Organization Science

Publication details, including instructions for authors and subscription information:
http://pubsonline.informs.org

Entrepreneurial Optimism in the Market for Technological Inventions

Gary Dushnitsky,

To cite this article:
Gary Dushnitsky, (2010) Entrepreneurial Optimism in the Market for Technological Inventions. Organization Science 21(1):150-167. http://dx.doi.org/10.1287/orsc.1090.0454

Organization Science
Vol. 21, No. 1, January–February 2010, pp. 150–167
ISSN 1047-7039 | EISSN 1526-5455 | 10 | 2101 | 0150
DOI 10.1287/orsc.1090.0454

Entrepreneurial Optimism in the Market for Technological Inventions

Gary Dushnitsky
The Wharton School, University of Pennsylvania, Philadelphia, Pennsylvania 19104,
gdushnit@wharton.upenn.edu

How do potentially optimistic entrepreneurs attract prospective investors? We investigate an entrepreneur's decision to pursue either *disclosure*—where investors inspect the invention—or a *contingent payment scheme* (CPS) offer (e.g., salary deferral, royalty-based license)—where an invention's value is inferred from the entrepreneur's willingness to make her pay contingent on the invention's success. Using a parsimonious model, we highlight the role of optimism and demonstrate that it only affects CPS ex post. As a result, a novel trade-off unfolds ex ante: In choosing an action that maximizes the valuation of the invention, a moderately wealthy entrepreneur weighs *optimism discount* (affecting CPS) versus *imitation discount* (affecting disclosure). More broadly, the paper advances a view of entrepreneurs as optimists, thus departing from the prevailing approach, which characterizes entrepreneurs as opportunistic individuals who consciously pursue self-serving goals.

Key words: entrepreneur; invention; investor; optimism; over-confidence; cognitive bias
History: Published online in *Articles in Advance* July 28, 2009.

> It can take some serious mental adjustment—and a whole new set of skills—to get an invention from the drawing board to the marketplace. Right now, no one values your invention as much as you do. And you may learn that your estimation of its value is unrealistic . . . .
>
> Value is in the eye of the beholder. When inventors ask me whether I think their invention has value, I can unequivocally answer yes, because at the very least the invention has value to one person: the inventor. (Opening paragraphs of *The Inventor's Bible* [Docie 2004, p. 11])

> In many startups the founders . . . have little to offer investors besides their hopes and dreams. [They may offer] to conduct extensive due diligence or may rely on incentive schemes . . . . (*The Origin and Evolution of New Businesses* [Bhide 1999, p. 4])

Extant work indicates that entrepreneurs are optimistic regarding their abilities and future prospects (e.g., Busenitz and Barney 1997, Camerer and Lovallo 1999). To capitalize on their inventions, however, entrepreneurs have to negotiate with judicious decision makers (e.g., venture capitalists, industry incumbents) who are well aware of entrepreneurs' traits (see above quotes). This paper studies the way in which potentially optimistic entrepreneurs attract prospective investors. We depart from the prevailing approach, which characterizes entrepreneurs as opportunistic individuals who consciously pursue self-serving goals, and instead advance a view of entrepreneurs as optimists.

As the opening quotes suggest, entrepreneurs typically offer *disclosure* or a *contingent payment scheme* (CPS) when approaching prospective investors (see Table 1). The term *disclosure* refers to the practice of attracting investors by first revealing the invention (e.g., showcasing a prototype or handing over blueprints). Investors carefully inspect the invention and, based on their due diligence, decide whether to seek the rights for it in return for a certain payment. The term CPS refers to the practice of attracting investors by offering a payment scheme that is contingent on success (e.g., a royalty-based license). Entrepreneurs might also offer to defer a salary or post a collateral. The invention is fully revealed only if investors accept the CPS offer. Using a parsimonious model, we incorporate previously documented entrepreneurial traits (i.e., wealth constraints and imitation concerns) and address the question: *Would potentially optimistic individuals employ a contingent payment scheme or disclosure when approaching a prospective investor?*

Prior research suggests that entrepreneurs will tie their compensation to outcomes when they believe their invention to be of high quality and that this contingent payment offer reassures prospective investors. This reassurance may be misplaced if entrepreneurs' beliefs that they will succeed are misplaced—which may happen when entrepreneurs are overly optimistic. We show that if optimism is very common, wary investors may depress inventions' valuation, an occurrence we term "optimism discount." The entrepreneurs may therefore opt to disclose their inventions to assure investors and avoid depressed valuations—even though this increases the risk of imitation. Thus this paper explores how the effect of optimism differs from the conventional implications of informational problems (i.e., adverse selection and moral hazard). The formal analysis uncovers a theoretically novel trade-off: In choosing an action that maximizes

Table 1 Entrepreneurs' Signaling Mechanisms

	Contingent payment scheme	Disclosure
Description:	An offer to make the distribution of payments contingent on outcomes, in return for rights to the invention	Presenting technical specifications of the invention prior to contracting
Examples:	A licensing contract; deferral of salary; preferred shares	Surrendering product's blueprints; offering access to laboratory notes; providing a product-prototype
Invention is revealed…	After contracting	Prior to contracting
Investors' perspective:	Investors infer invention's quality *indirectly*.	Investors assess invention's quality *directly*.
Entrepreneur's perspective:		
Pros	Ex-ante imitation is impossible.	Investors directly and accurately value the invention.
Cons	Investors may discount entrepreneurs' action as "too optimistic."	Ex-ante imitation is likely.

the valuation, a moderately wealthy entrepreneur weighs *optimism discount* (associated with CPS) against *imitation discount* (associated with disclosure).

The contribution of this work is fourfold. First, a formal model affords exact definitions of entrepreneurial traits and actions. The setup draws on a rich discussion and a careful mapping of real-world settings. The formalization facilitates an added precision that is often lacking in verbal analysis. In particular, we parsimoniously characterize entrepreneurial optimism. Whereas extant literature commonly views entrepreneurs as opportunistic, we advance a view of entrepreneurs as optimists and study the consequences.

Second, the model is useful in isolating key effects and uncovering nuanced trade-offs. To date, the literature suggests that CPS and disclosure are affected by wealth constraints and imitation risk, respectively. Scholars who study both actions show that wealthy entrepreneurs capture greater value via CPS rather than via disclosure (e.g., the seminal work of Anton and Yao 1994).[1] Our model underscores a third effect—the optimism effect—and integrates it with the wealth and imitation effects. It is shown, for the first time to our knowledge, that the presence of optimism affects the trade-off between CPS and disclosure (i.e., optimism shapes entrepreneurial choice through its effect on investors' valuation of CPS). The analysis yields a novel predication: In the presence of optimism, even entrepreneurs who are moderately wealthy may prefer disclosure to CPS.

Third, for management scholars the paper underscores more broadly the power of a formal approach to management theory. A key result is that even an "irrational" concept such as optimism can be understood not only through inductive studies derived from field observations but also via a logical analysis deduced from economic first principles. The formal analysis of an entrepreneur's choice is instrumental in articulating the otherwise subtle trade-off between CPS and disclosure.

Finally, the paper has implications for practice. The insights are particularly important nowadays as markets for inventions are rapidly expanding (Arora et al. 2001). We explicitly identify business endeavors—online invention marketplaces (e.g., www.ibridgenetwork.org, www.vfinance.com)—that could benefit from our analysis, and we expand on these issues in the conclusions.

The paper proceeds as follows. Section 1 reviews entrepreneurial traits and expands on optimism. The formal model is presented in §2. Section 3 delineates the differences between entrepreneurial optimism and opportunism, and §4 concludes.

1. Markets for Entrepreneurial Invention: Key Characteristics

We investigate technology-based entrepreneurs and the actions they undertake. A few examples include a biotech professor pursuing a relationship with a leading pharmaceutical firm or an Internet entrepreneur seeking to capitalize on an idea. An entrepreneur's attributes, an investor's features, and industry characteristics vary greatly by settings. Yet they share four fundamental factors. We review these factors, expanding on the one that has received the least attention in formal work: entrepreneurial optimism.

Asymmetric Information. Inventions are a result of entrepreneurs' insight (Schumpeter 1934). In the absence of tangible assets or an established track record, investors face difficulties in evaluating an invention's quality. Consequently, they may forgo relationships (e.g., investment or licensing) with entrepreneurs. That is, information asymmetries give rise to adverse selection and can result in market failure (Akerlof 1970). This is a salient problem in early-stage ventures (Gompers 1995).

Wealth Constraints. Entrepreneurs face a conundrum. They need to raise capital but have limited collateral to offer. It follows that the likelihood of entering entrepreneurship increases with personal wealth (Evans and Leighton 1989, Evans and Jovanovic 1989). The Panel Study of Entrepreneurial Dynamics shows that 67% of nascent entrepreneurs had to solicit external capital (Kim et al. 2006). In sum, would-be entrepreneurs often face wealth constraints.

Weak Intellectual Property Rights (IPR) Protection. Entrepreneurs find it difficult to maintain ownership over their ideas partly because IPR mechanisms such as patents do not offer full protection (Teece 1986, Levin et al. 1987, Arora 1995, Cohen et al. 2001). Specifically, inventions have the economic properties of a public good; investors cannot be prevented from using them once they are revealed (Arrow 1962).

Entrepreneurial Optimism. Research shows that individuals, managers, and engineers tend to overestimate their future prospects and relative skills (Taylor and Brown 1988, March and Shapira 1987, Zenger 1994, Shapira 1995). Over the past decade, a small yet growing body of work integrates optimism into entrepreneurship work. Because the concept of optimism is critical to this paper, we (a) review relevant empirical work, (b) discuss related explanations, and (c) explicate our modeling approach.

A substantial fraction of the entrepreneurial population exhibits undue optimism. An optimistic entrepreneur overestimates the prospects of the invention and may act in a way that is subjectively advantageous but can be objectively detrimental. For example, the U.S. Small Business Administration (1997) reports that 15% of individuals who are self-employed earn less than the minimum wage. Similarly, Moskowitz and Vissing-Jorgensen (2002) find that entrepreneurs are liable to substantial idiosyncratic risk yet earn returns that are lower than the return on a diversified portfolio. Only 34% of startups survive after ten years. Conditional on survival, however, the returns are greater. The authors conjecture that individual disposition offers one viable explanation: Entrepreneurship is attractive if individuals are optimistic about the probability of their survival.[2]

Åstebro (2003) studies a sample of 1,091 inventions evaluated by the Canadian Inventor's Assistance Program (IAP). The return on these inventions was unattractive; it was notably lower than the return on a portfolio of risky public equity. Only 75 inventions reached the market, and even they exhibited a negative median return. Hence, he attributes entrepreneurial pursuit to unrealistic optimism. Using the same data, Åstebro et al. (2007) find that 51% (29%) of individuals continue to spend time (money) on their invention even after specific IAP advice to cease all efforts.

In a seminal experiment, Camerer and Lovallo (1999) offer direct evidence of the relationship between optimism and entrepreneurship. They ask business school students whether they would enter a market if success is a function of skill. Most students who would enter exhibit optimism, thinking that the total profit earned by all entrants would be negative, but their own profit would be positive. Moreover, the pattern is stronger when students self-select to enter.[3]

Analyses of practicing entrepreneurs yield similar results. In a survey of 2,994 U.S.-based business owners, Cooper et al. (1988) ask, "What are the odds of your business succeeding?" and "What are the odds of any business like yours succeeding?" The positive responses to the former greatly exceed those to the latter. That is, a large fraction of the entrepreneurs perceives their prospects to be higher than what is warranted according to historical success rates. Landier and Thesmar (2009) analyze a sample of over 30,000 French individuals. They find a significant fraction of entrepreneurs holds expectations of future sales (as surveyed by the French statistical office) that systematically overshoot realized growth (derived from tax files).

Entrepreneurs exhibit a stronger optimistic disposition compared to employed individuals. Busenitz and Barney (1997) compare 124 founders to 95 executives. They find the former group overestimates its probability of being right. Arabsheibani et al. (2000) study data for 23,000 British households and find that the self-employed expect better financial outcomes than employees yet experience worse realizations. On average, a self-employed individual is twice as likely to err optimistically (realization below forecast) than pessimistically (realization above forecast).

The literature offers a host of explanations for these empirical findings. Weinstein (1980) points to cognitive (e.g., availability or representative biases; Tversky and Kahneman 1974) and motivational drivers (i.e., maintaining self-esteem via overestimation of positive events; Kirscht et al. 1966). He finds that optimism is prevalent when an event is construed as controllable and the individual has a personal stake in its outcome—two features characteristic of entrepreneurship. Recent work explains an optimistic disposition as a result of rational choice (Van den Steen 2004, Landier and Thesmar 2009). The intuition is as follows. Assume that on average there is realism in the population. Individuals are equally likely to over- or underestimate the probability of success. Individuals who over- (or under-) estimate future prospects will self-select to pursue (or forgo) entrepreneurship. Thus, on average, individuals who opt to become entrepreneurs hold optimistic beliefs.[4]

To conclude, empirical evidence suggests that a large part of the entrepreneurial population is unduly optimistic (e.g., realized performance falls below initial forecasts).[5] Because it is difficult to discern an individual's disposition ex ante, scholars and investors view entrepreneurs as a collective characterized by optimism (Manove and Padilla 1999, Shane and Venkataraman 2000). Namely, optimism is attributed to entrepreneurs as a *group* even though it might not characterize every *individual* entrepreneur. And entrepreneurs understand that. Thus an individual entrepreneur may believe herself to be a realist and at the same time recognize she is part of a group that is construed as overly optimistic.

We model an entrepreneur's traits accordingly. She always believes herself to be a realist and behaves like

one. Except for her possible optimism and the subjective perception it induces, the entrepreneur is a rational decision maker. She is forward-looking, understands the nature and implications of market interactions, and pursues a course of action aimed at maximizing her anticipated payoff. This "near-rational" approach is consistent with both empirical evidence and extant theories (Manove and Padilla 1999, Shane and Venkataraman 2000). It affords formal analysis of the strategic interaction between entrepreneurs and rational investors. Moreover, because it is comparable to existing models (where players are both rational and realists), this modeling approach underscores the effect of optimism.

Last, we emphasize that optimism is qualitatively different from opportunistic agency-behavior, which is commonly attributed to entrepreneurs. The latter denotes conscious behavior affecting one's (lack of) effort, whereas the former describes a biased evaluation of the invention. Section 3 expands on this point.

2. A Model of Entrepreneurial Actions

This section considers an entrepreneur, E, who can bring an invention to the market only through a prospective investor, firm i.[6] We model the entrepreneur's choice between CPS and disclosure in the presence of optimistic entrepreneurs. To that end, we formalize each entrepreneurial action and derive the optimism discount (§2.1) and imitation discount (§2.2). A supergame of entrepreneurial choice (§2.3) builds on these insights and formalizes the CPS-disclosure trade-off.

The entrepreneurial invention is either useful (good quality, $Q = G$) or useless (bad quality, $Q = B$) with probability p and $1 - p$, respectively ($p \in [0, 1]$). E does not observe the quality of the invention, Q, directly. Rather, E observes a signal about the invention's quality, q ($q = g, b$). E may be one of two types: either a realist ($T = R$) or an optimist ($T = O$) with probabilities ϕ and $1 - \phi$, respectively ($\phi \in [0, 1]$). A realist observes a fully revealing signal, but an optimist always observes a good signal irrespective of an invention's quality. Formally,

$$\Pr\{g \mid R, G\} = 1, \quad \Pr\{b \mid R, B\} = 1, \quad \Pr\{g \mid O\} = 1. \tag{1}$$

E always believes herself to be a realist and behaves in the same way that a realist with that signal would behave. In other words, both an optimistic entrepreneur and a realistic entrepreneur are rational decision makers who—other than their perception of an invention's quality—understand the implication of their own and others' actions and ultimately seek to maximize their own payoffs. Such a player is often referred to as a near-rational decision maker. Finally, E has limited wealth, L, and incurs a setup cost of F (e.g., business plan preparation, feasibility test, etc.).

The profit of firm i, gross of any contractual payments to E, is determined by the quality of the invention and denoted by Π^M, Π^R, Π^L ($\Pi^M > \Pi^R > \Pi^L$). If firm i utilizes a useful invention ($Q = G$), it grosses a maximum profit, Π^M. The firm grosses low profit, Π^L, if it does not hold a useful invention. If the firm contracts with an entrepreneur who holds a useless invention ($Q = B$), it grosses Π^L as well. Finally, firm i earns only an intermediate profit, Π^R, if it uses the entrepreneurial invention without a contract and the entrepreneur retaliates (§2.2 expands on this issue).

The firm knows the probabilities of a useful or useless invention as well as the fraction of realists and optimists in the population. However, it is uninformed as to the type of a focal E or the quality of E's invention. We also allow for an independent discovery of the invention by the firm; with probability α ($\alpha \in [0, 1]$), firm i discovers a useful invention. All parties are risk neutral and maximize expected payoff.

2.1. Contingent Payment Scheme

Assume an entrepreneur pursues a contingent payment scheme (CPS). She attempts to attract investors by making her payoff contingent on the invention's quality. Offering a licensing contract that specifies contingent royalty payments exemplifies such an action. Willingness to defer salary constitutes yet another example (Zott and Huy 2007, p. 88):

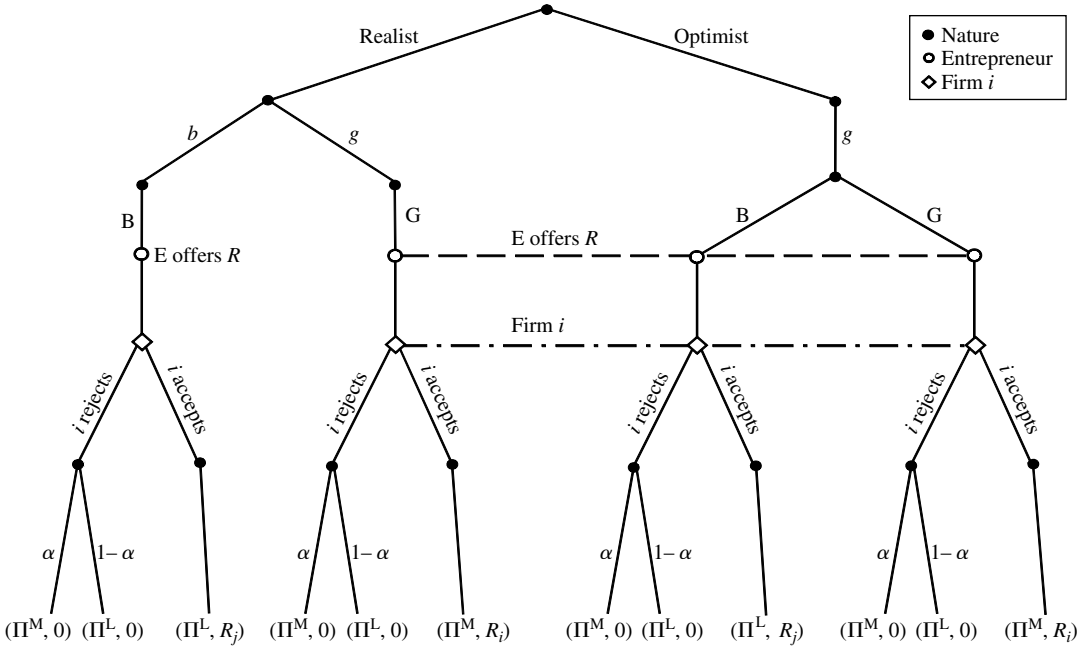
> We asked people to defer salary at the time. People turned back and wanted to defer more than we'd asked for. It was very moving, actually, for the management team. The investors were awe-struck by the fact . . . . They said that after they closed the financing round, it was one of the key things that really gave them belief in the business. (Founder, WIRE)

> Early on in the investment round, we started to include the fact that my partner was going to work for the first six months without any pay which the investors were very impressed with. (Cofounder, TRAVEL)

These actions are not profitable for people who know their inventions are useless. As a result, an individual who undertakes such an action leads investors to infer that they are faced with a useful invention. Along these lines, Lazear (1999) analyzes inventors' compensation schemes and concludes they are meant to resolve adverse selection due to information asymmetries at the time of contracting.

Formally, E first specifies a CPS contract, **R**, to firm i and reveals the invention only if the contract is accepted. A contract **R** between E and firm i represents a vector $R = (R_i, R_j)$, when R_x is the payment by firm i to E in the event that state x occurs (states i and j correspond to gross profit when firm i has or does not have, respectively, possession of a useful invention). Note that the contract is based on market outcomes rather than on

Figure 1 An Extensive Form of the CPS Game Tree



Notes. Players' proceeds are detailed as ([*Firm i profit*], [E *contractual payoff*]). Absent a contract, E receives no payoff, signified by "0." We make a presentational simplification, focusing on scenarios where E makes contractual offers and abstracting from those where E avoids making an offer. What would the nonreported branch look like? An "E-makes-no-offer" branch would have branches and payoffs similar to the "E-makes-offer-firm-rejects" branch that extends from that same node and would be part of that information set.

the quality of the invention. We assume that the latter is nonverifiable. Namely, the source and the quality of an invention may be difficult for a third party (e.g., the courts) to verify. Following Anton and Yao (1994, 2002), we assume that a third party can only verify events, i.e., a firm's market outcomes, that are consequences of using the invention.[7]

Consider the effect of entrepreneurial optimism on a contingent payment contract. Although the type of the entrepreneur, T, is unknown to all players (including E), the population probabilities of a good invention (p), and a realist E (ϕ) are known by everybody (Manove and Padilla 1999). E observes the quality signal, q, but the firm does not. We reiterate that the players' payoff functions are common knowledge. Specifically, the relevant payoff function for E is given by E's *anticipated* payoff function rather than by the *actual* payoff function (i.e., an optimist with a useless invention behaves as a realist with a useful invention). The firm understands this, so E's payoff function is common knowledge. The firm's payoff function incorporates p and ϕ, thus accounting for entrepreneurial optimism. As noted earlier, we assume that E—while myopic to her type—shares the knowledge of these parameters, so the firm's payoff functions are also common knowledge.

The timing of the game is as follows (Figure 1 details the game tree). At time t_0, nature randomly selects the invention's quality. E observes a signal regarding the invention's quality, q, rather than the actual quality, Q. That is, E privately observes a signal of a useful invention, $q = g$, with probability z.[8] At time t_1, E decides whether to approach and offer a contract **R** to firm i. If firm i accepts the offer, E decides whether to reveal the invention to the firm. At time t_2, firm i independently discovers the invention with probability α, profits are realized as a function of the invention's quality and ownership, and payments between the firm and E are settled.

A strategy for E, based on the signal she observes, q, consists of (1) offering a contract **R** to firm i and (2) if it is accepted, deciding whether to reveal the invention to the firm. A strategy for firm i consists of deciding to either accept or reject the contract based on its beliefs. Assume E has the bargaining power.

For a contract to act as a signal, it must satisfy individual rationality constraints for both the entrepreneur and the firm as well as incentive compatibility constraints for entrepreneurs with useful and useless inventions. We write these constraints below and solve for a Perfect Bayesian Equilibrium. In this game, the equilibrium is a strategy for each player ($E_{Q=G}$, $E_{Q=B}$, and firm i) and a set of beliefs for firm i such that each player's strategy maximizes its expected payoff given its beliefs, and beliefs are correct in equilibrium.[9] We delineate the firm's beliefs about the invention's quality below.

An individual rationality constraint states that a player prefers to participate and honor the contract rather than

not. We first consider the firm's individual rationality (FIR) constraint. The FIR requires that accepting the contract will leave the firm with a nonnegative net expected payoff. For simplicity, we briefly consider FIR in abstract of optimism. If firm i accepts the contract, it expects a useful invention, and thus its gross profit is Π^{M}. The gross profit to firm i if it declines the contract is $\alpha\Pi^{\mathrm{M}} + (1-\alpha)\Pi^{\mathrm{L}}$.[10] The contract cannot require a firm to pay more than the value it receives from the invention (i.e., the firm's gross profit when it accepts the contract minus its profit when the contract is declined), which equals $(1-\alpha)(\Pi^{\mathrm{M}} - \Pi^{\mathrm{L}})$. Accepting contract **R**, firm i anticipates making a payment of R_i to E, which reflects the firm's beliefs that the invention is useful. Thus, in the absence of entrepreneurial optimism, FIR is given by $R_i \le (1-\alpha)(\Pi^{\mathrm{M}} - \Pi^{\mathrm{L}})$.

We now consider the firm's FIR in the presence of optimism. The logic remains unchanged; accepting the contract should leave a firm with a nonnegative expected payoff. The presence of optimists, however, does affect the firm's willingness to pay. Among those that behave as if they hold a useful invention, there are, in fact, many entrepreneurs who misjudge their inventions. Investors understand that the value of an entrepreneur's self-proclaimed useful invention should be discounted. This insight is voiced by prominent scholars (Sahlman 1997) and venture capitalists (Kawasaki 2007):

> Typically, they are wildly optimistic, padding their projections. Investors know about the padding effect and therefore discount the figures in business plans. (Sahlman 1997, p. 98)

> An entrepreneur's projections are never conservative . . . . As a rule of thumb, when I see a projection, I add one year to delivery time and multiply by 0.1. (Kawasaki 2007)

These concerns are widely reported in the media: e.g., Kawasaki's observation above, Astebro's (2003) findings quoted in the prominent business magazine *The Economist* (2006). They are therefore well recognized by investors and entrepreneurs alike. Moreover, optimism levels are reported for various environments, be they specific countries (e.g., France [Landier and Thesmar 2009]) or industries (e.g., Internet ventures [Goldfarb et al. 2007]). These examples are in line with Camerer and Lovallo (1999, p. 307), who explain that optimism is evident when people enter entrepreneurship even though they have information that overall profits are negative. Note that for a given environment, one has to know only whether entrepreneurs as a group exhibit optimism. There is no need to know whether an individual entrepreneur is a realist or an optimist. On average, the more prevalent optimism is in that environment, the more likely it is that a focal entrepreneur is an optimist. As a result, firms discount all CPS offers, effectively connecting the fate of realists and optimists.

Formally, recognizing that E may be either a realist or an optimist and knowing the probability of either type (ϕ and $1-\phi$, respectively) as well as the probability of good- and bad-quality inventions (p and $1-p$, respectively), the firm interprets the informational content of an invention's quality signal, q. The firm calculates the probability that an invention with a good signal is indeed useful: $\Pr(G \mid g) = \Pr(G) * \Pr(g \mid G)/\Pr(g) = p/z$. Denote this probability ψ;

$$\psi \equiv \Pr(G \mid g) = \frac{p}{p + (1-\phi)(1-p)} \le 1. \qquad (2)$$

The firm can also easily calculate that $\Pr(B \mid b) = 1$.

Using these probabilities, if firm i accepts the contract, its expected gross payoff is equal to $\psi\{\Pi^{\mathrm{M}}\} + (1-\psi) \cdot \{\alpha\Pi^{\mathrm{M}} + (1-\alpha)\Pi^{\mathrm{L}}\}$. The first part of the expression is the firm's gross payoff if the contract is offered by E, who correctly interprets the invention's quality signal. The second part is the firm's gross payoff if the contract is offered by an optimist who incorrectly interprets her invention's quality signal (i.e., mistakenly thinking the invention is useful, whereas it is actually useless). Next, the gross expected profit to firm i when it declines the contract is $\psi\{\alpha\Pi^{\mathrm{M}} + (1-\alpha)\Pi^{\mathrm{L}}\} + (1-\psi)\{\alpha\Pi^{\mathrm{M}} + (1-\alpha)\Pi^{\mathrm{L}}\}$. Declining the contract—regardless of whether it was offered by a realist (first term) or optimist (second term)—implies that the firm's payoff is solely a function of its ability to independently discover a useful invention. Therefore, firm i's willingness to pay is equal to $\psi(1-\alpha)(\Pi^{\mathrm{M}} - \Pi^{\mathrm{L}})$. Note that firms' willingness to pay has diminished by ψ in the presence of optimism ($\psi \le 1$).

Accepting the contract **R**, firm i anticipates one of two potential outcomes. With probability ψ, the entrepreneur who offers a contract holds a useful invention (and E may be either a realist or an optimist), and firm i pays R_i. With probability $(1-\psi)$, the entrepreneur is an optimist with a useless invention, and firm i pays $\alpha R_i + (1-\alpha)R_j$.[11] Formally, firm individual rationality constraint is expressed as

$$\text{(FIR)} \quad \psi\{R_i\} + (1-\psi)\{\alpha R_i + (1-\alpha)R_j\} \le \psi(1-\alpha)(\Pi^{\mathrm{M}} - \Pi^{\mathrm{L}}). \qquad (3)$$

It follows that firm i is no worse off by accepting contract **R** irrespective of its beliefs regarding the entrepreneur's signal and the invention's quality.

Next, we delineate the entrepreneur individual rationality (EIR) constraint. Analogous to the FIR constraint, the EIR requires that the contract will leave the entrepreneur with a nonnegative net expected payoff. In the presence of optimistic entrepreneurs, the key to EIR is the fact that each and every entrepreneur—whether a realist or an optimist—believes herself to be a realist ($T = R$). From (1) and Bayes' Law, it becomes apparent that every entrepreneur interprets

the signal, q, as perfectly revealing the true quality of the invention, Q. Formally, from E's viewpoint, $\Pr(G \mid g, R) = \Pr(B \mid b, R) = 1$. E, who observes a good signal, anticipates an expected payoff of R_i, which must leave her with a nonnegative payoff. It should exceed the setup costs, F. Formally,

$$\text{(EIR)} \quad R_i \geq F. \tag{4}$$

Not only does a CPS contract ensure entrepreneurs' participation but also it facilitates separation based on the quality of the invention. Separation is the subject of the entrepreneur incentive compatibility (EIC) constraint. Ideally, the constraint should allow a firm to distinguish entrepreneurs with a useful invention from those with a useless invention. To that end, the contract has distinct incentives for entrepreneurs as a function of their inventions' quality. It entails a nonnegative payoff to E with a good-quality invention and a nonpositive payoff to E with a bad-quality invention. The former requirement is already satisfied by the EIR. The latter is captured by the EIC.

To construct the EIC constraint, we exploit the fact that a useless invention does not affect a firm's profit. Thus, when the firm's profit is driven solely by the likelihood of an independent firm discovery, E should earn a nonpositive payoff. That is, she should earn less than her setup costs, F. Interestingly, optimism does not enter the constraint. This is because each entrepreneur believes herself to be a realist, interpreting the observed signal, q, as perfectly revealing the invention's quality.

$$\text{(EIC)} \quad \alpha R_i + (1-\alpha) R_j \leq F \tag{5}$$

Finally, each contract may specify payments in two directions, from a firm to E or vice versa. Due to E's limited wealth, L, the last constraint, is a wealth (W) constraint (where $x = i, j$):

$$\text{(W)} \quad R_x \geq -L. \tag{6}$$

To see the set of feasible contracts that support a separating CPS equilibrium, we first set $R_j = -L$. This imposes the largest possible penalty on E in a state of the world that should not occur had she held a useful invention. Next, we rewrite the constraints to express R_i as a function of L and the other parameters.

$$\text{(FIR)} \quad R_i \leq \frac{(1-\alpha)p}{p+\alpha(1-\phi)(1-p)}(\Pi^{\mathrm{M}} - \Pi^{\mathrm{L}}) + \frac{(1-\alpha)(1-\phi)(1-p)}{p+\alpha(1-\phi)(1-p)} L \tag{7}$$

$$\text{(EIC)} \quad R_i \leq \frac{1}{\alpha} F + \frac{1-\alpha}{\alpha} L \tag{8}$$

$$\text{(EIR)} \quad R_i \geq F \tag{9}$$

From inequalities (7) and (8) it follows that under some conditions, E can drive a firm to indifference and extract the full expected value the invention has to the firm. Specifically, E can do so only if she has sufficient wealth, L, to compensate the firm in unwanted states of the world. E's wealth should be in excess of $L \geq \alpha(\Pi^{\mathrm{M}} - \Pi^{\mathrm{L}}) - ((p + \alpha(1-\phi)(1-p))/(p(1-\alpha)))F$. This inequality leads to an interesting result; under CPS the threshold level of wealth necessary to extract an invention's highest possible value diminishes as the proportion of optimists increases (i.e., $(1-\phi)$ increases). This counterintuitive result arises because in the presence of entrepreneurial optimism, the firm is likely to make lower payments in expectation (see inequality (3)). Proposition 1 delineates a separating equilibrium contingent payment scheme.

Proposition 1. *Let L and F satisfy*

$$\text{(i)} \quad \alpha(\Pi^{\mathrm{M}} - \Pi^{\mathrm{L}}) - \frac{p+\alpha(1-\phi)(1-p)}{p(1-\alpha)} F \leq L < \alpha(\Pi^{\mathrm{M}} - \Pi^{\mathrm{L}})$$

$$\text{(ii)} \quad F \leq \frac{p(1-\alpha)}{p+(1-\phi)(1-p)}(\Pi^{\mathrm{M}} - \Pi^{\mathrm{L}}).$$

Then a separating equilibrium with a "contingent payment" action exists where the equilibrium contract, $\mathbf{R}^*$, is given by

$$\text{(a)} \quad R_i = \frac{(1-\alpha)p}{p+\alpha(1-\phi)(1-p)}(\Pi^{\mathrm{M}} - \Pi^{\mathrm{L}}) + \frac{(1-\alpha)(1-\phi)(1-p)}{p+\alpha(1-\phi)(1-p)} L$$

$$\text{(b)} \quad R_x \geq -L, \quad \textit{where } x = j, 0$$

E, *with a useful invention, anticipates payoff equal to*

$$\frac{(1-\alpha)p}{p+\alpha(1-\phi)(1-p)}(\Pi^{\mathrm{M}} - \Pi^{\mathrm{L}}) + \frac{(1-\alpha)(1-\phi)(1-p)}{p+\alpha(1-\phi)(1-p)} L\text{–}F.$$

Proof. See Appendix A.

A novel result of Proposition 1 is the "optimism discount." It is a distinctive feature of a CPS separating equilibrium in the presence of optimistic entrepreneurs. Particularly, the contract facilitates separation between useful and useless inventions but only as long as those inventions are held by realistic entrepreneurs. From a firm's perspective, the probability of accessing a useful invention when accepting the above-delineated CPS contract is equal to ψ. In other words, the effectiveness of the CPS contract is limited; (a) it is higher than no separation ($p \leq \psi$) yet (b) lower than full separation ($\psi \leq 1$). Below we expand on this feature and discuss the consequent discount in entrepreneurial payoff.

Per point (a), the CPS contract is with merit. Realistic individuals with a useless invention will never offer the equilibrium contract. To see this, consider a CPS contract under pooling equilibrium. Here, a contract is offered by each and every individual in the population. From a firm's perspective, the probability of facing an entrepreneur with a useful invention is p, which is the population-wide probability of a useful invention (see proof of Proposition 1). It is straightforward to show $p \leq \psi$. Thus, a separating CPS contract still boosts the likelihood of accessing a useful invention compared to a situation of no separation (i.e., a pooling CPS contract).

Per point (b), the above delineated CPS contract faces a key challenge. To see that, consider a world in which optimists do not exist. It is a special case of our model where every E is a realist ($\phi = 1$). The equilibrium contract is analogous to Anton and Yao (1994, Prop. 3). Such a contract effectively separates those who hold useful inventions from those who do not (i.e., 100% of the entrepreneurs who offer a CPS are in possession of a useful invention). From a firm's perspective, the probability of accessing a useful invention when accepting this contract is equal to 1. In the presence of optimists, however, the probability is lower; it is equal to ψ ($\psi \leq 1$, see Equation (2)). This is because a firm might access a realist who holds a useful invention, but it might also face an optimist with a useless invention.

This feature of the CPS equilibrium gives rise to the "optimism discount." The payoff earned by an entrepreneur is a function of a firm's willingness to pay. In a world populated solely by realists, an entrepreneur may be able to capture the full value of the invention (e.g., Anton and Yao 1994). However, as a firm's ability to access useful inventions diminishes, so does the entrepreneurial payoff. Furthermore, the derivative of E's anticipated payoff to the probability of optimists $(1 - \phi)$ is negative within the parameter values. It suggests that an entrepreneur's payoff drops as the fraction of optimists in the population increases. To conclude, an entrepreneur's payoff peaks if there are no optimists in the population and decreases as their frequency increases. We denote this decrease in E's payoff as the "optimism discount."

2.2. Disclosure

Assume an entrepreneur pursues disclosure. She reveals technical details to a prospective investor. This can take the form of conferring blueprints or showcasing a prototype (Zott and Huy 2007, p. 91):

> The large company was going to do a formal search through a number of companies, and they really got so excited about WIRE—they truncated that process and they selected WIRE.... This win happened when the business founder gave what I'll call a controlled demonstration. The demo really looked great. (Investor, WIRE)

As the quote suggests, disclosure may attract investors by alleviating the adverse selection problem. However, it may also result in imitation. Once an invention is disclosed, investors have in effect acquired it without cost (Arrow 1962). Disclosure thus can have unfavorable implications for the entrepreneur. Many inventions, ranging from the sugar bag to the 56K computer modem, illustrate this point:

> In 1945, [Ben Eisenstadt, who later founded Sweet & Low] worked on the tea bagger [and] reconfigured the machine into the world's first sugar packer.... The Domino Sugar refinery was directly across the river from Lower Manhattan.... Ben met with the bosses of Domino...[t]he executives asked questions and studied Ben's plans. They thanked him and shook his hand and said he would be hearing from them. He went back to Cumberland and waited. One week, two weeks. It took a month to get someone on the phone. He was finally told, "No thank you, Mr. Eisenstadt. Your machine is quite clever. In fact, we've already built one of our own." (Cohen 2006, p. 51)

> [Stanford Professor] Townshend said substantial elements of his concept were shared with Rockwell in 1995 during unsuccessful negotiations. Those elements, he said, were unjustly integrated into the K56flex modems developed by Rockwell, and other vendors.... "Rockwell's K56flex modem technology appears to correspond in all material respects to Dr. Townshend's 'Asymmetrical High-Speed PCM Modem' technology...." (*Computer Reseller*, October 1997)

We emphasize that imitation is possible because the order of events under disclosure (i.e., reveal and then contract) is the reverse of that under CPS (i.e., agreement followed by disclosure). Put differently, a key feature of disclosure is that an entrepreneur allows a prospective investor to inspect the invention even before the relationship is governed by a contract (e.g., Dushnitsky and Shaver 2009). It is quite a common practice. For instance, Udell (1990) surveys firms that invest in external inventions. He finds that about half of the 243 firms encourage full disclosure prior to contracting. Some investors go further and remind entrepreneurs that the decision to approach and reveal the invention is at one's own discretion. Consider a recent example from a Web page of one corporate investor:

> Online Business Plan Submission. Step 1 of 2.... Any such submissions made to [investor] will not be subject to any non-disclosure, confidentiality, or other restrictions or obligations on the part of [investor] or any of its affiliates. Accordingly, we suggest that you do not submit to us any information that you feel may be confidential and whose confidentially may be compromised in this initial contact with [investor].

Formally, E pursues a disclosure course of action if she first reveals the invention to the firm and only then offers a contract. We use a similar notation, where a

contract **R** between E and firm i represents a vector of payments in each possible state of the world.

The timing of the game is as follows. At time t_0, nature randomly selects q with probability z, and E privately observes it. At time t_1, E decides whether to approach firm i, reveals the invention, and only then offers a contract **R**. At time t_2, firm i independently discovers the invention with probability α, profits are realized, and payments between the firm and E are settled. A strategy for E, based on the invention's type q, consists of disclosing to firm i and offering contract **R**. A strategy for firm i is a decision to accept or reject the contract based on the quality of the disclosed invention and the firm's beliefs. We solve for a Perfect Bayesian Equilibrium.

We repeat the key implications of entrepreneurial optimism as they pertain to the current setting (see §2.1 for details). The entrepreneur observes a signal about the invention's quality, q, rather than the true quality of the invention, Q. Moreover, E may be either a realist or an optimist, where an optimist always observes the good signal irrespective of the underlying quality of the invention. Next, consider firm i. In the previous subsection, a contract is offered and only then is the invention revealed. Consequently, firm i has to infer the invention's quality based on contract terms, the population probabilities of a good invention (p), and a realist E (ϕ). In this subsection, however, the entrepreneur reveals the invention up front and only then offers a contract. The firm can directly and accurately evaluate the invention's quality and is thus not affected by an optimistic entrepreneur.

The firm's individual rationality constraint differs from the CPS case. The reason is a change in the firm's willingness to pay. Disclosure implies that firm i is privy to E's invention prior to contracting and may choose to reject the contract yet imitate the invention. Thus, the value of contracting with E is no longer driven by the access it affords to the invention. Rather, the value of a contract stems from E's ability to retaliate and erode the firm's profit.[12] Formally, gross expected profit to firm i when it accepts the contract is Π^{M}, similar to the CPS. If firm i uses the invention but rejects the contract, E can retaliate, leaving the firm to gross an intermediate profit, Π^{R}. Thus, firm i will pay at most $(\Pi^{\mathrm{M}} - \Pi^{\mathrm{R}})$.

These insights are robust to entrepreneurial optimism. The firm, observing the invention prior to contracting, knows its quality with certainty. If it is a useful invention, E's threat is credible, and the firm is willing to pay as much as $(\Pi^{\mathrm{M}} - \Pi^{\mathrm{R}})$. If the invention is useless, the threat is not credible, and the firm will agree only to a nonpositive payment. It follows that E's expected payoff is R_i. Following Anton and Yao (1994), we denote this constraint the expropriation (EXP) constraint.

$$\text{(EXP)} \quad R_i \leq (\Pi^{\mathrm{M}} - \Pi^{\mathrm{R}}) \tag{10}$$

The entrepreneur individual rationality (EIR) constraint must leave her with a nonnegative net expected payoff. Recall that all entrepreneurs believe themselves to be realists, and E always interprets the signal, q, as perfectly revealing the true quality of the invention, Q (see (1) and Bayes' Law). Therefore, EIR in (4) holds: $R_i \geq F$.

The incentive compatibility constraint is no longer relevant because the invention is disclosed prior to contracting. That is, firm i knows the invention's quality with certainty, so the contract no longer serves as a separation mechanism. The wealth constraint (W) requires $R_x \geq -L$, where $x = i, j$. Proposition 2 delineates a separating equilibrium disclosure contract.

Proposition 2. *A separating equilibrium with a "disclosure" action exists for the equilibrium contract,* $\mathbf{R}^*$, *which is given by*

(i) $R_i = (\Pi^{\mathrm{M}} - \Pi^{\mathrm{R}})$.

E, *with a useful invention, anticipates payoff equal to* $(\Pi^{\mathrm{M}} - \Pi^{\mathrm{R}}) - F$.

Proof. See Appendix A.

Proposition 2 alludes to the "imitation discount." Specifically, E's anticipated payoff under disclosure is only a function of $(\Pi^{\mathrm{M}} - \Pi^{\mathrm{R}})$, whereas the full value of the invention (in an all-realist world) is a function of $(\Pi^{\mathrm{M}} - \Pi^{\mathrm{L}})$. The difference stems from the fact that a disclosure contract does not provide access to the entrepreneurial invention; it merely guarantees the firm would not be subject to retaliation if it takes advantage of the disclosed invention.

2.3. Choosing Between CPS and Disclosure

Anecdotal evidence indicates that entrepreneurs weigh the options at their disposal before deciding on the best way to attract a prospective investor.

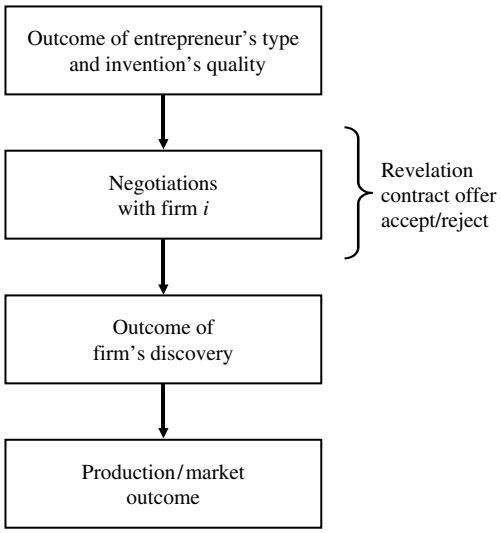
> There are two schools of thought about how you should handle this. The first is to divulge as much information to them as possible . . . . The second school of thought is to divulge only what is necessary to get your point across . . . . This decision is up to you and your sense of the competitive nature of your market . . . . (Docie 2004, p. 111)

Recall that the underlying issue is that asymmetric information problems prevent entrepreneurs from appropriating the value of their invention. Disclosure and CPS are the two widespread entrepreneurial actions that credibly mitigate these problems (Bhide 1999, p. 41):

> In many startups the founders . . . have little to offer besides their hopes and dreams. [They may offer] to conduct extensive due diligence or may rely on incentive schemes that, to some degree, motivate decision makers to increase the value of the firm.

The question, therefore, is: *What course of action is an entrepreneur likely to pursue?*

Figure 2 Structure of the Game



We propose that an entrepreneur weighs the "optimism discount" associated with CPS against the "imitation discount" associated with disclosure and pursues the one that yields a higher valuation (i.e., lower discount). An entrepreneur is said to engage in disclosure if critical technical information is revealed up front and no contingent payment is specified (e.g., Prof. Townshend attracts Rockwell by surrendering modem blueprints yet does not offer to make his pay contingent on success). Alternatively, we regard an entrepreneur's action as CPS if the entrepreneur offers to make payment contingent on success while providing only limited background information—such as description of functionality (*What does it do*?) rather than inner workings (*How does it do it*?)—regarding the invention (e.g., Townshend extends a royalty-based license following a brief demonstration yet withholds key algorithm and design details).

The entrepreneurial choice is driven by the differences in a firm's willingness to pay.[13] We show that even if a given entrepreneur believes herself to be a realist, the understanding that other entrepreneurs might be optimistic has an impact on her behavior. That is, the presence of optimist types affects what course of action E pursues. The reason is as follows. Ex post, the magnitude of E's payoff under a disclosure contract (CPS contract) is insensitive to (decreases in) the level of entrepreneurial optimism; see Proposition 2 (Proposition 1). Ex ante, the presence of optimism affects the choice between CPS and disclosure. The entrepreneur may decide to forgo disclosure and opt instead for CPS to the extent the latter is associated with a higher expected payoff.

Formally, CPS is optimal above the threshold

$$(1-\phi) \le \frac{p[(1-\alpha)(\Pi^{M}-\Pi^{L})-(\Pi^{M}-\Pi^{R})]}{(1-p)[\alpha(\Pi^{M}-\Pi^{R})-(1-\alpha)L]}.$$

As the fraction of optimistic entrepreneurs in the population increases (i.e., higher $(1-\phi)$ values), the likelihood that disclosure is the mechanism of choice rises. It is an intuitively appealing insight; as prospective investors or buyers become less assured of entrepreneurs' judgment and more wary of optimism, they will require inspection of the invention prior to contracting.

The notations do not change, and $\mathbf{R}$ denotes a vector of payments between E and firm i in each and every possible state of the world. The timing of the game is as follows (see Figure 2). At time t_0, nature randomly selects q with probability z, and E privately observes it. At time t_1, E decides which action to pursue. If E chooses CPS, the timeline progresses as in §2.1. If E opts for disclosure, the timeline progresses as in §2.2. A strategy for E includes the strategies delineated in §2.1 and §2.2 and the decision about which action to pursue.

Proposition 3. *Let L and F satisfy*

$$\text{(i)}\quad \alpha(\Pi^{M}-\Pi^{L}) - \frac{p+\alpha(1-\phi)(1-p)}{p(1-\alpha)}F \le L < \alpha(\Pi^{M}-\Pi^{L})$$

$$\text{(ii)}\quad F \le \frac{p(1-\alpha)}{p+(1-\phi)(1-p)}(\Pi^{M}-\Pi^{L})$$

and let $\hat{\phi}$

$$\text{(iii)}\quad \phi = 1 - \frac{p[(1-\alpha)(\Pi^{M}-\Pi^{L})-(\Pi^{M}-\Pi^{R})]}{(1-p)[\alpha(\Pi^{M}-\Pi^{R})-(1-\alpha)L]}.$$

If E *believes her invention is useful* $(q=g)$*, then there exists a separating Perfect Bayesian Equilibrium.*

(a) *Where* $\phi \le \hat{\phi}$, E *employs disclosure. Specifically, she reveals the invention to firm i and offers a contract* $\mathbf{R}^{*}$ ($\mathbf{R}^{*}$ *specified in Proposition* 2).

E*, with a useful invention, anticipates a payoff equal to* $(\Pi^{M}-\Pi^{R})-F$.

(b) *Where* $\phi > \hat{\phi}$, E *employs "contingent payment." Specifically, she offers a contract* $\mathbf{R}^{*}$ *to firm i* ($\mathbf{R}^{*}$ *specified in Proposition* 1)*. If the contract is accepted,* E *reveals the invention.*

E*, with a useful invention, anticipates a payoff of*

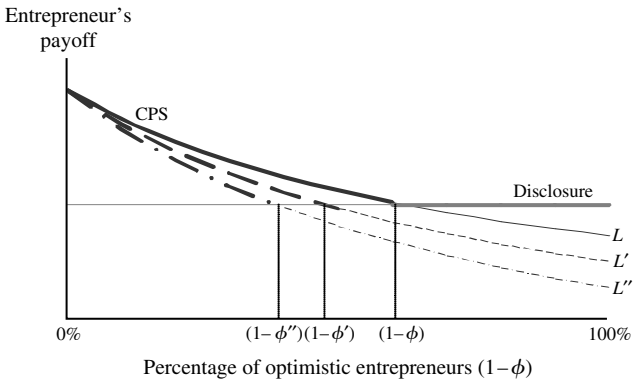
$$\frac{(1-\alpha)p}{p+\alpha(1-\phi)(1-p)}(\Pi^{M}-\Pi^{L}) + \frac{(1-\alpha)(1-\phi)(1-p)}{p+\alpha(1-\phi)(1-p)}L - F.$$

If E *believes her invention is useless* $(q=b)$*, she neither offers a contract nor reveals her invention.*

Proof. See Appendix A.

Figure 3 plots E's anticipated payoff under each course of action as a function of the fraction of opti-

Figure 3 Entrepreneur's Payoff as a Function of Each Course of Action and the Proportion of Optimists in the Environment



Notes. The figure delineates entrepreneur's payoff under each course of action within the parameter space of Proposition 3. It shows that entrepreneur's choice is affected by her personal wealth (L) and the prevalence of optimists in the environment ($1-\phi$). The entrepreneur pursues an action that is associated with the highest ex ante expected payoff (bold line). The threshold level of "optimism in the environment," at which an entrepreneur is likely to pursue disclosure rather than a contingent payment, shifts rightward (i.e., to a higher percentage of optimists in the environment: $(1-\phi'') < (1-\phi') < (1-\phi)$) as the entrepreneur's wealth rises from low through intermediate to high ($L'' < L' < L$).

mists in the environment. Recall that although E's payoff under a contingent payment is affected by E's wealth and the level of optimism, the payoff under disclosure is not. The figure also illustrates that the threshold level of environment optimism at which disclosure dominates contingent payment,

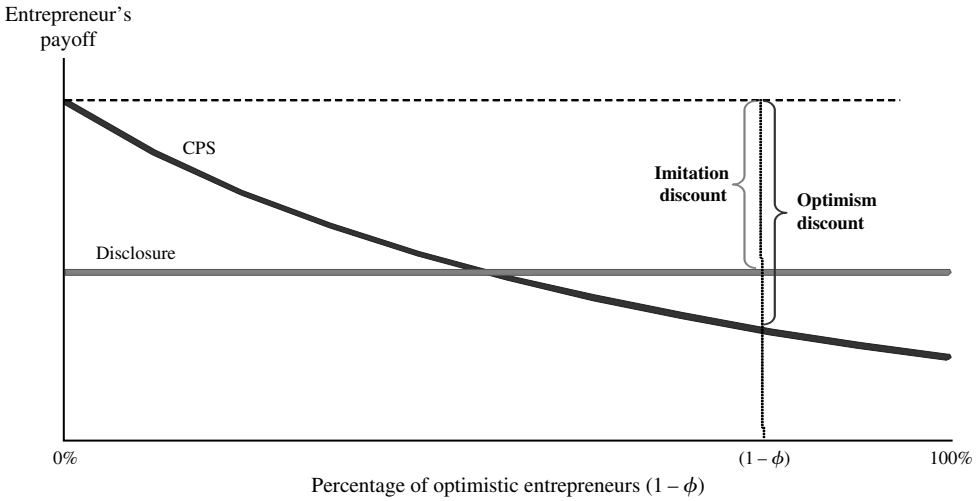
$$(1-\phi) \le \frac{p[(1-\alpha)(\Pi^M - \Pi^L) - (\Pi^M - \Pi^R)]}{(1-p)[\alpha(\Pi^M - \Pi^R) - (1-\alpha)L]},$$

is a function of the level of E's wealth. In particular, within the parameter space defined in Proposition 3, the threshold level at which disclosure dominates CPS shifts rightward (i.e., the percentage of optimists is higher) as the entrepreneur's wealth rises from low through intermediate to high ($L'' < L' < L$).

Figure 4 illustrates the novel theoretical trade-off uncovered in this paper. In choosing an action that maximizes her valuation, a moderately wealthy entrepreneur weighs "optimism discount" (CPS) versus "imitation discount" (disclosure). She opts for a course of action that is associated with the least discount. In either case, an entrepreneur is unable to appropriate the full value of the invention. When E opts for the latter, firm i may expropriate the invention. An entrepreneur can capture a portion of the value by threatening retaliation. When E pursues the former, firm i is wary of the invention's true quality. In light of optimism concerns, an entrepreneur captures a value that is lower than the maximum value of a useful invention.

A subtle observation regarding optimism and wealth follows. As either effect intensifies (i.e., higher level of optimism, tighter wealth constraints), entrepreneurs are more likely to employ disclosure than CPS. There is, however, a critical difference in the way each effect

Figure 4 The Entrepreneurial Trade-off: Optimism Discount versus Imitation Discount



Notes. The figure illustrates the novel theoretical trade-off uncovered in this paper. In choosing an action that maximizes her valuation, a moderately wealthy entrepreneur weighs "optimism discount" (affecting CPS) against "imitation discount" (affecting disclosure). She opts for a course of action that is associated with the least discount. In either case, she is unable to appropriate the maximum value of the invention, $(1-\alpha)(\Pi^M - \Pi^L) - F$. If an entrepreneur pursues disclosure, a firm may expropriate the invention. By threatening retaliation, the entrepreneur can still capture a portion of her invention's value (a function of $(\Pi^M - \Pi^R)$). If an entrepreneur offers CPS, a firm is wary about an invention's true quality. The entrepreneur can capture only as much as a firm construes, which is discounted in light of potential optimism bias (i.e., it is a function of $(\Pi^M - \Pi^L)$ and $(1-\phi)$).

is at play. For a given entrepreneur, personal wealth—or the lack thereof—is associated with the decision to pursue disclosure. In contrast, the prevalence of entrepreneurial optimism in a given environment drives a focal entrepreneur's disclosure, irrespective of whether she herself is an optimist.[14] Note that both personal wealth and optimism describe individual traits. Nonetheless, in our model, entrepreneurial action is driven by the *individual level* of personal wealth and the overall *group level* of optimism in the environment.

3. Discussion

3.1. Entrepreneurial Optimism vs. Opportunism

We underscore the fact that optimism is qualitatively different from opportunistic agency behavior, which is commonly attributed to entrepreneurs. Optimism and agency behavior are both commonplace among entrepreneurs and may result in misallocation of investors' resources. Nonetheless, the two traits differ not only in terms of the mechanisms that are at play but also in their implications.

To set the stage, consider Kaplan and Stromberg (2004), who study an exemplary entrepreneurial setting: the venture capital market. They identify fundamental problems affecting contracting between entrepreneurs and investors (Kaplan and Stromberg 2004, p. 2173):

> First, the VC is concerned that the entrepreneur will not work hard to maximize value after the investment is made. In such a case, when the entrepreneur's effort is unobservable to the VC, the traditional moral hazard approach, pioneered by Holmstrom (1979), predicts that the VC will make the entrepreneur's compensation dependent on performance . . . .
>
> Second, the VC may also be concerned that the entrepreneur knows more about his or her quality/ability than the VC. The model in Lazear (1986) shows that the VC can design contracts with greater pay-for-performance that good entrepreneurs will be willing to accept . . . .

Namely, Kaplan and Stromberg point to moral hazard and adverse selection. The latter arises when entrepreneurs possess private information prior to funding. Uninformed investors are concerned that entrepreneurs deliberately accept only valuations that exceed the value of their inventions. The former refers to a conscious lack of entrepreneurial effort. It arises when effort exerted after funding is hidden (i.e., unobservable or uncontractable). Kaplan and Stromberg imply that these problems may be alleviated by contractually making pay contingent on outcomes. Such a contract can circumvent adverse selection. It deters owners of useless inventions who are conscious of the fact that their invention cannot yield a valuable outcome (e.g., Leland and Pyle 1977, Lazear 1999). Similarly, the contract may mitigate moral hazard. It induces entrepreneurs, who are cognizant that their payoff is driven by outcomes, to labor toward useful commercialization of the invention.

Our model highlights the role of entrepreneurial optimism. It exacerbates the adverse selection problem by impacting the effectiveness of CPS contracts (see discussion following Proposition 1). An optimistic entrepreneur erroneously believes her useless invention is useful. She may undertake actions that are subjectively advantageous (given her erroneous beliefs) yet objectively detrimental. In particular, an optimist with a useless invention may mistakenly seek a contingent payment contract. Because it is impossible to distinguish those who hold useful inventions from the rest of the contract-wielding crowd, investors may discount CPS contracts altogether. That is, mitigating adverse selection is more challenging in the presence of optimism.

To further underscore the differences between optimism and moral hazard, we contrast a setting characterized by optimism with a setting liable to moral hazard. Because the purpose of this paper is to explore the impact of optimism, the main model explicitly abstracts from the problem of opportunism. Rather, it is the simplest possible model that conveys the impact of entrepreneurial optimism. In other words, to avoid confusion about whether it is opportunism or optimism that drives entrepreneurs' actions, we present a model in which one (i.e., optimism) rather than both (i.e., optimism and moral hazard) problems prevail.

Next, we compare the implications of optimism and moral hazard. To that end, we focus on a strategy that is common to both settings: the use of contingent, outcome-based contracts. We derive an optimal contract under moral hazard.[15] We then compare it to an optimal CPS contract in the presence of optimism and adverse selection. We see that a contingent payment contract resolves the moral hazard problem, yet it only mitigates the problem associated with optimism. Consider a world in which entrepreneurial moral hazard is the key problem. By accepting an equilibrium contract, a firm will surely gain access to a useful invention. Next consider a world in which entrepreneurial optimism is prevalent. An equilibrium contract does not guarantee access to a useful invention. The contract might have been mistakenly offered by an optimist who holds a useless invention.

We also point to some similarities. Although particular contractual terms may differ, the equilibrium contract does facilitate a transaction between entrepreneurs and investors. This is consistent with the quotes from Kaplan and Stromberg (2004). Moreover, the existence of an equilibrium contract is contingent on the level of an entrepreneur's wealth. Individuals who have only a limited amount of wealth are constrained in their ability to make a credible contractual offer. Whether a contract is feasible for individuals with moderate and large levels

of personal wealth is a function of the fraction of optimists in the population or the level of the personal cost of effort.

In closing, the discussion draws attention to two distinct yet often interchangeable characterizations of an entrepreneur: the optimist and the opportunist. While extant work commonly attributes opportunism to entrepreneurs, we are able to specify parsimoniously the impact of optimism on entrepreneurs' ensuing courses of action. We note that moral hazard refers to conscious action when entrepreneurs explicitly decide on the effort level, whereas optimism describes an unconscious bias affecting the evaluation of an invention. We believe that the use of formal models offers an added precision and clarity that is often lacking in verbal analysis.

3.2. Variance in Optimism Levels

The model is motivated by the observation that optimism is attributed to entrepreneurs as a group, though it may not characterize each entrepreneur (e.g., Kawasaki 2007, Manove and Padilla 1999, Sahlman 1997, Shane and Venkataraman 2000). It yields testable predications regarding entrepreneurs' choice between CPS and disclosure. To the best of our knowledge, no empirical work has ever studied the impact of optimism on the CPS-disclosure trade-off. Below, we briefly discuss avenues for future work.

Specifically, we observe that the levels of entrepreneurial optimism vary substantially across different environments. In Canada, for example, a study showed that 93% of the entrepreneurial inventions submitted to the IAP fell short of ultimately reaching the market (Astebro 2003). In France, as many as 23% of entrepreneurs fell short of meeting their expectations (Landier and Thesmar 2009). And in the United States, 22% of entrepreneurs believed they were more likely to experience success than others (Cooper et al. 1988). Recently the Global Entrepreneurship Monitor (GEM) project surveyed entrepreneurial activity using a consistent methodology and a set of comparable variables. Analyzing the GEM data, Koellinger et al. (2007) note a "surprisingly strong variance" in the percentage of optimistic entrepreneurs across 18 countries. In Argentina, for example, the fraction of respondents who were optimistic about their ability was twice as large as the fraction reported for Sweden.

These studies draw attention to the empirical implications of our model. To the extent that optimism levels shape investors' "optimism discount" and consequently affect entrepreneurs' choices, the prevalence of CPS and Disclosure should vary from country to country. In particular, the pursuit of disclosure as a means of attracting investors should be more likely in countries where optimism characterizes a greater fraction of entrepreneurs. Holding all else constant, one might expect disclosure to be more commonly used by Argentinean entrepreneurs than by Swedish entrepreneurs.

4. Conclusions

This paper investigates the question: *How do potentially optimistic entrepreneurs attract investors?* We focus on two commonly observed actions: (a) disclosure, when the entrepreneurs reveal the innovation first and then propose a contract, and (b) CPS, when entrepreneurs first propose a CPS contract and disclose the invention only after the contract is accepted by an investor. We focus on these two actions because other practices (e.g., employing prestigious executives or directors, partnering with incumbent firms) are available only in the later stages. Put differently, disclosure and CPS are likely to be the mechanisms through which entrepreneurs attract the first investor, the first director, or the first strategic partner.

A major result is that the possibility that an entrepreneur is "optimistic" (i.e., there is the presence of a nonzero fraction of optimists among the population of entrepreneurs) affects contracts when they are proposed before revelation (i.e., when employing CPS) but has no effect in the scenario in which the invention is revealed up front (i.e., disclosure). Ex ante, the frequency of optimists will affect which course of action entrepreneurs choose. For example, with a higher share of optimists in the focal environment, a moderately wealthy entrepreneur is more likely to opt for disclosure because a CPS signal may be discounted in light of potential optimism bias.

The paper makes several contributions. It distinguishes the effects of optimism from those of other entrepreneurial traits, and it does so in a way that lucidly articulates how CPS and disclosure are sensitive to these traits. Most important, by analyzing optimism separately from opportunism, we shed light on a little-explored idiosyncrasy of these entrepreneurial actions. Following leading studies that use formal models to illuminate management issues (e.g., Adner and Zemsky 2006, Makadok 2003, Khanna 1998, Mayer et al. 2004, Nickerson and Zenger 2002, Powell et al. 2006), our paper advances an understanding of the overall efficacy of disclosure and contingent payment scheme contracts. We believe that formalizing the economic rationale behind these entrepreneurial actions can sharpen the distinction between substantive and symbolic actions (e.g., Bercovitz and Feldman 2008, Goldfarb et al. 2008, Zott and Huy 2007).

An important area for future research is to empirically substantiate and calibrate the model. To gain a better understanding of the way in which entrepreneurs approach, attract, and contract with prospective investors, one can pursue rigorous case studies (e.g., Argyres 1999, Mayer and Argyres 2004) or large-sample analysis (e.g., Argyres et al. 2007, Mayer and Nickerson 2005). Large-sample analysis, for instance, can validate whether entrepreneurs act in a manner consistent with

the model's predictions and whether deviations are associated with inferior outcomes. In the transaction costs economics (TCE) literature, for example, Mayer and Nickerson (2005) and Sampson (2004) offer empirical insights into normative theory. They find that although some firms may behave in a way that is inconsistent with TCE predictions, such behavior is associated with poorer outcomes.

For practitioners, the paper offers several implications. For instance, consider online invention marketplaces, which are rapidly expanding nowadays (e.g., www.ibridgenetwork.org, www.innocentive.com, www.vfinance.com, or www.yet2.com). These markets for inventions (also known as idea clearinghouses) employ mechanisms that parallel the actions we study. A recent typology of medically oriented clearinghouses notes the use of disclosure-like and CPS-like mechanisms (van Zimmeren et al. 2006, p. 353): "Access and use can be offered by a clearinghouse on a royalty-free open-access basis (open access clearinghouse), or via standardized licenses (standardized license clearinghouse and royalty collection clearinghouse)." Moreover, online marketplaces mark a shift toward faceless transactions and away from past practices in which investment opportunities were centered on an investor's social circle.[16] To the extent that investors are no longer intimately familiar with the entrepreneurs who approach them, they are likely to be wary of optimists. Hence, optimism plays an increasingly salient role in shaping ensuing interactions. It follows that invention marketplaces may benefit from our findings. Marketplace operators, for example, may opt to (a) introduce online interfaces that facilitate entrepreneurial actions that mitigate investors' optimism discount or (b) offer independent certification services that eliminate the participation of optimists in the first place.

Acknowledgments

The author thanks the editor, Nicholas Argyres, and two anonymous referees for helpful suggestions. The author also appreciates useful comments from the participants of the 2005 Society of Entrepreneurship Scholars retreat, the 2006 West Coast Research Symposium, and the 2007 Academy of Management Conference (where this research was the recipient of the BPS division's Sumatra Ghoshal Research and Practice Award).

Appendix A. Proofs

Proof of Proposition 1. The proof proceeds in two parts. The first part shows that the separating contract maximizes E's payoff when the firm can do no better than accept it; in the second part we illustrate that separation dominates pooling for the relevant parameter values.

Of all feasible contracts, the contract delineated in Proposition 1 maximizes the payoffs to an entrepreneur who possesses a good-quality invention, given the constraints. For wealth levels in P1.1 and the setup cost levels in P1.2, the contract $\mathbf{R}^*$ maximizes E's payoff while satisfying the firm's individual rationality (FIR, see (7)) constraint. To see why the FIR rather than the entrepreneur incentive compatibility (EIC) constraint is the binding constraint on E's payoff, compare (7) and (8). As for the remaining constraints, the entrepreneur's individual rationality constraint is not binding for levels above the minimal setup cost delineated in P1.2.

Given that the contract $\mathbf{R}^*$ is offered, the firm can do no better than accept it regardless of its beliefs regarding the signal observed by the entrepreneur. In the discussion leading to inequality (3), we formally show that it is optimal for the firm to accept a contract offered by E who observes a good signal ($q = g$). Note: This holds in the presence of optimism. Moreover, if the firm believes that it is approached by E who observes a bad signal ($q = b$), it is still optimal to accept the contract. This is because E has to compensate the firm for bad states of the world by surrendering her wealth. Formally, if a contract is accepted, the firm's profit equals $\alpha(\Pi^{\mathrm{M}} - R_i) + (1-\alpha)(\Pi^{\mathrm{L}} + L)$; but if it is declined, the firm's profit is equal to $\alpha\Pi^{\mathrm{M}} + (1-\alpha)\Pi^{\mathrm{L}}$. The EIC ensures that $\alpha(\Pi^{\mathrm{M}} - R_i) + (1-\alpha)(\Pi^{\mathrm{L}} + L) \geq \alpha\Pi^{\mathrm{M}} + (1-\alpha)\Pi^{\mathrm{L}}$. In other words, EIC ensures that a firm receives nonnegative payoffs. Note that for a very high level of wealth, $L > \alpha(\Pi^{\mathrm{M}} - \Pi^{\mathrm{L}})$, optimism does not affect the entrepreneur's payoff because high-wealth entrepreneurs can fully insure a firm against unfavorable outcomes.

Finally, we show that within the relevant parameter values (i.e., P1.1 and P1.2), a pooling equilibrium yields an inferior payoff to an entrepreneur who observes a good signal. To that end, it is useful to note that the FIR under pooling is of the following form:

$$p(1-\alpha)(\Pi^{\mathrm{M}} - \Pi^{\mathrm{L}}) \geq p[R_i] + (1-p)[\alpha R_i + (1-\alpha)R_j]. \quad (11)$$

Under a pooling equilibrium, a firm faces the population of entrepreneurs. Its willingness to pay (i.e., the left term) is multiplied by p, the overall proportion of entrepreneurs in the population with good-quality inventions, rather than by ψ, which is their proportion among those who perceive themselves to hold a good invention.

Whereas the separating equilibrium calls for an incentive compatibility constraint (EIC), there is no such constraint for the pooling equilibrium. The entrepreneur rationality constraint under a pooling equilibrium, however, is similar to the EIC but with the reverse inequality:

$$\alpha[R_i] + (1-\alpha)[R_j] \leq F. \quad (12)$$

The wealth constraints remain unchanged. Given that (a) by definition $\psi \geq p$, (b) P1.1 satisfies inequalities (7) through (9), and (c) the inequality in (12) is opposite to that in (8), it follows that a contract supporting a pooling equilibrium does not exist for wealth levels of P1.1. □

Proof of Proposition 2. We show that this separating contract maximizes E's payoff, whereas the firm can do no better than accept it. The EXP constraint (10) defines an upper bound on R_i, whereas the EIR (4) defines a lower bound. Hence, the entrepreneur can do no better than offer a contract that satisfies EXP. Once privy to the invention, a firm i can do no better than accept the ensuing contract. As discussed in the text, if the invention is of good quality, firm i expects a gross payoff of Π^{M}. If the invention is imitated, E may threaten to retaliate, leading to a nonzero erosion in the firm's profit to

a level of Π^R. Hence, firm i is willing to pay $(\Pi^M - \Pi^R)$ to E who holds a good invention. Note that these insights are robust to entrepreneurial optimism because firm i, observing the invention prior to contracting, knows its quality with certainty. If it is a good-quality invention, E's threat is credible and the firm's willingness to pay is as stated above. If the invention is of bad quality, the threat is not credible, and the firm agrees only to a nonpositive payment. □

Proof of Proposition 3. Recall that the probabilities of a good invention (p), a realist E (ϕ), and the payoff functions of E and firm i are common knowledge. Moreover, the relevant payoff for E is given by her *anticipated* rather than *actual* payoff, which is understood by the firm.

For parameter values (i) and (ii), parts (b) and (a) of Proposition 3 delineate actions that were found to be optimal in Propositions (1) and (2), respectively. A comparison of E's anticipated payoffs under each action and parameter value in (iii) indicate which action is associated with a greater payoff. The entrepreneur will opt for that course of action.

We now review firms' beliefs. First, consider a firm's belief regarding an invention's quality. For the stated levels L and F and $\phi > \hat{\phi}$, a firm believes it is faced with E who observes a good signal ($q = g$) when it is approached by E who does not reveal the invention and rather offers a contract $\mathbf{R}^*$. Any other offer, a firm believes, is made by E who observes a bad signal ($q = b$). For the same levels of L and F, but $\phi \leq \hat{\phi}$, a firm believes it is faced with E who observes a good signal ($q = g$) when it is approached by E who does not reveal the invention and instead offers a contract $\mathbf{R}^*$. Any other offer, a firm believes, is made by E who observes a bad signal ($q = b$).

Out-of-equilibrium beliefs support the equilibrium. Consider E with a bad-quality invention ($q = b$) within the parameter values (i)–(iii) and (a). She cannot profit by disclosing the invention, as it is useless. As well, E cannot profit by offering CPS rather than disclosure; within the parameter values a firm expects a good entrepreneur to disclose the invention, and, hence, when offered CPS, a firm infers that it is faced with a useless invention. A firm accepts such a contract only if it yields a nonpositive payoff to E with a useless invention, suggesting the entrepreneur can do no better than to take neither action.

Next, consider the same entrepreneur ($q = b$) within the parameter values (i)–(iii) and (b). She cannot profit by offering contract $\mathbf{R}^*$ to firm i as it yields nonpositive payoffs given that E possesses a useless invention. Offering a contract with different terms would lead firm i to infer it is facing an owner of a bad-quality invention. Firm i accepts such a contract only if it yields nonpositive payoffs to E, making such deviation unprofitable for E. □

Endnotes

[1]Other important studies include Bhattacharya and Ritter (1983), Gallini and Wright (1990), Amit et al. (1990), Anand and Galetovic (2000), Gans and Stern (2000), and Anton and Yao (2002).

[2]Preferences for skewness, risk tolerance, and pecuniary or nonpecuniary benefits are other viable explanations.

[3]Rational predictions imply that knowing two facts should deter entry: (a) success depends on skill and (b) others self-select based on their own skill. The findings suggest individuals are overly confident and thus optimistic about their own prospects. Relatedly, Kahneman and Lovallo (1993), Baum and Singh (1996), and Moore et al. (2007) find that people focus on internal aspects of a focal case (an "inside view" focusing on personal abilities) while neglecting to assess it vis-à-vis a distribution of similar cases (an "outside view" on competition).

[4]Conditional on entering entrepreneurship, an individual holds a subjective estimate that is—on average—higher than the objective (population-wide) one. This logic of "selecting into entrepreneurship" is analogous to the winner's curse (e.g., Milgrom 1989).

[5]Also see Barberis and Thaler (2003), Forbes (2005), Hayward et al. (2006), Lant and Shapira (2008), Lowe and Ziedonis (2006), Sarasvathy et al. (1998), and Wu and Knott (2006).

[6]In a technical appendix, we extend the model to include two competing firms (i.e., an industry that consists of two firms i and j and an entrepreneur E). The appendix is available from the author upon request. The extension highlights the implications of competition for an entrepreneurial invention. The appendix shows that the results are robust to alternative assignment of bargaining power. It also emphasizes a specific form of entrepreneurial retaliation: freely sharing the invention with others (Anton and Yao 1994).

[7]The problem of adverse selection would be trivial if the quality of the invention is easily verifiable. In that case, there would be no need for a contingent payment contract or upfront disclosure, and the parties will contract directly on the provision of a useful invention. In particular, if the courts can verify that the entrepreneurial invention is useless (either because the entrepreneur is a realist who opportunistically sells a useless invention, as in existing models [e.g., Anton and Yao 1994], or because she is an optimist, as in our model), adverse selection becomes a moot point: Contracts will simply be written—and enforced—as a function of inventions' quality.

[8]The probability of observing a good signal can be written as: $z = \Pr(q = g) = p + (1 - \phi)(1 - p) = \Pr(T = R) \cdot [\Pr(g \mid R, G) * \Pr(Q = G) + \Pr(g \mid R, B) * \Pr(Q = B)] + \Pr(T = O)[\Pr(g \mid O, G) * \Pr(Q = G) + \Pr(g \mid O, B) * \Pr(Q = B)]$.

[9]Perfect Bayesian Equilibrium (PBE) is the equilibrium concept relevant for dynamic games of incomplete information. It is a refinement of Bayesian Nash Equilibrium (BNE). Gibbons (1992) offers a detailed technical explanation of PBE (BNE) on pages 173–256 (143–172). See Anton and Yao (1994) and Makadok and Barney (2001) for excellent applications of PBE and BNE, respectively. Below is a brief, nontechnical overview of PBE's four key requirements. Consider a signaling game in which a sender of given type (out of a set of potential types) sends a signal (out of a set of potential signals), and the receiver engages in a certain action (out of a set of potential actions). The first requirement is that the receiver holds a belief about which type of sender can send that signal. Second, the action the receiver chooses must maximize his expected payoff given the receiver's beliefs about which type could have sent that signal. Third, the sender (given her type) chooses to send a "best signal"; one that maximizes her payoff given the action a receiver is likely to choose. Fourth, if there exists a signal that is a best signal for some sender type, then the belief the receiver has about the type of the sender—in case the receiver observes such a signal—should satisfy Bayes's law.

[10]Recall that firm i may discover the invention independently with probability α. It earns Π^M if it discovers the invention and Π^L if it does not. Thus, without a contract, firm i's expected gross profit is $\alpha\Pi^M + (1-\alpha)\Pi^L$.

[11]Recall that the entrepreneurial payoff under the contract is a function of verifiable market outcomes rather than nonverifiable invention quality. See Endnote 7 and related discussion in the main text.

[12]Retaliation consists of any action that results in a nonzero erosion of a firm's profit. It can take various forms, ranging from legally contesting and delaying a firm from using the invention to freely sharing the invention with other firms (Anton and Yao 1994).

[13]We focus on the interesting case where CPS and disclosure are feasible. For the range of parameters, $L < \alpha(\Pi^M - \Pi^L) - [(p + \alpha(1-\phi)(1-p))/(p(1-\alpha))]F$, a CPS separating equilibrium does not exist, and disclosure is the signaling mechanism by default.

[14]Investors assess the level of optimism in a given environment, decide on an "optimism discount," and apply it to all CPSs offered to them. Cognizant of investors' behavior, entrepreneurs utilize the same statistics to determine the discount. Recall that although optimists mistakenly gauge an invention's quality, they accurately estimate the discount (yet being optimistic, they believe failure rates are irrelevant in their own case).

[15]Due to space limitation, we highlight key issues in this endnote. The full results are available upon request. We develop a model of moral hazard in an entrepreneurial setting. It involves a firm i, an entrepreneur E who has limited wealth, and an invention that is potentially useful. To turn it into a commercial success, E has to work hard; the invention is useful if the entrepreneur exerts costly personal effort and is useless absent entrepreneurial effort. Given our focus, and consistent with other moral hazard models, we assume E is a realist. The key result is an equilibrium contingent payment contract that resolves the moral hazard problem. The contract induces an entrepreneur to exert effort toward developing a commercially useful invention. That is, an equilibrium CPS contract between an entrepreneur and a firm will necessarily result in a useful invention. A contract exists for a less-wealthy entrepreneur as long as the personal cost of effort is low. A contract also exists when effort is more costly, provided the entrepreneur has more personal wealth to post as collateral.

[16]During the 20th century, socially embedded dealings characterized the venture capital markets (Shane and Cable 2002). Invention marketplaces, in contrast, bring together unrelated individuals from different parts of the country or even the world.

References

Adner, R., P. Zemsky. 2006. A demand-based perspective on sustainable competitive advantage. *Strategic Management J.* **27**(3) 215–239.

Akerlof, G. 1970. The market for lemons: Quality uncertainty and the market mechanism. *Quart. J. Econom.* **89** 488–500.

Amit, R., L. Glosten, E. Muller. 1990. Entrepreneurial ability, venture investments, and risk sharing. *Management Sci.* **36**(10) 1232–1245.

Anand, B., A. Galetovic. 2000. Weak property rights and hold-up in R&D. *J. Econom. Management Strategy* **9**(4) 615–642.

Anton, J. J., D. A. Yao. 1994. Expropriation and inventions: Appropriable rents in the absence of property rights. *Amer. Econom. Rev.* **84**(1) 191–209.

Anton, J. J., D. Yao. 2002. The sale of ideas: Strategic disclosure, property rights, and contracting. *Rev. Econom. Stud.* **69** 513–531.

Arabsheibani, G., D. de Meza, J. Maloney, B. Pearson. 2000. And a vision appeared unto them of a great profit: Evidence of self-deception among the self-employed. *Econom. Lett.* **67** 35–41.

Argyres, N. S. 1999. The impact of information technology on coordination: Evidence from the B-2 "stealth" bomber. *Organ. Sci.* **10**(20) 162–180.

Argyres, N. S., J. Bercovitz, K. J. Mayer. 2007. Complementarity and evolution of contractual provisions: An empirical study of IT services contracts. *Organ. Sci.* **18**(1) 3–19.

Arora, A. 1995. Licensing tacit knowledge: Intellectual property rights and the market for know-how. *Econom. Innovation New Tech.* **4** 41–59.

Arora, A., A. Fosfuri, A. Gambardella. 2001. *Markets for Technology: Economics of Innovation and Corporate Strategy*. MIT Press, Cambridge, MA.

Arrow, K. 1962. Economic welfare and the allocation of resources for innovations. R. R. Nelson, ed. *The Rate and Direction of Incentive Activity: Economic and Social Factors*. Princeton University Press, Princeton, NJ, 609–625.

Åstebro, T. 2003. The return to independent invention: Evidence of risk seeking, extreme optimism or skewness-loving? *Econom. J.* **113**(484) 226–239.

Åstebro, T., S. A. Jeffrey, G. K. Adomdza. 2007. Inventor perseverance after being told to quit: The role of cognitive biases. *J. Behav. Decision Making* **20**(3) 253–272.

Barberis, N., R. Thaler. 2003. A survey of behavioral finance. G. Constantinides, M. Harris, R. Stulz, eds. *Handbook of the Economics of Finance*. Elsevier/North-Holland, Amsterdam and Boston, 1053–1128.

Baum, J. A. C., J. Singh. 1996. Dynamics of organizational responses to competition. *Soc. Forces* **74** 1261–97.

Bercovitz, J., M. Feldman. 2008. Academic entrepreneurs: Organizational change at the individual level. *Organ. Sci.* **19**(1) 69–89.

Bhattacharya, S., J. Ritter. 1983. Innovation and communication: Signaling with partial disclosure. *Rev. Econom. Stud.* **50** 331–46.

Bhide, A. 1999. *The Origin and Evolution of New Businesses*. Oxford University Press, Oxford.

Busenitz, L., J. Barney. 1997. Differences between entrepreneurs and managers in large organizations. *J. Bus. Venturing* **12**(1) 9–30.

Camerer, C., D. Lovallo. 1999. Overconfidence and excess entry: An experimental approach. *Amer. Econom. Rev.* **89**(1) 306–318.

Cohen, R. 2006. *Sweet and Low: A Family Story*. Farrar, Straus and Giroux, NY.

Cohen, W., R. Nelson, J. Walsh. 2001. Protecting their intellectual assets: Appropriability conditions and why US manufacturing firms patent (or not). NBER Working Paper 7552, National Bureau of Economic Research, Cambridge, MA.

Cooper, A. C., C. Y. Woo, W. C. Dunkelberg. 1988. Entrepreneurs' perceived chances for success. *J. Bus. Venturing* **3** 97–108.

Docie, R. L. 2004. *The Inventor's Bible: How to Market and License Your Brilliant Ideas*. Ten Speed Press, Berkeley, CA.

Dushnitsky, G., J. M. Shaver. 2009. Limitations to inter-organizational knowledge acquisition: The paradox of corporate venture capital. *Strategic Management J.* Forthcoming.

Economist. 2006. Searching for the invisible man: Economics focus. (March 11).

Evans, D., B. Jovanovic. 1989. An estimated model of entrepreneurial choice under liquidity constraints. *J. Political Econom.* **97** 808–827.

Evans, D., L. Leighton. 1989. Some empirical aspects of entrepreneurship. *Amer. Econom. Rev.* **9**(3) 519–35.

Forbes, D. 2005. Are some entrepreneurs more overconfident than others? *J. Bus. Venturing* **20**(5) 623–40.

Gallini, N., B. Wright. 1990. Technology transfer under asymmetric information. *RAND J. Econom.* **21**(1) 147–160.

Gans, J. S., S. Stern. 2000. Incumbency and R&D incentives: Licensing the gale of creative destruction. *J. Econom. Management Strategy* **9**(4) 485–511.

Gibbons, R. 1992. *Game Theory for Applied Economists*. Princeton University Press, Princeton, NJ.

Goldfarb, B., D. Kirsch, D. A. Miller. 2007. Was there too little entry during the dot com era? *J. Financial Econom.* **86**(1) 100–144.

Gompers, P. 1995. Optimal investment, monitoring and the staging of venture capital. *J. Finance* **50**(5) 1461–1489.

Hayward, M., D. Shepherd, D. Griffin. 2006. A hubris theory of entrepreneurship. *Management Sci*. **52** 160–72.

Holmstrom, B. 1979. Moral hazard and observability. *Bell. J. Econom.* **10** 74–91.

Kahneman, D., D. Lovallo. 1993. Timid choices and bold forecasts: A cognitive perspective on risk taking. *Management Sci*. **39** 17–31.

Kaplan, S. N., P. Stromberg. 2004. Characteristics, contracts, and actions: Evidence from venture capitalist analysis. *J. Finance* **59** 2173–2206.

Kawasaki, G. 2007. Lies, lies, lies! *Entrepreneur Magazine* (March), http://www.entrepreneur.com/capitallies/index.html.

Khanna, T. 1998. The scope of alliances. *Organ. Sci.* **9**(3) 340–355.

Kirsch, D., B. Goldfarb, A. Gera. 2008. Form or substance: The role of business plans in venture capital decision making. *Strategic Management J.* **30**(5) 487–515.

Kim, P., H. E. Aldrich, L. Keister. 2006. Access (not) denied: The impact of financial, human, and cultural capital on entrepreneurial entry in the United States. *Small Bus. Econom.* **27** 5–22.

Kirscht, J. P., D. P. Haefner, S. S. Kegeles, I. M. Rosenstock. 1966. A national study of health beliefs. *J. Health and Human Behav.* **7** 248–254.

Koellinger, P., M. Minniti, C. Schade. 2007. "I think I can, I think I can": Overconfidence and entrepreneurial behavior. *J. Econom. Psych.* **28**(4) 502–527.

Landier, A., D. Thesmar. 2009. Contracting with optimistic entrepreneurs: Theory and evidence. *Rev. Financial Stud.* **22**(1) 117–150.

Lant, T., Z. Shapira. 2008. Managerial reasoning about aspirations and expectations. *J. Econom. Behav. Organ.* **66**(1) 60–73.

Lazear, E. 1986. Salaries and piece-rates. *J. Bus.* **59** 405–431.

Lazear, E. P. 1999. Output-based pay: Incentives or sorting. NBER Working Paper 7419, National Bureau of Economic Research, Cambridge, MA.

Leland, H. E., D. H. Pyle. 1977. Information asymmetries, financial structure, and financial intermediation. *J. Finance* **32** 371–387.

Levin, R. C., A. K. Klevorick, R. R. Nelson, S. G. Winter. 1987. Appropriating the returns from industrial research and development. *Brookings Papers on Econom. Activity* 3 783–820.

Lowe, R., A. Ziedonis. 2006. Overoptimism and the performance of entrepreneurial firms. *Management Sci.* **52** 173–186.

Makadok, R. 2003. Doing the right thing and knowing the right thing to do: Why the whole is greater than the sum of the parts. *Strategic Management J.* **24**(10) 1043–1055.

Makadok, R., J. Barney. 2001. Strategic factor market intelligence: An application of information economics to strategy formulation and competitor intelligence. *Management Sci.* **47**(12) 1621–1638.

Manove, M., J. Padilla. 1999. Banking (conservatively) with optimists. *RAND J. Econom.* **30**(2) 324–350.

March, J., Z. Shapira. 1987. Managerial perspectives on risk and risk taking. *Management Sci.* **33**(11) 1404–1418.

Mayer, K. J., N. S. Argyres. 2004. Learning to contract: Evidence from the personal computer industry. *Organ. Sci.* **15**(4) 394–410.

Mayer, K. J., J. A. Nickerson. 2005. Antecedents and performance implications of contracting for knowledge workers: Evidence from information technology services. *Organ. Sci.* **16**(3) 225–242.

Mayer, K. J., J. A. Nickerson, H. Owan. 2004. Are supply and plant inspections complements or substitutes? A strategic and operational assessment of inspection practices in biotechnology. *Management Sci.* **50**(8) 1064–1081.

Milgrom, P. 1989. Auctions and bidding: A primer. *J. Econom. Perspectives* **3**(3) 3–22.

Moore, D., J. Oesch, C. Zietsma. 2007. What competition? Myopic self-focus in market-entry decisions. *Organ. Sci.* **18**(3) 440–454.

Moskowitz, T. J., A. Vissing-Jorgensen. 2002. The returns to entrepreneurial investment: A private equity premium puzzle? *Amer. Econom. Rev.* **92**(4) 745–778.

Nickerson, J. A., T. R. Zenger. 2002. Being efficiently fickle: A dynamic theory of organizational choice. *Organ. Sci.* **13**(5) 547–566.

Powell, T. C., D. Lovallo, C. Caringal. 2006. Causal ambiguity, management perception, and firm performance. *Acad. Management Rev.* **31**(1) 175–196.

Presti, K. 1997. Glitch found in Rockwell 56-kbps modem chipsets. *Computer Reseller News* (March 24) 14.

Sahlman, W. A. 1997. How to write a great business plan. *Harvard Bus. Rev.* **75** 98–108.

Sampson, R. C. 2004. The cost of misaligned governance in R&D alliances. *J. Law Econom. Organ.* **20**(2) 484–526.

Sarasvathy, D. K., H. A. Simon, L. Lave. 1998. Perceiving and managing business risks: Differences between entrepreneurs and bankers. *J. Econom. Behav. Organ.* **33** 207–226.

Schumpeter, J. 1934. *The Theory of Economic Development*. Harvard University Press, Cambridge, MA.

Shane, S., D. Cable. 2002. Network ties, reputation, and the financing of new ventures. *Management Sci.* **48**(3) 364–381.

Shane, S., S. Venkataraman. 2000. The promise of entrepreneurship as a field of research. *Acad. Management Rev.* **25**(1) 217–226.

Shapira, Z. 1995. *Risk Taking: A Managerial Perspective*. Russell Sage Foundation, New York.

Taylor, S. E., J. D. Brown. 1988. Illusion and well-being: A social psychology perspective on mental health. *Psych. Bull.* **103**(2) 193–210.

Teece, D. J. 1986. Profiting from technological innovation: Implications for integration, collaboration, licensing and public policy. *Res. Policy* **15**(6) 286–305.

Tversky, A., D. Kahneman. 1974. Judgment under uncertainty: Heuristics and biases. *Sci.* **185** 1124–1131.

Udell, G. 1990. It's still caveat, inventor. *J. Product Innovation Management* **7**(3) 230–243.

U.S. Small Business Administration. 1997. The state of small business: A report to the President. Report, U.S. Small Business Administration, Washington, DC.

Van den Steen, E. 2004. Rational overoptimism (and other biases). *Amer. Econom. Rev.* **94**(4) 1141–1151.

van Zimmeren, E., B. Verbeure, G. Matthijs, G. Van Overwalle. 2006. A clearing house for diagnostic testing. *World Health Organ.* **84** 352–359.

Weinstein, N. D. 1980. Unrealistic optimism about future life events. *J. Personality Soc. Psych.* **39**(5) 806–820.

Wu, B., A. Knott. 2006. Entrepreneurial risk and market entry. *Management Sci.* **52**(9) 1315–1330.

Zenger, T. 1994. Explaining organizational diseconomies of scale in R&D: The allocation of engineering talent, ideas, and effort by firm size. *Management Sci.* **40**(6) 708–729.

Zott, C., Q. Huy. 2007. How entrepreneurs use symbolic management to acquire resources. *Admin. Sci. Quart.* **52**(1) 70–105.