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Financing the Entrepreneurial Venture

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We model financial contracting in entrepreneurial ventures. In our incomplete contracts framework, the entrepreneur can design contracts contingent on three possible control right allocations: entrepreneur control, investor control, and joint control, with each allocation inducing different effort levels by both the entrepreneur and the investor. We find that a variety of contracts resembling financial instruments commonly used in practice, such as common stock, straight and convertible preferred equity, and secured and unsecured debt, can emerge as optimal, depending on two key factors: entrepreneur/investor effort complementarity and investors' opportunity cost of capital. The results of our model are consistent with, and yield new explanations for, empirical regularities such as (a) the prevalence of equity-type contracts in high-growth ventures and of debt-type contracts in lifestyle ventures; (b) geographical and temporal differences in equity-type instruments used in high-growth ventures; and (c) the impact of firm and loan characteristics on the choice between secured and unsecured debt.

Key words: entrepreneurial finance; incomplete contracts; debt versus equity
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1. Introduction

Entrepreneurial ventures play a crucial role in the economy. In the United States, small firms "represent more than 99.7% of all employers [...and] create more than 50% of the nonfarm private GDP"[1]; yet to even get started, they almost invariably require external funds. An important research question then, is: How do founders finance these capital requirements? At the same time, startups also are distinct from more established firms in at least two critical ways: (1) they are subject to far less restrictive disclosure laws than large publicly held corporations, and their profits and cash flows are not easily verifiable by a court of law; and (2) both the entrepreneur and the investor may play active roles in the management of the venture, but their respective levels of involvement (i.e., effort) are difficult to measure. Is there a connection between these ventures' distinct features and their financial contracts? The objective of this paper is to characterize the optimal contracting choices of an entrepreneur seeking financing from an investor in a model where these two unique features of startups play critical roles.

[1] The Office of Advocacy of the U.S. Small Business Administration (SBA) defines a small business as an independent business having fewer than 500 employees. These statistics can be obtained from the "Frequently Asked Questions" pages at http://www.sba.gov/advo/. In particular, see answers to "How important are small businesses to the U.S. economy?" on p. 1.

1.1. Overview of the Model

When profits cannot easily be verified, the allocation of property rights and control rights (board rights, voting rights, veto rights, etc.) becomes particularly relevant because it affects ex post bargaining power and the resulting distribution of profits. Such allocation provides foresighted agents with incentives to exert profit-generating effort, and it therefore has a real impact on total surplus (Grossman and Hart 1986, Hart and Moore 1990; henceforth GHM). In our model, three possible control allocations are feasible. With "entrepreneur control," all control and ownership rights are assigned to the entrepreneur, who thus has full ex post bargaining power and extracts all rents. Anticipating this, she[2] exerts high effort, while the investor, who anticipates no reward, does not participate in the venture's management. Conversely, with "investor control," all control goes to the investor who exerts high effort, while the entrepreneur does not participate. Finally, with "joint control," the two players share ownership and control, bargaining power, and hence ex post rents. They both participate, but exert less effort than they would if either had full control. Under these conditions, the optimal allocation of control rights for the entrepreneur is simple, as shown in Aghion and

[2] For clarity purposes, throughout the paper we refer to entrepreneurs as female, and to investors as male.

Tirole (1994; henceforth AT).[3] Entrepreneur control is infeasible: The investor would anticipate no reward and refuse to provide capital. Joint control dominates investor control if and only if the positive impact of higher entrepreneur effort associated with joint control more than offsets the negative impact of lower investor effort, a GHM-type result.

We depart from AT's basic framework by allowing for an "interim" profit opportunity to be generated, with some probability, at some point during the game. This simple departure provides a significantly richer framework in which to analyze the entrepreneur's financing possibilities because the different control right allocations can now be contingent on repayments to the investor drawn from interim cash flows. Indeed, an important and novel result of this paper is that a number of contracts resembling financial instruments commonly used in practice—such as voting equity, convertible and straight (or participating) preferred equity, as well as secured and unsecured debt—can emerge as optimal.

The next step, then, is to determine the conditions under which each of these candidate contracts is optimal. To that end, we show that contractual optimality depends on two factors: the *complementarity* between the efforts of the entrepreneur and investor, and the *investor's cost of capital*. Three other key results then emerge. First, while debt-type contracts (secured and unsecured debt) tend to dominate at lower levels of effort complementarity, equity-type contracts (common and preferred equity) become optimal as effort complementarity increases. Debt-type contracts rely mainly on entrepreneur control and investor control (depending on whether debt payments are made), which are not affected by effort complementarity because under these control allocations only one player exerts effort. In contrast, equity-type contracts rely more on joint control, which elicits effort by both players. Effort complementarity increases the impact of joint efforts, and hence the relative attractiveness of equity-type contracts.

Second, within the equity-type category, the entrepreneur must make other, more specific choices. We show that common stock, convertible preferred equity, and straight preferred equity become optimal successively as the cost of capital increases. Common stock, which, relative to convertible preferred equity, gives more control rights to the entrepreneur, also gives a higher expected return, and is chosen whenever feasible. However it is less "investor friendly" than convertible preferred, which accordingly can be used as a backup option to secure financing when the investor's cost of capital is too high for his participation constraint to hold with common stock. The same reasoning explains the difference between convertible preferreds and the even more "investor friendly" straight preferreds.

Third, within the debt-type category, the entrepreneur must decide between secured and unsecured debt, and we show that the former dominates the latter in two situations: when effort complementarity is particularly low, or when the investor's cost of capital is high.

Importantly, these results are consistent with, and help us formalize explanations for, a number of largely unexplained regularities documented in the next section, including: (1) the key financing difference between high-growth ventures (i.e., classic startups) and lifestyle ventures (e.g., restaurants, hair salons, etc.),[4] which favor equity-type instruments and debt-type instruments, respectively; (2) the geographic and temporal differences in equity-type instruments used in high-growth ventures; and (3) the impact of firm and loan characteristics on the choice between secured and unsecured debt.

1.2. Related Literature and Key Contributions

This paper stands between two lines of research on financial contracting. From a methodological standpoint, our model is related to several classic papers from the security design literature, including Bolton and Scharfstein (1990, 1996), Aghion and Bolton (1992), Dewatripont and Tirole (1994), and Hart and Moore (1998), which examine the characteristics of optimal financial instruments in the context of contractual incompleteness. Our modeling of debt as an incentive device for the entrepreneur to make cash repayments to the investor when cash flows are not verifiable, for example, builds on the work of Bolton and Scharfstein (1990) and Hart and Moore (1998), in particular.

This paper is also related to the more recent literature on venture capital contracts, which, unlike the work on security design mentioned above, focuses on the financing of entrepreneurial ventures specifically. The primary purpose of this line of research

[3] AT's classic paper is in fact a model of innovation that analyzes the optimal allocation of property rights between an innovator and its customer. However, one can also interpret it as a study of the allocation of control rights between an entrepreneur and an investor. See also Hellmann (1998), Yerramilli (2004), and Dessein (2005) for models of control right allocation in financial contracts.

[4] The terms "high-growth" and "lifestyle" ventures are commonly used to divide entrepreneurial ventures into two broad categories. See Haynes et al. (1999), Davis (2003, p. 180), Hisrich et al. (2006, pp. 19–20), Harvard Business School (2006), and Mahdjoubi (2007). High-growth ventures are usually defined as ventures in which the goal is value creation and growth, with the entrepreneur recognizing the importance of the investor's role in achieving these goals. In contrast, lifestyle ventures provide a good living for the entrepreneur, but do not have the growth or value creation potential of high-growth ventures.

is to offer new insights into the predominant use of convertible securities in venture capital contracts in the United States today.[5] Researchers have proposed several theories in which convertible securities emerge as a response to single-sided (Bergmann and Hege 1998), double-sided (Casamatta 2003, Repullo and Suarez 2004, Hellmann 2006), or sequential (Schmidt 2002) moral hazard issues affecting the entrepreneur/investor relationship; to potential signal manipulation ("window-dressing") by the entrepreneur (Cornelli and Yosha 2003); as well as to conflicts of interest between the entrepreneur and the investor in "exit" situations such as trade sales and initial public offerings (IPOs) (Berglöf 1994, Bascha and Walz 2001) or liquidation events (Marx 1998).

Our model fills a gap between the security design literature, which does not address the financing of entrepreneurial ventures specifically, and the venture capital contracting literature, which focuses on the somewhat narrow subset of startups financed with venture capital. Indeed, the primary contribution of this model is to propose a theory that explicitly takes into account the distinctive characteristics of entrepreneurial ventures, yet is general enough to address issues related not only to high-growth ventures financed by venture capitalists (VCs), but also to lifestyle ventures, which represent more than 90% of all startups (Davis 2003). This approach yields new results and explanations for a number of empirical regularities, such as the ones mentioned above, which have received less attention in the prior literature.

A key component of this contribution results from simultaneously incorporating the two distinctive characteristics of startups described at the start of this introduction—namely, the difficulty in verifying profits and the possibility of joint entrepreneur/investor efforts—into a richer contracting framework where a variety of commonly used financial securities can emerge as optimal. We believe that our approach is novel in that regard: In the security design literature, for example, Bolton and Scharfstein (1990, 1996) and Hart and Moore (1998) posit nonverifiability of cash flows, but focus on debt contracts only. In contrast, Aghion and Bolton (1992) and Dewatripont and Tirole (1994) do rely on the verifiability of profits to model both equity-like contracts and debt-like contracts.[6] Moreover, none of these papers addresses the issue of joint entrepreneur/investor effort. In the venture capital literature, although joint effort is examined (Casamatta 2003, Repullo and Suarez 2004, Hellmann 2006), the nonverifiability of profits is generally not explicitly modeled;[7] and as noted above the focus is on convertible securities specifically.

The second key component of our contribution arises from clarifying the conditions under which financial instruments are selected. While other researchers (e.g., Aghion and Bolton 1992) have hinted at a role for the investor's cost of capital in financial contracting, we argue that two dimensions, rather than one, may determine the optimal contract, and thus must be jointly considered. Our model is novel in explaining why each one of the main financial instruments used in practice is optimal for some combination of investor's cost of capital and entrepreneur/investor effort complementarity.

This paper is organized as follows. Section 2 presents empirical regularities that our model helps explain. Sections 3 and 4 describe the model, and analyze feasible contracts. Section 5 derives optimal contracts, and §6 relates key results to stylized facts. Section 7 concludes by suggesting model applications to other areas of management more broadly. All proofs are in the online appendix (provided in the e-companion).[8]

2. Empirical Regularities

Several striking empirical facts characterize the financing of entrepreneurial ventures. Consider high-growth entrepreneurs, who have access to venture capital. As shown in Table 1, the evidence suggests that in Canada and Europe they use both equity-type instruments and debt-type instruments.

[5] There is also a small but growing literature on the entrepreneur's choice between venture capital and bank financing. In Landier (2002), this choice depends on the "quality" of the entrepreneur's exit option, which itself depends on the legal environment and on the "stigma of failure." In Ueda (2004), venture capitalists are better at project evaluation, but banks are less likely to expropriate the entrepreneur. Winton and Yerramilli (2004) show that both uncertainty in continuation strategy choices, and skewness of cash flow distributions, tend to favor venture capital financing over bank financing. de Bettignies and Brander (2007) examine how the relative VC/entrepreneur productivity affects the latter's choice between venture capital and bank finance.

[6] As noted in Fluck (1998), there exists an inherent tension between the nonverifiability of profits and the modeling of equity-type contracts. She solves the problem by arguing that equity holders who have the right to dismiss the manager, and have an unlimited time horizon, can discipline the manager into paying out dividends with a credible threat of dismissal. Myers (2000) and Dybvig and Wang (2002) also use the threat of dismissal to introduce equity in a model with nonverifiable cash flows. We circumvent this issue by arguing that, in entrepreneurial ventures, the crucial components of equity contracts are the control rights typically associated with them (rather than claims on cash flows that are irrelevant when these are not verifiable) because they give to the investor ex post bargaining power, and hence access to rents.

[7] In some multi stage models (e.g., Berglöf 1994, Bascha and Walz 2001, Repullo and Suarez 2004), nonverifiability is present in the early stages, but disappears in later stages. In our model, cash flows remain unverifiable throughout.

[8] An electronic companion to this paper is available as part of the online version that can be found at http://mansci.journal.informs.org/.

Table 1 **Financial Instruments Used in Venture Capital Deals (as % of Total Deals)**

	Equity	Debt	Conv. debt	Pref. equity	Other
Europe (Bottazzi et al. 2004)	55.5	6.5	7.5	25.5	5
Canada, Can. VCs (Cumming 2005)	36.3	15	12.4	18.1	18.2
Canada, U.S. VCs (Cumming 2002)	34.6	12	12	36.5	4.8
Germany (Basha and Walz 2002)	26.6	38.7	0	10.6	25.1

Notes. In Cumming (2005), the preferred equity category consists of 7.27% straight preferred equity and 10.87% convertible preferred equity. In Cumming (2002), the preferred equity category consists of 15.38% straight preferred equity and 21.15% convertible preferred equity. Finally, Bascha and Walz (2002) explain that in Germany, the so-called "silent parternship," a debt-type instrument, is commonly used (33.1%); it is categorized as debt. Moreover, private limited companies are not allowed to use convertible debt. They use other instruments instead, which are categorized as "other."

Even in the United States, where the prevalent use of convertible preferred equity in the financing of high-growth ventures by VCs is well documented (Sahlman 1990, Lerner 1994, Gompers 1995, Bergmann and Hege 1998, Gompers and Lerner 1999, Kaplan and Strömberg 2002), high-growth entrepreneurs have access to other forms of financing. Venture lending, for example, has recently emerged, which provides debt-type instruments to these ventures in the form of venture leasing, venture debt, or subordinated debt (Hardymon et al. 2005). Venture lenders have been very active recently,[9] providing an interesting alternative to equity financing for high-growth ventures in the United States.

Now consider lifestyle ventures. Data describing such ventures specifically is more difficult to find. However, as these ventures represent more than 90% of all startups, we conjecture that data describing entrepreneurial ventures in general should provide an accurate representation of lifestyle ventures. Under this assumption, it appears that lifestyle entrepreneurs, like high-growth entrepreneurs, also have access to various financing options, including both equity and debt financing. Using the 2004 UK Survey of Small and Medium Enterprise (SME) Financing, Fraser (2005) illustrates this point clearly, and we report some of his findings in Table 2.

Empirical Regularity 1. Both high-growth entrepreneurs and lifestyle entrepreneurs use a variety of financial instruments to fund their projects, including equity-type instruments and debt-type securities.

Table 2 **External Sources of Finance Used to Establish the Startup**

Source	Pop. percent.	Source	Pop. percent.
Bank loan	20.4	Other credit	4.7
Friends/Family loan	12.7	Friends/Family equity	1.3
Mortgage on home	6.5	Venture capital equity	0.3
Credit card	3.3	Other external sources	4.6

Source. Adapted from Fraser (2005).
Note. These numbers refer to the subset of SMEs (businesses with less than 250 employees) that are defined as startups (aged less than two years).

It is clear from Tables 1 and 2 that although high-growth entrepreneurs and lifestyle entrepreneurs use a variety of financial instruments, they differ in the type of instrument they use predominantly. In Europe, for example, 80% of ventures financed by VCs used equity-type contracts (Bottazzi et al. 2004). In contrast, in lifestyle ventures debt-type contracts seem preferred: In the United Kingdom in 2004, less than 6% of lifestyle ventures used equity-type instruments, while 20.4% used bank loans (Fraser 2005).

Empirical Regularity 2. While high-growth ventures use equity-type instruments predominantly to finance their projects, lifestyle ventures use debt-type instruments mostly.

Examining high-growth ventures more closely, two interesting facts emerge. First, as noted above, today convertible preferred equity is ubiquitous in venture capital deals in the United States, but this was not always the case: Another type of instrument, namely, straight preferred equity, dominated until the mid-1980s (Hardymon and Lerner 2001). Second, as depicted in Table 1, even today, the dominance of convertible preferred equity in high-growth ventures seems somewhat specific to the United States. In Europe and Canada, common equity rather than convertible preferred stock seems to predominate (Bottazzi et al. 2004, Cumming 2005).

Empirical Regularity 3. Within the high-growth venture category, temporal and geographic differences do exist in the type of equity instrument used most predominantly.

Finally, lifestyle ventures have interesting financial characteristics also. First, the debt contracts used include both secured debt and unsecured debt in significant proportions.[10] This is illustrated in Table 2: While credit cards and friends/family loans tend to be unsecured, mortgages are secured, and bank loans could be either secured or unsecured. In the United States, for example, approximately 60% of loans taken by small firms are collateralized (Leeth and Scott

[9] Debt providers such as Western Technology Investments and Lighthouse Capital raised $720 million and $366 million, respectively, in May 2003 (Hardymon et al. 2005). Perhaps better known is Silicon Valley Bank (Leamon and Hardymon 2001), and its spin-off Gold Hill Venture Lending, which raised $200 million in the summer of 2004 (Hardymon et al. 2005).

[10] Brealy and Myers (2003, p. 1049) broadly define secured debt as a debt contract that (1) has specific assets pledged as collateral that can be seized in case of default, and (2) is senior to other claims. Unsecured debt in contrast has no collateralized assets and is subordinated to secured debt.

1989). Interestingly, the average proportion of secured loans is somewhat lower when one analyzes not only small firms but larger ones as well (Berger and Udell 1990); and this suggests that smaller—and presumably younger and more entrepreneurial firms—use more secured debt relative to other firms. This is consistent with Leeth and Scott (1989), who find that age of the firm has a significantly negative impact on the probability of issuing secured debt. They also find that loans with shorter maturity, and loans taken by professional or financial firms, are all significantly less likely to be secured.

Empirical Regularity 4. Lifestyle ventures use both secured and unsecured debt in significant but varying proportions, depending on loan maturity, firm age, and industry.

In what follows, we propose a general theory of entrepreneurship that is consistent with all four empirical regularities, and that can shed light on the financing of all entrepreneurial ventures (including high-growth and lifestyle ventures) across borders and over time.

3. Basic Setup

A wealth-constrained entrepreneur e has in mind a one-period, positive net present value project, which requires an initial capital outlay $k = \$1$ from an investor i. Both e and i are risk neutral. At date 0, the entrepreneur makes a take-it-or-leave-it contractual offer to the investor,[11] whose next-best opportunity yields an expected net return r over the period. We call r the investor's (dollar) net opportunity cost of capital. At date 1, the project yields a profit opportunity v with probability p, zero otherwise.

At date 1/2, the entrepreneur and the investor exert nonverifiable efforts q^e and q^i, respectively, which increase the expected profits: $v(q^e, q^i, \alpha) = (q^e + q^i) + \alpha q^e q^i$, with $\alpha \in [0, \hat{\alpha}]$ and $\hat{\alpha} < 2$. Parameter α is a measure of *entrepreneur/investor effort complementarity*. When $\alpha = 0$, entrepreneur effort and investor effort are perfect substitutes, but the two efforts become more complementary as α increases. Cost of effort for both e and i is $c(q) = \frac{1}{2}(q)^2$, with $q = q^e, q^i$.

3.1. Contracts and Equilibrium Efforts

We assume that contracts are incomplete in that profits cannot be verified by the courts—although they are observable by entrepreneurs and investors—and are therefore noncontractible at date 0. Indeed, the initial contract specifies only the allocation of control (or property) rights over the venture, which can be of three types.

With *entrepreneur control* (E), the entrepreneur is the sole owner of the venture and has complete control over the assets and the decisions to be made. This brings two types of benefits to the entrepreneur. First, it bring nonpecuniary benefits: she "enjoys" having full control over the venture, and receives a private (nonverifiable) benefit b^e from it.[12] Second, it brings pecuniary benefits. If the profit opportunity v arises, e can unilaterally seize it and extract all rents for herself, and i, who has no control rights, cannot interfere with that decision and gets nothing. At date 1/2, anticipating this, e maximizes $[b^e + pv(q^e, q^i, \alpha) - c^e(q^e)]$ w.r.t. q^e, taking q^i as given; and i exerts no effort (i.e., no involvement). The unique Nash equilibrium (NE) is $q_E^{e*} = p$ and $q_E^{i*} = 0$, with total expected surplus $V_E = b^e + pv(q_E^{e*}, q_E^{i*}) - c(q_E^{e*}) = b^e + \frac{1}{2}p^2$.

With *investor control* (I), it is the investor who is the sole owner of the venture and has complete authority over assets and decisions. He enjoys private benefits of control b^i, and access to 100% of the rents at date 1. The entrepreneur gets nothing. In equilibrium, e exerts $q_I^{e*} = 0$ and i exerts $q_I^{i*} = p$, generating total expected surplus $V_I = b^i + pv(q_I^{e*}, q_I^{i*}) - c(q_I^{i*}) = b^i + \frac{1}{2}p^2$. We make the natural assumption that e enjoys higher private benefits from control than i ($b^e > b^i$), which implies $V_E > V_I$.

Finally, with *joint control* (J), the entrepreneur and the investor jointly own the venture and share control rights. They therefore bargain over the profit opportunity v if is arises. Following AT, we assume that bargaining at date 1 yields a payoff of $\frac{1}{2}v$ to both e and i.[13] Anticipating this outcome, at date 1/2, e exerts an effort q^e that maximizes $[p\frac{1}{2}v(q^e, q^i, \alpha) - c(q^e)]$, taking q^i as given. Similarly, i chooses effort q^i to maximize $[p\frac{1}{2}v(q^e, q^i, \alpha) - c(q^i)]$, taking q^e as given. One can easily derive the unique NE in effort where e and i exert efforts $q_J^{e*}(\alpha) = q_J^{i*}(\alpha) = p/(2 - p\alpha) > 0$ for all $\alpha \in [0, \hat{\alpha}]$. The total expected surplus generated at date 1 is $V_J(\alpha) = pv(q_J^{e*}(\alpha), q_J^{i*}(\alpha), \alpha) - c(q_J^{e*}(\alpha)) - c(q_J^{i*}(\alpha)) = ((3 - p\alpha)/(2 - p\alpha)^2)p^2$, and e and i each obtain the same expected payoff $V_J^e(\alpha) = V_J^i(\alpha) = \frac{1}{2}V_J(\alpha)$.

[11] We implicitly assume that the entrepreneur is "talented" and that there are many investors competing to finance her project ex ante. This assumption is common in the literature. See, e.g., Bascha and Walz (2001), Berglöf (1994), Bergmann and Hege (1998), Marx (1998), and Repullo and Suarez (2004).

[12] Evidence of these nonpecuniary benefits of control can be found in Hamilton (2000) and Moscowitz and Vissing-Jorgensen (2002).

[13] As noted in Aghion and Tirole (1994, p. 1190), "[t]he equal split outcome will, for example, result from a Rubinstein (1982) bargaining process with alternative offers by the two parties and no time delay between two successive offers […]." Equivalently, this outcome will result from Nash bargaining if, for example, the realization of the profit opportunity (e.g., the sale of the ventures' products/services) requires the agreement of both e, and i. In the event of a breakdown in bargaining, the sale cannot take place, and the profit opportunity vanishes. In the context of Nash bargaining, this is equivalent to threat points of zero for both players, which leads to a 50-50 split in equilibrium (Binmore et al. 1986).

3.2. Aghion and Tirole (1994)

The basic setup presented so far is closely related to AT's classic model of innovation that, although it analyzes the optimal allocation of property rights between an innovator and its customer, can be interpreted as a study of the allocation of control rights between an entrepreneur and an investor. Focusing on the case where $r = 0$ and $\alpha = 0$, they show that in this type of setup, e must choose between investor control and joint control. (Entrepreneur control is not feasible because i anticipates he will receive nothing at date 1, and thus has no interest in putting down initial capital k; e, who is wealth constrained, cannot compensate him at date 0 for the lost rents at date 1.) She can extract all expected rents at date 0 through transfers from i (who is not wealth constrained), and thus maximizes total surplus. She chooses joint control over investor control if and only if $V_J(0) - V_I \geq 0$, which can be expressed as $[(pq_J^{e*} - c(q_J^{e*})) - 0] - [(pq_I^{i*} - c(q_I^{i*})) - (pq_J^{i*} - c(q_J^{i*}))] \geq b$. Joint control is optimal if and only if e's marginal product of effort is large enough relative to i's, a GHM-type result.[14]

3.3. Interim Profits, Effort Complementarity, and Cost of Capital

In this paper, we depart from AT's basic framework by allowing for a profit opportunity u to be generated, with some probability p, at some point before date 1/2, say date 1/4.[15] Allowing for the possibility of an *interim profit opportunity* has important consequences in this model. It provides us with a significantly richer framework to analyze the financing possibilities available to the entrepreneur because the different control right allocations can now be contingent on a repayment to the investor at date 1/4, drawn from cash flow u. We will show that several debt- and equity-type contracts resembling financial instruments commonly used in practice can emerge as optimal.

Contractual optimality is shown to depend on two factors. The first factor is the size of V_J relative to both V_I and V_E, unlike AT, where what matters is the size of V_J relative to V_I only. Entrepreneur/investor effort complementarity is an ideal measure for this.[16] Indeed, α strictly increases the total surplus from joint control, $V_J(\alpha)$, by (i) increasing the value of collaboration (joint efforts) for any given strictly positive levels of effort by e and i, and (ii) increasing the marginal products of effort for e and i, and hence their equilibrium effort levels $q_J^{e*}(\alpha)$ and $q_J^{i*}(\alpha)$. Yet α has no impact on total surplus under entrepreneur control and investor control, V_E and V_I, because one player or the other chooses zero effort.[17] Accordingly, α increases V_J relative to V_I and V_E, and plays a important role in our model. The second factor is i's cost of capital r, which must be lower than his expected return in order for him to participate at date 0. Different contracts yield different maximum payoffs to the investor and hence different threshold levels of r above which the project cannot be financed. A contract that does not maximize the entrepreneur's payoff when r is low may still be optimal when r is high, if the optimal contract for low r is no longer feasible for high r. AT assume away this issue by setting $r = 0$.

For simplicity, we assume that u can be costlessly diverted by the entrepreneur. This assumption can be interpreted in two ways. First, u may be privately observable to e. This is not implausible early on in the entrepreneur/investor relationship (e.g., until date 1/4 inclusive) when information asymmetry is a common problem. Second, early on in a new venture, profit opportunities may depend mostly on e's human capital, rather than on the physical assets of the firm. Then, regardless of the allocation of control (on the physical assets), e can extract all rents (Hart 1995, pp. 56–57).[18]

[14] This is only one of several key results proposed by AT. Other results are more specific to the innovator/customer interpretation of their model, and are not explicitly discussed in this paper. They include, for example, discussions of cofinancing, multiple innovations, multiple users, and size of innovations.

[15] The case where u is generated after date 1/2, i.e., after efforts have been exerted, yields less clearcut results, in part because the role of entrepreneur/investor effort complementarity in the determination of the optimal contract is more limited. Keeping u at date 1/4, but making it endogenously determined by another set of efforts before that date, would bring complications without real benefit because in this model, the actual size of u has little impact. Similarly, the interim and final profit draws are assumed to be independently distributed for simplicity.

[16] In contrast, the relative marginal efficiency of effort, which is a good way to interpret the size of V_J relative to V_I in AT, is ill-suited as a measure of the size of V_J relative to both V_I and V_E. This is because an increase in V_J can be interpreted simultaneously as an increase in the marginal efficiency of the entrepreneur relative to that of the investor (because $V_J - V_S$ goes up, as in AT) or as a decrease (because $V_J - V_E$ goes up).

[17] One can easily derive $dV_J(\alpha)/d\alpha = p^3(4 - p\alpha)/(2 - p\alpha) > 0 \ \forall \alpha \in [0, \hat{\alpha}]$, and verify that $dV_E(\alpha)/d\alpha = dV_I(\alpha)/d\alpha = 0$.

[18] The assumption of costlessly diverted interim profits greatly simplifies the model by ensuring that control rights affect the distribution (and size) end-of-game profits, but not of interim profits. It also helps highlight the importance of debt contracts, which are designed to provide incentives to the entrepreneur to return some of these interim profits to the investor, by stripping her of control rights, and hence of access to date 1 profits, if she defaults on interim payments. Indeed, this assumption is common in models where debt plays an important role. See, e.g., Bolton and Scharfstein (1990, 1996), Hart and Moore (1998), among others. In contrast, if interim profits are observable, and if control rights do matter at date 1/4 in the same as they do at date 1, e can use control rights to commit to return interim profits to the investor: she may choose investor control until date 1/4 (along with a payment from i at date 0), followed by entrepreneur control or joint control. In other words, e may prefer to sell the venture to i with equity vesting for her after date 1/4.

In the main text, we focus on values for b^e, b^i, and $\hat{\alpha}$ such that (1) $V_J(0) < V_I$ and $V_J(\hat{\alpha}) > V_E$, and (2) $V_J(\hat{\alpha}) \leq 2V_I$. Condition (1) ensures that the set $[0, \hat{\alpha}]$ of feasible values of α spans three regions (rather than two or less), thereby highlighting the key role of effort complementarity. Let $\underline{\alpha}$ and $\bar{\alpha}$ be such that $V_J(\underline{\alpha}) = V_I$ and $V_J(\bar{\alpha}) = V_E$. Then, in region $A_1 = [0, \underline{\alpha})$, $V_J(\alpha) < V_I$; the effort complementarity benefits associated with joint control are low, and are dominated by the benefits associated with investor control, which include private benefits and incentive benefits from giving full control to i. In region $A_2 = [\underline{\alpha}, \bar{\alpha})$, $V_I \leq V_J(\alpha) < V_E$; the effort complementarity benefits are moderate, i.e., sufficiently high for joint control to dominate investor control, but smaller than the benefits associated with entrepreneur control, which include private benefits and incentive benefits from giving full control to e. In region $A_3 = [\bar{\alpha}, \hat{\alpha}]$, $V_E \leq V_J(\alpha)$, the effort complementarity benefits are high, and joint control yields the highest total surplus. Condition (2) is a simplifying assumption made for expositional purposes, and is relaxed in the online appendix.[19]

Finally, we place no restriction on renegotiation of the allocation of control rights. It will take place on the equilibrium path whenever the renegotiated outcome makes both parties weakly better off. Without loss of generality, we make the simplifying assumption that e has full bargaining power in renegotiation and extracts the entire renegotiation surplus. If the project generates payoff u at date 1/4—the "good" state of the world—e can use this cash and is therefore no longer wealth constrained[20] (i is never wealth constrained by assumption). In that case, whenever the control allocation specified in the initial contract does not yield the highest total expected payoff, renegotiation will take place, even if it leads to a decrease in gross expected payoff to e or i, as renegotiation transfers ensure increases in net expected payoffs for both players. In contrast, if the project generates no cash at date 1/4—the "bad" state of the world—e remains wealth constrained. In that case, the gross renegotiation payoff to i cannot decrease because e cannot "bribe" him into renegotiation with a monetary transfer.

[19] Conditions (1) and (2) place only weak restrictions on the parameter space. Consider any $p \in (0, 1)$. It is easily shown that $b^i > \frac{1}{4}p^2$ and $b^e \in (b^i, 2b^i + \frac{1}{2}p^2)$ imply $V_J(0) < V_I$ and $V_I < V_E < 2V_I$, respectively. Because $V_J(\alpha)$ is strictly increasing in α, there must exist $\bar{\alpha} > 0$ such that $V_J(\bar{\alpha}) = V_E$, and $\bar{\bar{\alpha}} > \bar{\alpha}$ such that $V_J(\bar{\bar{\alpha}}) = 2V_I$. Then, any $\hat{\alpha} \in (\bar{\alpha}, \bar{\bar{\alpha}}]$ is such that $V_J(\hat{\alpha}) > V_E$ and $V_J(\hat{\alpha}) \leq 2V_I$. One can also verify that $b^i < \frac{1}{2}p^2$ is sufficient to ensure that $V_J(2) > 2V_I$, which implies that $\bar{\bar{\alpha}} < 2$ and that $q_J^{e*}(\alpha) = q_J^{i*}(\alpha) = p/(2 - p\alpha) > 0$ for all $\alpha \in [0, \bar{\bar{\alpha}}]$.

[20] We assume that u is "large enough." A sufficient condition is $u \geq V_J(\hat{\alpha})$.

4. Contractual Choices for the Entrepreneur

In this section, we start by characterizing two debt-type contracts (*standard debt* and *debt with reorganization*) and two equity-type contracts (*voting equity* and *preferred equity*) that are feasible when interim cash flows can occur with some probability. For each contract, we derive renegotiation-proofness conditions, which ensure that the contract is implementable in its initial form, with no incentive for renegotiation at any point on the equilibrium path. We then show that these four renegotiation-proof contracts are the only potentially optimal contracts in this framework: renegotiated contracts and other contracts are either infeasible or dominated.

4.1. Standard Debt (SD)

When investor control and entrepreneur control are the only two feasible control right allocations, the optimal contract assigns entrepreneur control if a (verifiable) debt repayment d_{SD} is paid out to i at date 1/4; and investor control in the event of default (see, e.g., Bolton and Scharfstein 1990, 1996; Hart and Moore 1998). Upon gaining full control following default, i may run the venture himself, or most likely will liquidate the firm. Thus, here the expected surplus under investor control, V_I, can be interpreted as the expected liquidation value of the firm, itself a function of liquidation effort q^i by the investor.[21] This "standard debt" contract is still potentially optimal here, and the (subgame-perfect) equilibrium path that follows from these contractual terms is characterized in the online appendix.

A natural outcome to emerge from these initial terms is one where, in the good state, e pays d_{SD} to i, keeps $u - d_{SD}$ for herself, and expects net payoff V_E from entrepreneur control at date 1; and in the bad state, e defaults and gets nothing, while i obtains control and gets V_I. We call this the *renegotiation-proof outcome*, which yields expected returns $R_{SD}^e = p(u - d_{SD} + V_E)$ and $R_{SD}^i = pd_{SD} + (1-p)V_I - k$ to e and i, respectively. Because e has full bargaining power at date 0, she sets d_{SD} such that $R_{SD}^i = r$ (i.e., such that i is indifferent between investing or not[22]), and thus extracts all ex ante rents, with an expected return $R_{SD}^{e*} = p(u + V_E) + (1-p)V_I - k - r$.

In regions A_1 and A_2, this renegotiation-proof outcome is the subgame-perfect equilibrium, as long as

[21] Alternatively, the buyer of the assets may be the one exerting effort i and expecting surplus V_I. If buyers are competitively supplied, the initial investor extracts all rents, with a sale price equal to the expected payoff of V_I.

[22] In the special case when k and r are so low that $(1-p)V_I \geq k + r$, the entrepreneur set $d = \varepsilon$, with $\varepsilon \to 0$, and requests a transfer τ_{SD} from the investor at date 0 such that $(1-p)V_I - k - \tau_{SD} = r$.

$d_{SD} \leq d_{SD}^{\max} = V_I$. In fact, $d_{SD} > V_I$ is infeasible: in the good state, e would prefer to default and then renegotiate from investor control to entrepreneur control, in exchange for renegotiation transfer V_I to i: this would give her an expected payoff $-V_I + V_E > -d_{SD} + V_E$. This places an upper bound on the payment $R_{SD}^{i\max} = pV_I + (1-p)V_I - k = V_I - k$ that i can expect to receive, and implies that SD is implementable in renegotiation-proof (or any) form only as long as $r \leq R_{SD}^{i\max}$. In region A_3 where joint control yields the highest total expected payoff, SD is not implementable in its initial form, as renegotiation to joint control will inevitably take place in the good state. In sum:

Lemma 1. *The* SD *contract is implementable in its initial form only in regions A_1 and A_2, as long as the investor's cost of capital r is smaller than $R_{SD}^{i\max}$, in which case it yields an expected payoff R_{SD}^{e} to the entrepreneur.*

4.2. Debt with Reorganization (DR)

Another potential debt contract allows e to retain full control (entrepreneur control) if she makes a debt repayment d_{DR} at date 1/4, and converts to joint control otherwise. With this contract, default is followed by reorganization with both agents sharing control, rather than liquidation as in the SD contract. We call this *debt with reorganization*.

This contract is very similar to SD, and the renegotiation-proof outcome from the DR contract yields expected payoffs $R_{DR}^{e} = p(u - d_{DR} + V_E) + (1-p)\frac{1}{2}V_J(\alpha)$ and $R_{DR}^{i} = pd_{DR} + (1-p)\frac{1}{2}V_J(\alpha) - k$ to e and i, respectively. At date 0, e sets d_{DR} such that $R_{DR}^{i} = r$, and expects a return $R_{DR}^{e*} = p(u + V_E) + (1-p)V_J(\alpha) - k - r$.[23]

This renegotiation-proof outcome is subgame-perfect in region A_2, although the possibility of renegotiation places an upper bound $d_{DR}^{\max} = \frac{1}{2}V_J(\alpha)$ on d_{DR}, and on the payment $R_{DR}^{i\max} = \frac{1}{2}V_J(\alpha) - k$ that i can expect to receive. In region A_3, DR is not implementable in its initial form because as in the case of SD, renegotiation to joint control always occurs in the good state. Finally, in region A_1, DR is not implementable in its initial form either, as renegotiation from joint control to investor control would occur in the bad state. Thus:

Lemma 2. *The* DR *contract is implementable in its initial form only in region A_2, as long as the investor's cost of capital r is smaller than $R_{DR}^{i\max}$, in which case it yields an expected payoff R_{DR}^{e} to the entrepreneur.*

The distinction between SD and DR is similar to the distinction between *secured* and *unsecured debt*, in the sense that default is (weakly) more likely to be followed by liquidation with secured debt than with unsecured debt, which itself is more likely to be followed by reorganization. The reason is that with secured debt, in case of default the creditor may have the right to seize the collateralized assets and liquidate them, and can also petition to force a Chapter 7 (liquidation) bankruptcy. In contrast, with unsecured debt, the creditor has no rights over specific assets, and in practice will find it more difficult to force a liquidation. Instead, a Chapter 11 reorganization will likely take place, a process during which incumbent management typically still takes part in business, but creditors gain substantial control over the venture (Hart 1999).[24]

4.3. Voting Equity (Q)

In entrepreneurial ventures where cash flows are arguably difficult to verify and consequently contracts contingent on them are unlikely to be honored, one may wonder why equity contracts (claims on cash flows) are so commonly used. We posit that it is the delegation of control rights to the investor, which is nearly always included in entrepreneurial contracts involving equity, rather than the cash flow rights themselves, which enables the investor to extract some rents ex post. Indeed, in our model, joint control generates a stream of payoffs to the investor that is similar to the one typically obtained in an equity contract. For that reason, we call the contract that assigns joint control unconditionally *voting equity*. Focusing on control rights rather than cash flow rights enables us to introduce an equity-like contract in the model and to compare with other contracts, all the while keeping the assumption of nonverifiability of cash flows and performance that is distinct in entrepreneurial ventures.

Contract Q is very simple: at date 0, the entrepreneur gives joint control to the investor in exchange for payment $k + \tau_Q$. Transfer $\tau_Q \geq 0$ is chosen such that i expects $R_Q^{i} = \frac{1}{2}V_J(\alpha) - k - \tau_Q = r$, implying an expected return $R_Q^{e} = pu + V_J(\alpha) - k - r$ for e.

It is easily shown that contract Q is not renegotiation-proof in regions A_1 and A_2: in the good state, for example, renegotiation to entrepreneur control will occur, making everyone better off because $V_E \geq V_J(\alpha)$. In region A_3, Q is implementable in its initial form, but yields a maximum payoff $R_Q^{i\max} = \frac{1}{2}V_J(\alpha) - k$ to i. Thus:

Lemma 3. *The* Q *contract is implementable in its initial form only in region A_3, as long as the investor's cost of*

[23] In the special case when k and r are so low that $(1-p)\frac{1}{2}V_J - k \geq r$, the entrepreneur sets $d = \varepsilon$, with $\varepsilon \to 0$, and requests a transfer t_{DR} from the investor at date 0 such that $(1-p)\frac{1}{2}V_J - k - t_{DR} = r$.

[24] Naturally, this is assuming that, as in our model, the payoff to the creditor is higher with liquidation than with reorganization. In the converse case, default will likely be followed by reorganization regardless of the type of debt.

capital r is smaller than $R_{\mathrm{Q}}^{i\max}$, in which case it yields an expected payoff R_{Q}^{e} to the entrepreneur.

4.4. Preferred Equity (P)

The fourth possibility is to assign joint control conditionally on a prespecified debt payment d_{P} at date 1/4, and investor control in the event of default. With this contract, the expected returns for e and i are $R_{\mathrm{P}}^{e} = p(u - d_{\mathrm{P}} + \frac{1}{2}V_{\mathrm{J}}(\alpha))$ and $R_{\mathrm{P}}^{i} = p(d_{\mathrm{P}} + \frac{1}{2}V_{\mathrm{J}}) + (1-p)V_{\mathrm{I}} - k$, respectively. At date 0, e sets d_{P} such that $R_{\mathrm{P}}^{i} = r$, with an equilibrium expected return $R_{\mathrm{P}}^{e*} = p(u + V_{\mathrm{J}}) + (1-p)V_{\mathrm{I}} - k - r$. In the special case when r is smaller than $p\frac{1}{2}V_{\mathrm{J}}(\alpha) + (1-p)V_{\mathrm{I}} - k$, the entrepreneur set $d_{\mathrm{P}} = \varepsilon$, with $\varepsilon \to 0$, and requests a transfer τ_{P} from the investor at date 0 such that $p\frac{1}{2}V_{\mathrm{J}}(\alpha) + (1-p)V_{\mathrm{I}} - k - \tau_{\mathrm{P}} = r$.

Like the Q contract, P is not renegotiation-proof in regions A_1 and A_2 because in the good state e and i will renegotiate to entrepreneur control, making everyone better off because $V_{\mathrm{E}} \geq V_{\mathrm{J}}(\alpha)$. In region A_3, the possibility of renegotiation places an upper bound $d_{\mathrm{P}}^{\max} = V_{\mathrm{I}}$ on d_{P}, and hence on the return that i can expect to receive $R_{\mathrm{P}}^{i\max} = V_{\mathrm{I}} - k$. Thus:

Lemma 4. *The* P *contract is implementable in its initial form only in region A_3, as long as the investor's cost of capital r is smaller than $R_{\mathrm{P}}^{i\max}$, in which case it yields an expected payoff R_{P}^{e*} to the entrepreneur.*

This contract closely resembles the two main categories of preferred equity contracts observed in practice. *Straight preferred contracts* (and the similar participating preferred contracts) typically specify the redemption value of the investment (say d), the redemption date (say date 1/4), and the amount of common stock to be issued in combination with the preferred stock, which gives the investor some cash flow rights in addition to the prespecified redemption value ("double-dipping"). If the company cannot make the redemption payment, the assets are liquidated, with the proceeds accruing to the investor first ("liquidation preference"). This is very similar to the P contract with strictly positive equilibrium d.

Convertible preferred contracts give the investor the choice between redeeming his stock at the prespecified redemption value d, and converting it into common stock. In the bad state, the investor does not convert, thus forcing liquidation and making use of the liquidation preference attached to his security to extract as much out of the liquidation value as possible. In contrast, in the good state he converts, provided that the rents he can get with the common stock after conversion is higher than the redemption value. This resembles the P contract when d tends to zero. Accordingly, in what follows we call the P contract CP equity when equilibrium d tends to zero, i.e., when $r \in [0, R_{\mathrm{CP}}^{i\max}]$ with $R_{\mathrm{CP}}^{i\max} = p\frac{1}{2}V_{\mathrm{J}} + (1-p)V_{\mathrm{I}} - k$; and SP equity when $d > 0$, i.e., when $r \in (R_{\mathrm{CP}}^{i\max}, R_{\mathrm{SP}}^{i\max}]$ with $R_{\mathrm{SP}}^{i\max} = R_{\mathrm{P}}^{i\max}$. Note that the SP contract is more "investor-friendly" than the CP contract: it allows the investor to "double-dip" (in the good state) by claiming the redemption payment d in addition to the share of the total payoff $\frac{1}{2}V_{\mathrm{J}}$.

4.5. Entrepreneur's Contractual Portfolio

In the foregoing analysis, we have characterized four types of contracts and the conditions under which each one is implemented in its initial (renegotiation-proof) form. We focus on renegotiation-proof contracts simply because—as shown in the online appendix—renegotiated contracts are all equivalent to, or dominated by, at least one of the renegotiation-proof contracts. The intuition comes from the fact that the renegotiated outcome of a contract can always be replicated with a renegotiation-proof contract. However, the same outcome, when it is the result of renegotiation rather than of initial contractual terms, may in some cases require the investor to give up some rents in renegotiation that he could have kept with a renegotiation-proof contract. In such cases, the maximum payoff $R^{i\max}$ to the investor, and the threshold level of r below which the project can be financed, are lower with the renegotiated contract than with the renegotiation-proof one; and there are thus projects that can be financed with the latter but not with the former. For example, in region A_1, renegotiated DR yields the same payoff to the entrepreneur as renegotiation-proof SD; but is weakly dominated because there exists a range of values of r over which only renegotiation-proof SD is feasible.

In addition to the four contracts just described, several other types of contracts could in principle be offered by e to the investor at date 0. For example, unconditionally assigning investor control, which may be optimal in the adapted AT model in §3 (where there is no interim profit opportunity), could still be offered by e in our model with potential cash flows at date 1/4. This and other types of contracts, however, are shown never to be optimal in our framework. These results imply the following proposition.

Proposition 1. SD, DR, Q, *and* P *are, in their renegotiation-proof form, the only potentially optimal contracts when the entrepreneur has full bargaining power in renegotiation. All other contracts are suboptimal.*

5. Optimal Contracting

At date 0, e chooses renegotiation-proof contract $H \in \{\mathrm{SD}, \mathrm{DR}, \mathrm{Q}, \mathrm{P}\}$, which maximizes her expected payoff, R_H^e, subject to implementability. We examine the three entrepreneur/investor effort complementarity regions A_1, A_2, and A_3 in turn.

5.1. Low Entrepreneur/Investor Effort Complementarity—Region A_1: $\alpha \in [0, \underline{\alpha})$

In region A_1, e's optimization program at date 0 is easy to solve. One can deduce from Lemmas 1–4 that the SD contract is the only contract implementable in its initial form in that region, and hence must be the optimal contract for e.

Proposition 2. *In region A_1, where entrepreneur/investor effort complementarity is low,* SD *is the optimal contract for the entrepreneur.*

The intuition is simple. When effort complementarity α is low, participation by both e and i is relatively unproductive, and its benefits are dominated by the private and incentive benefits associated with giving full control to either i or e. Joint control therefore yields a smaller total payoff than the other two control allocations, namely, investor control and entrepreneur control, and this creates scope for renegotiation whenever joint control occurs. As shown in §4, contracts like DR, Q, and P, which are based at least in part on joint control, are not renegotiation-proof in region A_1. From Proposition 1, we know that in their renegotiated form, these contracts are suboptimal, leaving renegotiation-proof SD, which does not rely on joint control, as the optimal contract.

5.2. Moderate Entrepreneur/Investor Effort Complementarity—Region A_2: $\alpha \in [\underline{\alpha}, \bar{\alpha})$

When effort complementarity is moderate, the benefits from joint participation and efforts are larger than the benefits associated with investor control, but smaller than those associated with entrepreneur control, and accordingly, $V_I \le V_J(\alpha) < V_E$. For this reason, equity-type contracts are not renegotiation-proof in region A_2: as shown in §4, renegotiation from joint control to entrepreneur control would always occur in the good state of the world. Because renegotiated contracts were shown to be suboptimal, only renegotiation-proof DR and SD remain potentially optimal here.

Low opportunity cost of capital. Comparing R^e_{DR} and R^e_{SD}, it is easy to see that e's expected return from a date 0 standpoint is higher with DR than with SD. In the good state of the world, both contracts yield the same expected payoff associated with entrepreneur control (V_E), while in the bad state DR leads to joint control, which is superior to investor control associated with SD: $V_J(\alpha) > V_I$. Thus, DR is e's preferred choice, and is chosen whenever feasible, i.e., whenever $R^{i\max}_{DR} \ge r$.

High opportunity cost of capital. In contrast, when the cost of capital $r > R^{i\max}_{DR}$, the project cannot be financed with DR because i's participation constraint cannot be satisfied: the maximum expected payoff that e can commit to return to i with that contract, $R^{i\max}_{DR}$, is smaller than the cost of capital r. The project, however, may be financed with SD. Indeed, comparing $R^{i\max}_{SD}$ and $R^{i\max}_{DR}$, we note that

$$R^{i\max}_{SD} - R^{i\max}_{DR} = p\big(V_I - \tfrac{1}{2}V_J(\alpha)\big) + (1-p)\big(V_I - \tfrac{1}{2}V_J(\alpha)\big) = V_I - \tfrac{1}{2}V_J(\alpha) > 0, \quad (1)$$

implying that if the cost of capital $r \in (R^{i\max}_{DR}, R^{i\max}_{SD}]$, the project can be financed with an SD contract, but *not* with a DR contract. In the bad state where default occurs, with SD the entrepreneur can commit not to interfere in period 2 by relinquishing all controls to i in case of default: i gets all of V_I. In contrast, with DR the entrepreneur cannot commit not to extract a slice $\frac{1}{2}V_J(\alpha)$ of the total surplus, leaving only $\frac{1}{2}V_J(\alpha) < V_I$ to i. In the good state, the maximum interim repayment d that e can commit to repay is the transfer that would have to be paid to i in case of default and renegotiation. This amount is V_I with SD and $\frac{1}{2}V_J(\alpha) < V_I$ with DR. In other words, SD puts e into a worse bargaining position in renegotiation; consequently, e is willing to pay more to avoid it. In sum:

Proposition 3. *In region A_2, where entrepreneur/investor effort complementarity is moderate,* DR *is optimal for the entrepreneur when the investor's cost of capital is relatively low. At higher levels of cost of capital,* SD *becomes the optimal contract.*

Intuitively, control rights provide access to rents, and hence DR, which, relative to SD gives more control rights to e, also gives her a higher expected return. But DR gives relatively less control to i, and hence a lower expected payoff, which implies that the threshold level of r above which his participation constraint fails to hold, is lower. Beyond that threshold, DR is no longer feasible, while SD, which is more "investor-friendly," still is.

5.3. High Entrepreneur/Investor Effort Complementarity—Region A_3: $\alpha \in [\bar{\alpha}, \hat{\alpha})$

When effort complementarity is high, participation by both parties is crucial to the success of the venture, and joint control generates the highest total surplus: $V_J(\alpha) \ge V_E > V_I$. Accordingly, in region A_3, it is debt-type contracts, which rely on entrepreneur control in the good state, that are not implementable in their initial form because renegotiation to joint control would always occur. Hence, in region A_3, only Q and P are potentially optimal.

Low opportunity cost of capital. It is easily verified that $R^e_Q > R^e_P$, i.e., that e expects a higher return with contract Q than with contract P. In the good state of the world, both contracts yield $V_J(\alpha)$; in the bad state, P leads to liquidation and yields payoff V_I, which is strictly smaller than $V_J(\alpha)$, the payoff associated with Q. Thus, Q is e's preferred choice whenever feasible, i.e., when $R^{i\max}_Q \ge r$.

High opportunity cost of capital. When $r > R_Q^{i\max}$, the project cannot be financed with Q. It turns out, however, that $R_P^{i\max} - R_Q^{i\max} = R_{SD}^{i\max} - R_{DR}^{i\max} > 0$: the maximum expected payoff that e can commit to return to i is larger with a P contract than with a Q contract, for reasons similar to the ones explaining $R_{SD}^{i\max} - R_{DR}^{i\max}$. The key implication is simply that when the cost of capital $r \in (R_Q^{i\max}, R_P^{i\max}]$, the project can be financed with a P contract, but *not* with a Q contract. Thus:

Proposition 4. *In region A_3, where entrepreneur/investor effort complementarity is high,* Q *is optimal for the entrepreneur when the investor's cost of capital is relatively low. At higher levels of cost of capital,* P *becomes the optimal contract.*

The intuition behind this proposition is the same as the one behind Proposition 3, simply replacing DR by Q and SD by P.

Recall that when $r \in [0, R_{CP}^{i\max}]$, the P contract takes the form of CP, and when $r \in (R_{CP}^{i\max}, R_{SP}^{i\max}]$ with $R_{SP}^{i\max} = R_P^{i\max}$, it takes the form of SP. One can readily verify that $R_{CP}^{i\max} > R_Q^{i\max}$, which has an interesting implication in our model. The part of region A_3 where P is optimal, i.e., where $r \in (R_Q^{i\max}, R_P^{i\max}]$, can be divided into two subregions. In the area of region A_3 where $r \in (R_Q^{i\max}, R_{CP}^{i\max}]$, the optimal contract is CP: the entrepreneur can convince the investor to put down the initial capital requirement k with a P contract, even with $d \to 0$, as the prospect of joint control in the good state is sufficient to satisfy i's participation constraint. In the area where $r \in (R_{CP}^{i\max}, R_P^{i\max}]$, the optimal contract is SP: as r increases, it becomes necessary to promise a strictly positive date 1/4 redemption payment d to i to convince him to invest, in addition to the share of date 1 surplus he was already getting with the convertible preferred contract. In sum:

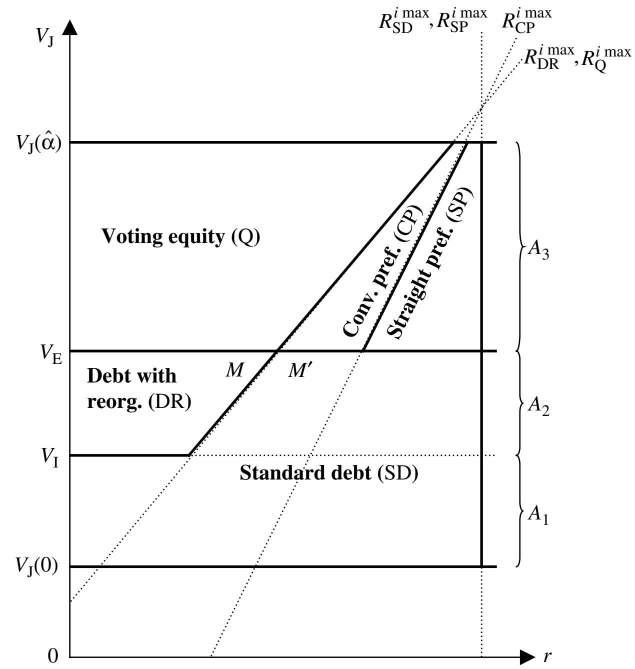
Corollary 1. *Two types of* P *are optimal in region A_3.* CP *is the optimal contract when $r \in (R_Q^{i\max}, R_{CP}^{i\max}]$, while* SP *is the optimal contract when $r \in (R_{CP}^{i\max}, R_P^{i\max}]$.*

6. Overall Picture: A Theory Consistent with Empirical Regularities

The foregoing results imply that the optimal contract depends on two primary factors: entrepreneur/investor effort complementarity, and cost of capital. To see this point more clearly, we represent the entrepreneur's optimal contractual choice graphically in a $(r, V_J(\alpha))$ space in Figure 1.[25]

[25] We represent the entrepreneur's optimal contractual choice graphically in a $(r, V_J(\alpha))$ space instead of (r, α) because it is simpler graphically. Because $V_J(\alpha)$ is a continuous and strictly increasing function of α, this is without loss of generality.

Figure 1 Optimal Contracts



Notes. Each line associated with contract H on the figure represents an "iso-return" line for the investor, drawn at $R_H^{s\max} = r$: It is the locus of points for which that contract yields an expected return for the investor that is exactly equal to his opportunity cost of capital, leaving him indifferent between investing and not investing. A project can be financed with contract H if and only if it yields a return to the investor that is weakly superior to r, if and only if it corresponds to a point located west of the iso-return line. Thus, at each point, the optimal contract maximizes the entrepreneur's return among all implementable contracts that have an iso-return line east of that point. For example, at point M both SD and DR are feasible because this point lies west of both iso-return lines. Contract DR, which in region A_2 yields a higher return to the entrepreneur, is optimal. In contrast, point M' lies east of the DR iso-return line, but west of the SD iso-return line, and thus at that point SD is the only feasible contract, and hence the optimal one. Note that the figure is drawn for a probability success $p = 1/2$. We do this for simplicity, but the results of the paper hold for all $0 < p < 1$.

Consistent with Empirical Regularity 1, our model predicts that financial instruments commonly used in practice, such as voting equity, convertible and straight (or participating) preferred equity, as well as secured and unsecured debt, can emerge as optimal. This is illustrated in Figure 1, which also helps us shed light on the other stylized facts described in §2.

An important question in entrepreneurial finance concerns the trade-off between debt and equity: Which should be used, and when? It is sometimes suggested that entrepreneurs prefer debt-type instruments but are forced to turn to equity instruments because they lack tangible assets to secure the debt. Yet this explanation seems incomplete because unsecured debt is readily available: 40% of loans taken by small firms are unsecured (Leeth and Scott 1989). We propose a different explanation:

Proposition 5. *Debt-type contracts such as* SD *and* DR *tend to be optimal for projects with relatively low* *entrepreneur/investor effort complementarity. In contrast, equity-type contracts such as voting equity, convertible preferred equity, and straight preferred equity tend to be optimal for projects with relatively high effort complementarity.*

A key difference between debt-type contracts and equity-type contracts is that equity-type contracts place more emphasis on joint control. Equity-type contracts thus encourage simultaneous, collaborative efforts by both the entrepreneur and the investor. As effort complementarity rises, the relative value of these collaborations, and of the contracts that facilitate them, also increases.

This result can explain Empirical Regularity 2—that while high-growth entrepreneurs use equity-type instruments predominantly, lifestyle entrepreneurs use debt-type instruments mostly—inasmuch as there is more investor/entrepreneur effort complementarity in high-growth ventures than in lifestyle ventures. Effort complementarity is indeed a dimension along which the two venture types differ sharply. High-growth entrepreneurs need the advice and expertise of the investor to complement their own technical knowledge and generate growth. For this reason they turn to VCs, who can offer not only cash, but also a number of growth-enhancing complementary services (Bygrave and Timmons 1992). VCs provide value-added services in the form of mentoring (MacMillan et al. 1988), strategic planning and help obtaining additional financing (Gorman and Salhman 1989, Erhlich et al. 1994). They also help entrepreneurs recruit key managers (Hellmann and Puri 2002), facilitate the development of cooperative strategies such as licensing and strategic alliances (Gans et al. 2002, Hsu 2006), speed up the time to bring products to market (Hellmann and Puri 2000), and provide certification of startup quality to less-informed outsiders (Megginson and Weiss 1991, Stuart et al. 1999, Hsu 2004). Interestingly, Sapienza et al. (1996, p. 440) find that "VCs [add] most value to those ventures already performing well," suggesting that these value-added services are indeed complementary to entrepreneurial effort. In contrast, lifestyle entrepreneurs have lower growth expectations, and as shown in Table 2, they do not use the complementary services available from VCs, preferring instead the "cash-only" services offered by banks.

Beyond the debt-equity trade-off, the entrepreneur makes more specific choices. Within the equity-type category, for example, how does the entrepreneur decide between the options available to her?

Proposition 6. *When equity-type contracts are optimal (region A_3), the entrepreneur switches from* Q *to* CP, *and in turn to* P, *as the investor's cost of capital rises.*

As r increases, the entrepreneur must increase the investor's expected payoff to secure financing, and gradually switches to contractual offers that are relatively more favorable to the investor. This is consistent with Empirical Regularity 3, which points to *temporal* and *geographic* differences in the type of security used in high-growth ventures. Our model suggests that the switch from straight preferred equity to convertible preferred equity, which occurred in high-growth ventures in the United States in the mid-1980s may have been the result of a decrease in investors' cost of capital. This is consistent with Hardymon and Lerner (2001), who attribute these temporal changes to the increase in competition among VCs that took place at that time, and that may have led to a fall in required returns.

Moreover, we propose that the current contractual differences between the United States and Europe, where convertible securities and common equity are predominantly used, respectively, may result from regional differences in cost of capital, with U.S. VCs requiring higher rates of return than their European counterparts, and inducing entrepreneurs to offer more investor-friendly contracts. This explanation is consistent with Manigart et al. (2002), who report that compared to U.S. VCs, Belgian, British, Dutch, and French VCs require significantly lower rates of return.[26]

Within the debt-type category, the entrepreneur also has a choice available to her, between standard debt and debt with reorganization:

Proposition 7. *When debt-type contracts are optimal (regions A_1 and A_2), the entrepreneur chooses* SD *over* DR *when* (1) *entrepreneur/investor effort complementarity is relatively low, or* (2) *the investor's cost of capital is relatively high.*

The intuition for this follows from the combined discussions of optimality in regions A_1 and A_2. When effort complementarity is low, so is the benefit from joint control, and reorganization may be less attractive relative to liquidation. In that case, SD helps the enterpreneur commit to liquidation following default, which is ex ante optimal. Even if effort complementarity is sufficiently high for the entrepreneur to prefer

[26] Various factors may explain why required rates of return are higher in the United States than in Europe such as, e.g., the relative maturity of venture capital markets in the United States (Manigart et al. 1997) or the higher degree of sophistication amongst U.S. VCs (Kaplan et al. 2006). Manigart et al. (2002) also suggest that while independent U.S. VCs tend to maximize investment returns, European VCs, who are funded in larger proportion by the public sector and by corporations, may have somewhat different objectives—e.g., job creation, regional development, product market complementarities—achievable only at the expense of a lower return.

DR, if the investor's cost of capital is high enough, she may have to offer the more investor-friendly SD to secure financing.

Interpreting SD and DR as secured and unsecured debt, respectively (see §4), this result provides a plausible explanation for Empirical Regularity 4, which suggests that loans in more mature startups, with shorter maturity, or taken by professional or financial firms (relative to retail), are all significantly less likely to be secured. To the extent that there are more banks competing to finance more mature startups than earlier-stage ventures, the rates of return required by banks might be lower for mature startups, which favors unsecured debt over secured debt. Similarly, the investor's cost of capital is also likely to be lower on loans with shorter maturity, favoring unsecured debt. Finally, our model suggests that professional and financial firms, with a large proportion of intangible human assets, should place a high value on the collaborative efforts of entrepreneurs and investors in reorganization—rather than on liquidation—following default, and therefore should have a higher incidence of unsecured—rather than secured—financing relative to retail-oriented firms.

7. Concluding Remarks

We propose a general theory of financial contracting in entrepreneurial ventures broadly defined, including both high-growth ventures and lifestyle ventures. Several contracts resembling the financial instruments commonly used in practice can emerge as optimal, depending on two factors: entrepreneur/investor effort complementarity, and the investor's cost of capital. Our results address key contracting issues, such as the debt/equity trade-off, and the optimal contractual choices within the equity or debt categories; and shed light on the various empirical regularities discussed in §2.

The results of our model extend beyond financial contracting, and have implications for the management literature more broadly. In entrepreneurship, for example, the issue of managerial oversight by the investor continues to receive much attention; and this is a dimension along which high-growth ventures and lifestyle ventures differ sharply. Investors in high-growth ventures monitor entrepreneurial activity and venture performance very closely. Evidence for this can be gleaned from the VCs' substantial power on the boards of their portfolio companies. Sahlman (1990) and Kaplan and Strömberg (2002) report that VCs are nearly always represented on the board and, compared to founders, hold more seats (41.4% versus 35.4%) and have majority more often (25.4% versus 13.9%). Board representation, in turn, has a strong impact on the VCs' ability to monitor management and intervene in the venture (Kaplan and Strömberg 2004).[27] On the other hand, in lifestyle ventures the degree of oversight by investors is much lower: The board of directors is composed predominantly of insiders rather than investors and outsiders, is controlled mainly by the entrepreneur, and consequently plays a rather limited monitoring role (Jain 1980, Rosenstein 1988).[28] These monitoring differences may be related to differences in the optimal contractual choice. As shown, high-growth entrepreneurs prefer equity-type contracts while lifestyle entrepreneurs prefer debt. To the extent that equity is associated with more intense monitoring than debt, this could explain the monitoring differences across venture types. Our model suggests that this ought to be the case when profits are not verifiable: While with equity contracts the entrepreneur voluntarily gives up monitoring rights (and hence bargaining power in renegotiation) as a commitment device to return profits to the investor, with debt-type contracts there is no need for monitoring because the threat of losing control in case of default motivates the entrepreneur to return profits to the investor through debt repayments.

Our framework also has implications for organizational sociology, where ideas related to the status, or prestige, of organizations, have received much attention recently. Entrepreneurial status comes from two primary sources: her social network, and her successful past experiences (Podolny 1993, Podolny and Phillips 1996), which bring a number of benefits. Social networks are associated with lower likelihood of venture failure (Shane and Stuart 2002), faster time to IPO (Stuart et al. 1999, Chang 2004), higher venture valuation (Stuart et al. 1999, Hsu 2007), higher likelihood of subsequent innovation (Podolny and Stuart 1995), and improved access to capital (Shane and Cable 2002, Shane and Stuart 2002). Similarly, successful founding experience for the entrepreneur improves her access to venture capital, and has a positive impact on venture valuation (Hsu 2007). Accordingly, the entrepreneur's high status enables her to "pick and choose among potential [investors]" (Stuart 1999, p. 377), who compete for high-status deals and therefore require a

[27] Furthermore, entrepreneurs regard monitoring of venture performance as one of the VCs' primary activities (Rosenstein et al. 1990, 1993; Ehrlich et al. 1994), as do the VCs themselves (Rosenstein 1988, MacMillan et al. 1988).

[28] Also consistent with this differential degree of monitoring in high-growth and lifestyle ventures, Gompers (1995) finds that lower tangible assets to total assets ratios, higher market-to-book ratios, and greater R&D intensities, all of which are associated with high-growth ventures rather than lifestyle ventures, lead to more frequent monitoring.

lower rate of return.[29] Entrepreneurial status may thus affect financial contracting through its impact on the required rate of return: High-status, high-growth entrepreneurs are more likely to convince VCs to use common equity rather than preferred equity, relative to their low-status colleagues; and high-status lifestyle entrepreneurs are more likely to convince bankers to provide unsecured, rather than secured debt.

Finally, our model yields implications for the management of technology, and for intellectual property protection (IPP) in particular. Since Anton and Yao's (1994) influential paper on weak IPP and expropriation, an interesting literature has emerged, which focuses on two broad themes: The consequences of weak intellectual property rights on firms' commercialization strategies (Gans et al. 2002) and on licensing more specifically (Gans and Stern 2000); and the link between the strength of IPP and the organization (Anton and Yao 1995, Anand et al. 2004) and financing (Anand and Galetovic 2000) of R&D. We conjecture that the strength of IPP for the entrepreneur may also affect the optimal design of securities in the financing of innovation: Decreasing IPP strength could lead to a switch from preferred stock to common stock, and/or from secured to unsecured debt.[30] Formalizing the link between IPP and security design would be an interesting and fruitful avenue for future research.

8. Electronic Companion

An electronic companion to this paper is available as part of the online version that can be found at http://mansci.journal.informs.org/.

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[29] To the extent that they improve the entrepreneur's social network and status, current high-status investors may also have a negative impact on the return required by other investors in future rounds of financing.

[30] To see this, suppose that we introduced a measure of IPP in our model by assuming that, upon learning about the project at date 0, the investor can, with some probability, steal the idea from the entrepreneur and obtain some constant expected payoff. The higher (lower) this probability, the weaker (stronger) the IPP. The impact of this modification on our model is simple: an increase in the probability of expropriation works like a positive transfer to the investor, and is formally identical to a fall in his cost of capital, ceteris paribus. The prediction, then, is clear from Figure 1: Anticipating more rents extracted by the investor, the entrepreneur compensates by offering contracts that are less "investor-friendly," such as common stock or unsecured debt.

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