proposals. In which case, she will flip a coin to decide which proposal to endorse.

The parameter τ measures the relative importance of ID's reputation among entrepreneurs as opposed to investors. If $\tau = 1/2$ we can say that the ID is unbiased or impartial. By contrast if $\tau > 1/2$ the ID is biased to favor E, and if $\tau < 1/2$ the ID is biased to favor V. Note, by definition there is a one-to-one monotonically decreasing mapping between τ and $\bar{a}_{ID}$. When $\tau = 1/2$ it follows that $\bar{a}_{ID} = a^*$, since $g(.5, a) = .5U(a)$. Given this relationship, we can also characterize bias by comparing $\bar{a}_{ID}$ to a^*. ID is unbiased if $\bar{a}_{ID} = a^*$; ID favors E if $\bar{a}_{ID} < a^*$; and ID favors V if $\bar{a}_{ID} > a^*$.

For each potential ID, τ is expressed in reduced form and treated as exogenous to the financing contract. This is obviously a simplification, since it would be possible for E and V to affect ID's interests by awarding her a fraction of the Firm's cash-flow rights. In practice, independent directors in VC-backed firms are often given a very small share of common stock, but I am unaware of large awards that could have a significant impact on ID's behavior. By ruling this out, I am effectively assuming that giving ID high-powered financial incentives is not worth the cost to E or V. This assumption is not critical, however, since it merely limits the potential benefits of ID-arbitration.

Similar to the previous section, under ID-arbitration the parties can still renegotiate the choice of action after realization of θ. E and V collectively hold a majority of the Firm's board seats and can thus renegotiate without needing to consult the ID. However, as is shown below, the ID remains important since her preferred outcome affects the parties' bargaining positions entering the renegotiation.

In this section I make two additional assumptions. First, I assume that neither E nor V can bribe ID. This abstracts away from the problem of collusion that can arise in three-party bargaining (Tirole, 1986). There are two justifications for this assumption. First, the law prohibits director vote buying. Side payments to influence a director's vote could

subject the involved parties to personal liability or other sanctions.[13] Second, there may be a strong reputational penalty attached to receiving a bribe. If an ID is caught taking a bribe or otherwise colluding with one of the primary parties, her reputation in the entrepreneur or investor community, whichever was harmed by the bribe, may be severely damaged, and given that IDs are appointed by 'unanimous consent' she is unlikely to serve as an independent director for other firms in the future.

Second, I assume that E and V can observe ID's preference ordering and, similarly, that ID does not make any errors in selecting between a_E and a_V. The parties are in a long term relationship with ID, and want to select an ID with predictable views. This assumption eliminates uncertainty and simplifies the analysis, but it may be unrealistic. To address this concern I expand the model to allow for uncertainty in section 4.3.

The remainder of section 4 models the incentives of ID-arbitration. Section 4.1 models the equilibrium proposals a_E and a_V without renegotiation. Section 4.2 considers how renegotiation may affect the outcome. Section 4.3 expands the model to consider the effect of uncertainty. Section 4.4 compares ID-arbitration to the alternative governance arrangements.

4.1. ID-arbitration Without Renegotiation

Under ID-arbitration neither E nor V can unilaterally cause the Firm to pursue their preferred action. Instead, they must propose actions that would be endorsed by ID. To obtain ID's endorsement both E and V will propose actions converging upon the ID's preferred outcome. E has an incentive to set $a_E = \bar{a}_{ID}$, since any alternative proposal would make E worse off, either because $a_E > \bar{a}_{ID}$, or if $a_E < \bar{a}_{ID}$ because E's proposal would lose at arbitration to some $a_V > \bar{a}_{ID}$ where $g(\tau, a_E) < g(\tau, a_V)$. For similar reasons V also has an incentive to set $a_V = \bar{a}_{ID}$. In equilibrium $a_E = a_V = \bar{a}_{ID}$ and there is no disagreement to be arbitrated. The intuition behind this result is similar to economic models of bargaining under final offer arbitration (Crawford, 1979) and the median voter theorem from political science (Downs, 1957; Calvert, 1985). In each case the disputing parties (political candidates) have an incentive to propose the action (platform) most preferred by the arbitrator (median voter). The following proposition shows, without renegotiation, convergence towards ID's preferred action.

<u>Proposition 3</u>: *If E and V can observe τ and renegotiation is unavailable, then:*
  (i)   *In a firm under ID-arbitration $a_E = a_V = \bar{a}_{ID}$ is the unique Nash equilibrium; and*
  (ii)   *Investment under ID-arbitration is feasible if and only if $K \leq Ey(\bar{a}_{ID})$.*

<u>Proof</u>: See Appendix.

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[13] This would violate the director's fiduciary duty of loyalty, and it also may be legally prohibited on other grounds.

Proposition 3 illustrates two immediate benefits to ID-arbitration. First, by converging upon $\bar{a}_{ID}$ the parties are able to reach a compromise solution, between $\bar{a}_E$ and $\bar{a}_V$, without renegotiation. The benefit of this compromise is clearest when ID is unbiased (i.e. when $\bar{a}_{ID} = a^*$), since in this case the parties will converge directly upon the ex post efficient outcome.

Second, ID-arbitration may be feasible in circumstances where E-control would violate V's participation constraint. E-control is only feasible if $K \leq E(1 - \pi)y(\bar{a}_E)$ for some $\pi \in [0, 1]$, whereas ID-arbitration is feasible whenever $K \leq Ey(\bar{a}_{ID})$. Since $(1 - \pi) \leq 1$ and $y(\bar{a}_E) \leq y(\bar{a}_{ID})$ for all τ, it follows that there is a range of investments for which ID-arbitration is feasible but E-control is not. This occurs whenever, for all $\pi \in [0, 1]$ there is an ID such that:

$$E(1 - \pi)y(\bar{a}_E) < K \leq Ey(\bar{a}_{ID}) \tag{15}$$

Without an ID, such firms would have to be operated under V-control, potentially leading to an inefficient outcome (even with renegotiation).

If equation (15) holds and the parties can find an unbiased ID, then the firm can reach the efficient outcome under ID-arbitration, but not under the alternative governance arrangements. Proposition 3 also shows, however, that without renegotiation a biased ID would lead to an inefficient outcome. The next section considers how renegotiation under ID-arbitration might address this.

4.2. Renegotiation under ID-arbitration

Under ID-arbitration renegotiation is desirable whenever ID is biased. The type of renegotiation, however, depends on whether the ID is biased to favor the entrepreneur or the investor (i.e. whether $\bar{a}_{ID}$ is less than or greater than a^*).

When $\bar{a}_{ID} < a^*$ the entrepreneur prefers $\bar{a}_{ID}$ to a^*, and will only agree to the first-best if she receives a sufficient payment from V. In particular, E will propose a^* in exchange for a payment equal to $(1 - \pi)[y(a^*) - y(\bar{a}_{ID})]$. Similar to above, this payment will give the entire surplus from renegotiation to E. V will agree to the renegotiation since the change in action exactly offsets the payment. When $\bar{a}_{ID} < a^*$ ID-arbitration will always lead to the efficient outcome through renegotiation between E and V.

By contrast, when $\bar{a}_{ID} > a^*$ the investor prefers $\bar{a}_{ID}$ to a^*. The investor will only agree to the first-best if he receives a sufficient payment from E. Renegotiation in this direction, however, is limited by E's lack of wealth. This is the same problem that we considered in section 3.2 above. Even though E has no wealth she can give up her share of the Firm's monetary returns. To reach the first-best E must pay V at least $(1 - \pi)[y(\bar{a}_{ID}) - y(a^*)]$. This payment is only possible if, after realizing θ, the following relationship holds:

$$y(a^*) \geq (1 - \pi)y(\bar{a}_{ID}) \tag{16}$$

When (16) does not hold, E cannot pay V enough to induce the first-best; however, similar to the discussion of renegotiation under V-control, the parties can still renegotiate to an intermediate action, between a^* and $\bar{a}_{ID}$ (assuming $\pi \neq 0$). When $\bar{a}_{ID} > a^*$ renegotiation is potentially limited by E's wealth constraint.

While renegotiation can affect the action pursued under ID-arbitration, it has no affect on V's participation constraint. By assumption E has all the bargaining power and captures the entire surplus from any renegotiation. Consequently V's welfare is unaffected. V's participation constraint is only satisfied if the expected monetary returns from ID's preferred action are greater than the ex ante investment. Thus, ID-arbitration remains feasible if and only if $K \leq Ey(\bar{a}_{ID})$. The above analysis of renegotiation under ID-arbitration is summarized in the following proposition.

Proposition 4: *In a firm under ID-arbitration, if E and V can renegotiate, the outcome depends on the relationship between $\bar{a}_{ID}$ and a^*:*
(i)   *If $\bar{a}_{ID} = a^*$ the Firm will pursue the first-best outcome without renegotiation,*
(ii)   *If $\bar{a}_{ID} < a^*$ the Firm will pursue the first-best outcome following renegotiation between E and V, and*
(iii)   *If $\bar{a}_{ID} > a^*$, for some θ, the Firm may not pursue the first-best outcome since renegotiation is limited by E's wealth constraint; and*
The feasibility of ID-arbitration is unaffected by renegotiation. Investment under ID-arbitration remains feasible if and only if $K \leq Ey(\bar{a}_{ID})$.

With renegotiation the efficiency of ID-arbitration does not necessarily depend on finding an unbiased ID. As long as ID is not biased in favor of V, the parties can always renegotiate to the efficient outcome. Regardless whether renegotiation occurs, ID-arbitration may be feasible in circumstances where E-control would not.

4.3. Robustness to Uncertainty

The model described above assumes the parties can observe ID's preference ordering. It also assumes that ID does not make any errors in selecting between a_E and a_V. In this section I relax both assumptions by introducing uncertainty.

Uncertainty is more realistic in two important respects. First, it captures the fact that neither E nor V can perfectly observe τ or $\bar{a}_{ID}$. Second, it also captures the possibility that ID may simply make errors if asked to arbitrate. In the latter case, even if τ and $\bar{a}_{ID}$ were known to the primary parties, the ID may mistakenly conclude that a proposal generating a lower value in g should win. Introducing uncertainty over τ (or equivalently over $\bar{a}_{ID}$) can address both concerns.

With uncertainty, convergence to ID's preferred action is no longer a Nash equilibrium, and the divergence between E and V's respective proposals increases with the amount of uncertainty. This is modeled in the literature on final offer arbitration (Brams and Merrill, 1983; Farber, 1980), and in the political science literature on electoral competition between policy motivated candidates (Wittman, 1977; Calvert, 1985). While these settings are somewhat different, both sets of models assume that the distribution of uncertainty is common knowledge to the disputing parties (candidates). Brams and Merrill (1983) find a non-convergent Nash equilibrium, where the equilibrium proposals are centered on the median (i.e. $E\bar{a}_{ID}$), but some distance away from it on each side. Calvert (1985) shows that the degree of divergence increases with the amount of uncertainty.

Since these results are proved in the literature I will not reproduce them here. Rather, I will simply illustrate how uncertainty could affect the structured bargaining game.[14] To use a near-worst case scenario, I assume that ID's preferred outcome is distributed uniformly over the action set.

Let $A = [0, 1]$. I assume that $\bar{a}_{ID}$ is uniformly distributed over A, and the distribution of $\bar{a}_{ID}$ is common knowledge to E and V. At date 2, the parties respective objective functions are:

$$U_V(a) = 1 - (1 - a)^2 \tag{17}$$

$$U_E(a) = 1 - a^2 \tag{18}$$

For this example, the first-best action, $a^* = 1/2$, while E and V have an incentive to pursue $\bar{a}_E = 0$, and $\bar{a}_V = 1$. Furthermore, given a uniform distribution, it follows that ID is unbiased in expectation (i.e. $E\bar{a}_{ID} = 1/2 = a^*$).

For any two proposals, a_E and a_V, E wins whenever the realized value of $\bar{a}_{ID}$ is closer to a_E, and loses when it is closer to a_V.[15] Since $\bar{a}_{ID}$ is distributed uniformly over [0, 1] it follows that a_E is chosen by ID with probability $(a_E + a_V)/2$ when $a_E < a_V$, and with probability $1 - [(a_E + a_V)/2]$ when $a_E > a_V$. The entrepreneur and investor's expected utilities, with $\bar{a}_{ID}$ distributed uniformly, can be expressed as:

$$EU_E(a_E, a_V) = \begin{cases} U_E(a_E)((a_E + a_V)/2) + U_E(a_V)(1 - (a_E + a_V)/2) & \text{if } a_E < a_V \\ U_E(a_V)((a_E + a_V)/2) + U_E(a_E)(1 - (a_E + a_V)/2) & \text{if } a_E > a_V \end{cases} \tag{19}$$

$$EU_V(a_E, a_V) = \begin{cases} U_V(a_E)((a_E + a_V)/2) + U_V(a_V)(1 - (a_E + a_V)/2) & \text{if } a_E < a_V \\ U_V(a_V)((a_E + a_V)/2) + U_V(a_E)(1 - (a_E + a_V)/2) & \text{if } a_E > a_V \end{cases} \tag{20}$$

Given this setup, what actions will E and V propose, absent renegotiation? We solve for Nash equilibrium (a_E, a_V) in the following proposition.

Proposition 5: *In a firm under ID-arbitration, with $\bar{a}_{ID}$ distributed uniformly over the action set A = [0, 1], and with U_V and U_E as stated in equations (17) and (18) respectively, there is a unique pure strategy Nash equilibrium where $a_E = 1/4$ and $a_V = 3/4$.*

Proof: See Appendix.

In earlier sections, when E and V could observe τ (and thus $\bar{a}_{ID}$) directly, there was no benefit and a potential cost to proposing anything other than $\bar{a}_{ID}$. By contrast, when uncertainty is introduced, both parties benefit (at the expense of the other) by proposing an action closer to their ideal. Essentially, the parties are willing to trade off a small loss in the probability of having their proposal selected by ID, for a gain in the event that their proposal is selected by ID. Consequently, both parties move away from $E\bar{a}_{ID} = .5$ and towards their preferred action. In the current example both proposals move an equal distance away from $E\bar{a}_{ID}$, and each party expects to win at arbitration half the time.

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[14] This example is suggested by McCarty and Meirowitz (2007) at pages 105-107.

[15] In this example, the ID's preference ordering (i.e. g) is symmetric about its optimum (i.e. $g(\tau, \bar{a}_{ID} + \varepsilon) = g(\tau, \bar{a}_{ID} - \varepsilon)$ for any $\varepsilon > 0$). Consequently, we can simply consider the distance between each proposal and $\bar{a}_{ID}$ to determine the selected proposal.

This divergent equilibrium is not optimal behavior. The first-best action, $a^* = 1/2$ gives both E and V an expected payoff of 12/16 (i.e. $y(a^*) = b(a^*) = 12/16$). From equations (19) and (20), however, we find that the Nash equilibrium ($a_E = 1/4$, $a_V = 3/4$) gives both parties a lower expected payoff, equal to 11/16 for both E and V. Uncertainty can cause a loss of efficiency even if the ID is unbiased in expectation.

This loss of efficiency creates an incentive for E and V to renegotiate. Similar to above, E has all the bargaining power in the renegotiation. In this example E will agree to pursue a^* in exchange for a payment of 1/16 from V. This would allocate the entire surplus from renegotiation to E, giving E an expected payoff of 13/16 ($b(a^*)$ + 1/16 = 13/16). V will agree to the renegotiation since the change in action benefits V enough to justify the payment, leaving V indifferent ($y(a^*) - 1/16 = 11/16$). With renegotiation, uncertainty should not prevent the parties from reaching the efficient outcome.

The real problem caused by uncertainty is it can make it harder to satisfy V's participation constraint. Because of uncertainty E can holdup V for additional payments in renegotiation. In this example, V's expected payoff after renegotiation is 11/16. However, if uncertainty were removed V's expected payoff would rise to 12/16. This illustrates that the range of investments for which ID-arbitration is feasible can decrease when uncertainty is introduced. The magnitude of this problem depends on the expected distribution of θ and the allocation of bargaining power between E and V. In some instances, uncertainty may make V unwilling to invest under ID-arbitration.

Despite this limitation, uncertainty does not undermine the basic benefits of ID-arbitration. Even with a uniform distribution, a severe form of uncertainty, the parties still propose compromise solutions that fall between $\bar{a}_E$ and $\bar{a}_V$. In this respect, the magnitude of holdup caused by uncertainty is less than under E-control and V-control. Even with uncertainty, the parties may prefer ID-arbitration to both E-control and V-control.

4.4. Comparison of ID-arbitration to Alternative Governance Arrangements

ID-arbitration effectively allows a continuum of different control allocations, with E-control and V-control representing extreme ends of the spectrum. Without an independent director, the firm cannot commit to any action between the two extremes, $\bar{a}_E$ and $\bar{a}_V$, favored by the entrepreneur and investor. This problem is not solved by state-contingent control, which merely leads to $\bar{a}_E$ in some circumstances and $\bar{a}_V$ in others. While the final action under E-control or V-control may be renegotiated, the points $\bar{a}_E$ and $\bar{a}_V$ are still relevant since they define each party's threat position entering the renegotiation, potentially leading to a significant holdup problem. Under E-control the threat of holdup may violate the investor's ex ante participation constraint. Under V-control the threat of holdup may lead to an inefficient action ex post.

By contrast, under ID-arbitration the parties can commit to an interior solution. By adding an independent director to the board, E and V effectively agree to follow the

independent director's preferred outcome, $\bar{a}_{ID}$, whenever they disagree.[16] Commitment to the ID's preferred outcome can reduce the threat of holdup in two ways.

First, from an ex post perspective, there is less need for renegotiation. This benefit is clearest when ID is unbiased (i.e. when $\bar{a}_{ID} = a^*$), since in this case the parties will converge directly upon the efficient outcome. Even when ID is biased, however, the use of ID-arbitration can reduce the need for renegotiation. Each party's threat position entering the renegotiation is moderated by ID-arbitration. E, for example, can no longer demand to be compensated for giving up the benefits she would have received under E-control. Instead, she can only demand to be compensated for the benefits she would have received if $\bar{a}_{ID}$ were implemented. While renegotiation may still be necessary to reach the efficient outcome, the renegotiation payment will be less than it would have been under E-control.[17]

Ex post efficiency is particularly important in comparing ID-arbitration to V-control. For a range of investments E-control may produce insufficient monetary returns and the relevant choice is between ID-arbitration and V-control. While both may be able to satisfy V's participation constraint, the relative advantage of ID-arbitration is it can insure ex post efficiency in circumstances where V-control may lead to an inefficient outcome.

Second, from an ex ante perspective, ID-arbitration may be feasible in circumstances where E-control would violate V's participation constraint. E-control is only feasible if $K \leq E(1 - \pi)y(\bar{a}_E)$ for some $\pi \in [0, 1]$, whereas ID-arbitration, which generates greater monetary returns, is feasible whenever $K \leq Ey(\bar{a}_{ID})$. As noted in section 4.1 there is a range of investments for which ID-arbitration is feasible but E-control is not. This scenario occurs whenever the investment satisfies equation (15).

The preceding analysis suggests a new pecking order. We can divide potential investments into three categories or ranges based on the amount invested (K) relative to the firm's expected monetary returns under various governance arrangements:

- <u>Range 1</u>: use E-control[18] when $K \leq E(1 - \pi)y(\bar{a}_E)$ for some $\pi \in [0, 1]$;

- <u>Range 2</u>: use ID-arbitration when $E(1 - \pi)y(\bar{a}_E) < K \leq Ey(\bar{a}_{ID})$ for all $\pi \in [0, 1]$[19];

- <u>Range 3</u>: use V-control when $Ey(\bar{a}_{ID}) < K \leq Ey(\bar{a}_V)$.

[16] The solution provided by ID-arbitration has some similarity to Aghion, Dewitrapont, and Rey (1994), Noldeke and Schmidt (1995), and Edlin and Reichelstein (1996) in which the contracting parties can set different default positions (i.e. a specific performance contract) in the event that renegotiation fails. With ID-arbitration the default position is set equal to the ID's preferred outcome.

[17] We can compare the renegotiation payments under E-control and ID-arbitration. To reach the first-best under E-control the investor must pay the entrepreneur an amount equal to $(1 - \pi_E)[y(a^*) - y(\bar{a}_E)]$; however, under ID-arbitration the investor only needs to pay $(1 - \pi_{ID})[y(a^*) - y(\bar{a}_{ID})]$, where π_E and π_{ID} are the cash-flow rights awarded to E under each governance arrangement respectively. The second renegotiation payment is smaller since $y(\bar{a}_{ID}) > y(\bar{a}_E)$ and $\pi_E < \pi_{ID}$.

[18] Technically firms in Range 1 could also use ID-arbitration. Provided the ID is not biased to favor V, both ID-arbitration and E-control would lead to the efficient outcome.

[19] I am assuming that there is no uncertainty regarding ID's preferred outcome. If we introduce uncertainty, the scope of Range 2 may be somewhat smaller. In other words, uncertainty could push some firms to use V-control rather than ID-arbitration.

The optimal allocation of control rights for each range is illustrated in figure 2.

Figure 2: Optimal Board Configuration
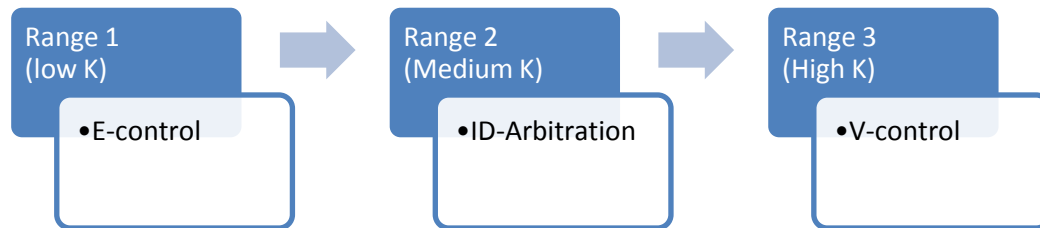
The desirable board configuration is driven by two considerations: (i) ex post efficiency, and (ii) ex ante feasibility. I first consider ex post efficiency. E-control is always ex post efficient, as a result of renegotiation (Proposition1). ID-arbitration also leads to the first-best outcome in most cases. However, it can lead to a suboptimal outcome if ID is biased in favor of V (Proposition 4). V-control is the most problematic from an ex post perspective, since renegotiation is necessary and may be limited by E's wealth constraint (Proposition 2). This suggests that E-control should be used whenever possible, and V-control should generally be avoided (unless it is the only feasible alternative).

To be feasible, however, a board configuration must pledge sufficient monetary returns to satisfy V's participation constraint. E-control is only feasible in Range 1 (Proposition 1). ID-arbitration is feasible in Ranges 1 and 2 (Proposition 3), assuming no uncertainty regarding the ID's preferred outcome. With uncertainty the scope of Range 2 would be somewhat smaller (see discussion in Section 4.3). V-control is feasible in all three Ranges (Proposition 2). Firms in Range 1 can choose from any of the three alternatives, and are likely to favor E-control since it is ex post efficient. Firms in Range 2 will choose ID-arbitration over V-control for the same reason.

This analysis suggests testable predictions. Firms should move from E-control to ID-arbitration to V-control as the amount invested increases, and as the divergence between E and V's interests widens. Also, the size of Range 2 depends on the ID's preferred outcome. Thus, in markets or industry sectors where there are less potential ID candidates, or where ID's are more likely to favor E for whatever reason, we should see less firms using ID-arbitration and more firms using V-control.

5. DATA ON STARTUP BOARDS

These predictions are roughly consistent with empirical evidence from VC contracts. I consider data on board configurations and independent director appointment rights.

Kaplan and Strömberg (2003) classify board control from over 200 rounds of VC financing into four categories: (i) entrepreneur control, (ii) neither VC nor entrepreneur control (i.e. shared control), (iii) VC control in 'adverse' state only, and (iv) full VC control.

Their 'shared' control category is analogous to ID-arbitration, since the tie-breaking vote(s) on these boards are held by independent directors. Kaplan and Strömberg (2003) estimate ordered logit regressions using this board control classification, in the order above, as their dependent variable. The dependent variable increases with the extent of VC control. They find positive and significant coefficients for pre-revenue ventures, and industries with a higher volatility, such as R&D-intensive industries. VC's demand more control when there is greater uncertainty regarding the firm's financial viability. In unreported regressions Kaplan and Strömberg (2003) claim that the accumulated amount of VC financing is also positive and significant, suggesting that VCs demand more control as their financing constraint increases.

Unfortunately, since these estimates use an ordered (as opposed to an unordered) dependent variable we cannot separately compare the use of shared control (i.e. ID-arbitration) to E-control or V-control. The positive coefficients, however, suggest that VC-backed firms are more (less) likely to use ID-arbitration relative to E-control (V-control) when there is greater uncertainty about the project's financial viability, and as additional VC funds are invested. These results are broadly consistent with my model. This is particularly true if we assume, as Kaplan and Strömberg do, that greater uncertainty over the project's financial viability increases the likelihood and magnitude of conflicts between the entrepreneur and the investor.

Kaplan and Strömberg interpret these results as supporting Aghion and Bolton's (1992) model regarding the use of state-contingent control. They reach this result since they consider shared control a form of state-contingent control: "We interpret the situation where neither the VC nor the founder is in control as similar to state-contingent control. For example, in boards where [independent] board members are pivotal, it seems plausible that these members will vote with the VC as founder performance declines" (Kaplan and Strömberg, 2003). This characterization may make sense if, as in Aghion and Bolton (1992), there are only two actions to choose from. However, if there are more than two possible actions to consider, as in my model, ID-arbitration can behave differently: the independent director may prefer an action that neither the entrepreneur nor the investor would select if given control. My analysis suggests that the use of shared control documented by Kaplan and Strömberg (2003) is not simply an alternate form of state-contingent control, but rather is a distinct decision-making process. Existing data, however, are consistent with both explanations, suggesting a need for further research.

To get a better sense of whether independent directors are expected to perform an arbitrating role, I also consider data on independent director appointments. In VC-backed firms independent directors are mutually appointed a firm's entrepreneurs and VC investors (Kaplan and Strömberg, 2003). This selection process is addressed in a firm's corporate charter and in voting agreements negotiated in connection with each round of financing. These documents typically specify that independent directors must be 'unanimously approved' by the firm's entrepreneurs and VC investors. In other examples, the contract may specify that independent directors must be approved by a majority of the firm's entrepreneurs (common stockholders) and VC investors (preferred stockholders) voting separately (Broughman, 2008). In either case, an independent director must be separately approved by both the entrepreneurs and investors (either through unanimity or

majority rule). This selection process, similar to arbitrator selection generally (Bloom and Cavanagh, 1986), helps ensure that an independent director's interests are not captured by either party. It also suggests that the parties recognize that an independent director may need to settle a disagreement.

6. CONCLUSION

This paper addresses an important gap in the financial contracting literature. The literature treats control as "an indivisible right that can be held at any given time by only one party" (Kirilenko, 2001). In contrast, data from VC-backed firms shows that board control is typically shared – more than 60% of the time – with a third-party independent director holding the tie-breaking board seat (Kaplan and Strömberg, 2003). Existing financial contracting models cannot explain the most commonly observed startup board configuration.

To fill this gap in the literature, I model the incentives created by a three member board composed of an entrepreneur, an investor, and an independent director ('ID-arbitration'). I use a bargaining game similar to final-offer arbitration to specify a firm's choice of action under ID-arbitration. I show that ID-arbitration can reduce opportunistic behavior by causing the entrepreneur and the investor to converge towards the action most preferred by the independent director. Consequently, ID-arbitration can lead to the efficient outcome in circumstances where alternative governance arrangements – entrepreneur control, investor control, or state-contingent control – are either unavailable or likely to lead to suboptimal results.

My analysis suggests a 'pecking order' theory of control rights. To reach the most efficient outcome and still satisfy the investor's financing constraint, firms should move from entrepreneur control, to ID-arbitration, and finally to investor control as the amount invested increases, and as the divergence between the interests of the entrepreneur and the investor widens. These predictions are roughly consistent with empirical evidence from VC contracts. Kaplan and Strömberg (2003), for example, find that VC-backed firms are more (less) likely to use ID-arbitration relative to entrepreneur control (investor control) when there is greater uncertainty regarding the project's financial viability, and as additional funds are invested.

This study suggests a need to study more complex control arrangements than what is typically addressed in corporate finance. I expand the literature by considering a particular three-party board structure (ID-arbitration); however, numerous other multi-party control arrangements occur in entrepreneurial finance. Among other concerns, the model in this article could be extended by (i) allowing state-contingent control in conjunction with ID-arbitration, (ii) modeling the use of protective provisions that require unanimous consent for particular actions (i.e. a sale of the firm may require VC consent), and (iii) modeling additional constituencies (i.e. multiple investors with different interests). Similar to the analysis here, models of voting and coalition formation from political science may prove insightful for understanding complex governance issues in corporate finance.

APPENDIX

This appendix contains proofs for Proposition 3 and 5:

Proposition 3: *If E and V can observe τ and renegotiation is unavailable, then:*
(i)   *In a firm under ID-arbitration E and V both have an incentive to propose the ID's preferred action (i.e. $a_E = a_V = \bar{a}_{ID}$); and*
(ii)   *Investment under ID-arbitration is feasible if and only if $K \leq Ey(\bar{a}_{ID})$.*

Proof part (i): Let $f_E(a_V)$ and $f_V(a_E)$ be best response correspondences for E and V respectively, given the other party's proposal. I begin with E's best response. If $a_V \leq \bar{a}_{ID}$ no proposal less than a_V can defeat a_V, by definition of g. So, E's best response is to choose $a_E = a_V$ or a proposal that would lose to a_V. This implies that $f_E(a_V \leq \bar{a}_{ID}) = [a_b, a_V]$. Alternatively, if $a_V > \bar{a}_{ID}$ E wants to choose the smallest proposal that defeats a_V. Such a proposal, however, does not exist, since for any $a_E < a_V$ where $g(\tau, a_E) > g(\tau, a_V)$ there exists $\varepsilon > 0$ such that $g(\tau, a_E - \varepsilon) > g(\tau, a_E)$. This follows since A is a compact action set. Thus, $f_E(a_V > \bar{a}_{ID}) = \emptyset$. Still, for any a_E that beats a_V it is clear that $a_V > \bar{a}_{ID}$ is suboptimal for V. Similar arguments show that $f_V(a_E \geq \bar{a}_{ID}) = [a_E, a_y]$ and $f_V(a_E < \bar{a}_{ID}) = \emptyset$, and, similarly, for any a_V that beats a_E it is clear that $a_E < \bar{a}_{ID}$ is suboptimal for E. From above we know that E's best response to $a_V = \bar{a}_{ID}$ is given by $f_E(\bar{a}_{ID}) = [a_b, \bar{a}_{ID}]$, while V's best response to $a_E = \bar{a}_{ID}$ is given by $f_V(\bar{a}_{ID}) = [\bar{a}_{ID}, a_y]$. It follows that $a_E = a_V = \bar{a}_{ID}$ is a Nash equilibrium because $\bar{a}_{ID}$ is an element of the best response correspondence for both candidates. Now I show uniqueness (i.e. $a_E = a_V = \bar{a}_{ID}$ is the only Nash equilibrium). Suppose there is a Nash equilibrium other than $a_E = a_V = \bar{a}_{ID}$. Since $f_E(a_V > \bar{a}_{ID}) = \emptyset$ and $f_V(a_E < \bar{a}_{ID}) = \emptyset$, it follows that the only other possible candidates for Nash equilibria must satisfy $a_V < \bar{a}_{ID} < a_E$. This relationship in conjunction with $f_E(a_V < \bar{a}_{ID}) = [a_b, a_V]$ and $f_V(a_E > \bar{a}_{ID}) = [a_E, a_y]$ implies that $a_E > a_V$ and $a_E < a_V$. This contradiction implies that $a_E = a_V = \bar{a}_{ID}$ is the unique Nash equilibrium.

Proof part (ii): From part (i) we know that V's expected utility from ID arbitration is $EU_V(\bar{a}_{ID}, \pi)$. When $\pi = 0$, it follows that $U_V = y$ for any choice of action. Thus, if $K \leq Ey(\bar{a}_{ID})$ there exists π (namely $\pi = 0$) such that investment under ID arbitration satisfies V's participation constraint. Conversely, if $K > Ey(\bar{a}_{ID})$ there is no allocation of cash-flow rights under ID-arbitration that would satisfy V's participation constraint, since π cannot be less than zero.

Proposition 5: *In a firm under ID-arbitration, with $\bar{a}_{ID}$ distributed uniformly over the action set A = [0, 1], and with y and b as stated in equations (17) and (18) respectively, there is a unique pure strategy Nash equilibrium where $a_E = 1/4$ and $a_V = 3/4$.*

Proof: Suppose E knows that V will propose some $a_V \in [0, 1]$, then we can rule out $a_E > a_V$ since E would prefer a_V. Treating a_V as a fixed parameter, E will propose $a_E \in [o, a_V]$ to maximize

$$\max_{a_E}[b(a_E)((a_E + a_V)/2) + b(a_V)(1 - (a_E + a_V)/2)] \tag{A1}$$

Substituting $b(a) = 1 - a^2$ into equation (A1) and differentiating with respect to a_E gives us the following first-order condition:

$$-\frac{3}{2}a_E^2 - a_E a_V + \frac{a_V^2}{2} = 0$$

Solving for a_E yields two solutions, only one of which is the range $[o, a_V]$. This solution gives us the following best response function: $a_E(a_V) = a_V/3$. Since the second derivative of (A1) is negative, this solution is a local maximum for any $a_V \in [0, 1]$.

We can solve a similar maximization problem for V by treating $a_E \in [0,1]$ as a fixed parameter and solving V's objective function

$$\max_{a_V}[y(a_E)((a_E + a_V)/2) + y(a_V)(1 - (a_E + a_V)/2)] \tag{A2}$$

Differentiating with respect to a_V, we find the following best response function: $a_V(a_E) = (2 + a_E)/3$. Furthermore, the second derivative of (A2) is negative, making this solution a local maximum. To find a Nash equilibrium (a_E, a_V) we solve the following system of equations, given by each parties' best response function: $a_E = a_V/3$ and $a_V = (2 + a_E)/3$. This gives us the unique solution $a_E = 1/4$ and $a_V = 3/4$.

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