MANAGEMENT SCIENCE
Vol. 53, No. 6, June 2007, pp. 919–933
ISSN 0025-1909 | EISSN 1526-5501 | 07 | 5306 | 0919

informs

DOI 10.1287/mnsc.1060.0648

When Do Employees Become Entrepreneurs?

Thomas Hellmann
Sauder School of Business, University of British Columbia, Vancouver, British Columbia V6T 1Z2, Canada
hellmann@ubc.sauder.ca

This paper examines an economic theory of when employees become entrepreneurs. It jointly addresses the two fundamental questions of when employees generate innovations, and whether these innovations are developed as internal ventures or outside the firm. The model shows that if generating innovations distracts employees from their assigned tasks, firms may discourage innovation. Firms may reject profitable opportunities that fall outside of their core activities. If employees own the intellectual property (IP), they may leave to do a start-up. The allocation of IP rights also affects the generation of innovation. The external entrepreneurial environment is a complement to firm-internal innovation. If the external environment is particularly good, firms may embrace employee innovation and take advantage of it through spin-offs.

Key words: entrepreneurship; innovation; intellectual property rights; strategic management; employment policy
History: Accepted by Scott Shane, technological innovation, product development, and entrepreneurship; received April 11, 2006. This paper was with the author 5 months for 2 revisions.

1. Introduction

Where do entrepreneurs come from? Employees of established companies turn out to be one of the most important sources for entrepreneurship. The semiconductor industry, for example, has an impressive genealogy, where, generation after generation, employees left their parent company to launch the next entrant.[1] In a sample of fast-growing private companies, Bhidé (1994, p. 151) finds that "71 percent of all founders had replicated or modified an idea encountered through previous employment." Similarly, Cooper (1985) reports that in a broad cross section of industries 70 percent of all founders pursued opportunities closely related to their previous employment.

A popular complaint is that established firms simply miss out on all these great opportunities,[2] yet this hardly constitutes a systematic explanation. This paper argues that the departure of employees to become entrepreneurs can be understood as a natural equilibrium outcome in the process of innovation. In addition, we stress that it is not the only possible equilibrium outcome. While some employees leave, others stay to develop their innovations internally, turning employees into intrapreneurs.[3] Other firms use their employees' innovations to found spin-offs.[4] To get a better understanding of the supply of entrepreneurs, we need to ask how companies manage employee innovations.

This paper provides a theory of how firms formulate polices that affect the generation and development of employee innovations. We consider a model where a wealth-constrained employee sometimes obtains a new idea that is unrelated to her assigned employment task. She faces a multitask choice of either focusing on her task, or exploring the new idea. The incentive to remain focused depends on how likely she is to succeed with the assigned task, and how well the task is compensated. The attraction of pursuing a new idea is that it may generate far greater returns (including private benefits) than the employee could ever hope to earn on her assigned task. However, pursing an idea is risky, and whether it generates returns depends on how it can be commercialized.

In managing the employee's incentives, the firm faces a fundamental trade-off between exploitation and exploration. The firm wants the employee to

[1] The "traitorous eight" left Shockley Labs to create Fairchild Semiconductor, which itself saw its employees starting, among others, National Semiconductor, Intel, AMD, and LSI Logic, which in turn became parents to Cypress, Zilog, Sierra Semiconductor, and many other semiconductor companies.

[2] This notion has been popularized by Smith and Alexander (1999), who describe how Xerox "fumbled the future" by not capitalizing on some of its inventions for the personal computer, such as the mouse. Interestingly, Smith and Alexander put little emphasis on the fact that Xerox's main line of business was photocopiers, with which it was a highly successful and profitable firm during this period. Chesbrough (2002) provides a more thoughtful analysis of the Xerox experience.

[3] Bartlett and Mohammed (1995) report that 3M allows employees to use 15 percent of their time to develop new ideas. The company also has an objective of generating 25 percent of its sales from products that are less than five years old.

[4] Allen (1998) discusses Thermo-Electron as an example of a company that makes extensive use of spin-offs.

focus on the core task, yet the employee is attracted to idea exploration, which holds promise of greater private benefits. The firm can offer bonuses for core tasks and define policies for developing employee innovations. An important assumption is that the firm is able to commit to policies, even if they are ex post inefficient. The analysis generates four types of equilibria. First, in a *focused* equilibrium, the firm provides sufficient bonuses to keep all employees focused on their assigned tasks. The firm has a policy of refusing to develop any innovations that fall outside of the core activities, although in equilibrium employees never generate innovations. Second, the *stubborn* equilibrium is similar to the focused equilibrium, except that some employees (those with ideas and poor prospects for their assigned task) explore their ideas and sometimes generate profitable innovations. The firm sticks to its policy of refusing to support innovations. In equilibrium the employee leaves to become an entrepreneur (this requires that the employee owns the (intellectual property (IP)). In the first two equilibria, the firm actively discourages idea exploration. In the next two equilibria the firm accepts that it cannot "stem the tide" of its employee's ambitions, and decides to "go with the flow." In the *intrapreneurial* equilibrium, employees excessively explore their ideas, and the firm makes the best of their innovations by developing them as internal ventures. The *entrepreneurial* equilibrium is similar, except that development occurs through start-ups (if the employee owns the IP) or spin-offs (if the firm owns the IP).

The model generates several key insights. In the first two equilibria firms actively discourage employee innovation. In the stubborn equilibrium this even leads to a "dramatic" sequence of events, where employees prefer to develop their innovations inside the firm, the firm refuses (even though this is ex post inefficient), and the employees leave to become entrepreneurs. The model explains the curious empirical phenomenon that some entrepreneurs start their companies only after being rejected by their employers. While this may lead to a perception of "firms missing opportunities," the analysis shows that the firm's intransigence may be part of an optimal ex ante policy to promote greater focus on core tasks.

The model also generates new insights about IP rights and the importance of the external environment. If the employee owns the IP, as the external environment becomes increasingly attractive, the outcomes go from the focused, to the stubborn, to the intrapreneurial, to the entrepreneurial equilibrium. Contrast this with the case in which the firm owns the IP: For most parameter values the firm implements the focused equilibrium; only if the external environment becomes very attractive does the firm switch to the entrepreneurial equilibrium. Allocating IP rights to the employee thus increases employee innovation. The key intuition is that if the firm owns the IP, then the external environment only constitutes an opportunity for the firm. If the employee owns the IP, then the external environment also constitutes a threat, and the firm has to accommodate employee innovation more.[5]

The paper differs from the prior literature in several important respects. Most of the literature on innovation uses a single-task model (e.g., Aghion and Tirole 1994, Anand and Galetovic 2000, Gans and Stern 2000) and focuses on underinvestment in innovation. This paper considers a multitask model where incentives for innovation may interfere with incentives for core tasks. The prior literature explains employee departures as efficient outcomes (e.g., Cassiman and Ueda 2006, Lewis and Yao 2001, Pakes and Nitzan 1983), whereas our analysis can account for employee departures that are ex post inefficient. This is because the firm can commit to an optimal ex ante policy that trades off the benefits of greater employee focus with the costs of inefficient employee departures. Moreover, unlike some of the previous literature, the allocation of IP rights matters in this model. The reason that the Coase theorem does not apply is that firms can commit to ex post inefficient outcomes. The paper is related to several other literatures, not only economic theory, but also empirical research, ranging from ethnographic observation, to legal study, to econometric data analysis. Rather than attempting to summarize all this in the introduction, we defer the full literature discussion until after we have developed the theory.

The remainder of this paper is structured as follows. Section 2 derives the theory model. Section 3 provides an extensive discussion, including a literature review. It is followed by a brief conclusion. All proofs are given in the online appendix (provided in the e-companion).[6]

2. The Theory

2.1. The Base Model

Suppose there is a firm and a wealth-constrained employee. At date 0 an employment contract is drafted. At date 1 the employee may get a new idea that is unrelated to her main employment task. She has a

[5] The analysis takes the legal regime as exogenous, and assumes that the firm and the employee cannot privately reallocate property rights. This case is realistic if the law forbids such private recontracting. In California, for example, the law does not enforce certain private contracts that reallocate IP rights back to the firm. See Gilson (1999) and Hyde (1998).

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

private choice about whether to explore her idea or to focus on her assigned task. If she sticks to her task, she generates some verifiable value at date 3. If she explores her idea, she discovers at date 2 whether or not the idea is feasible. If it is feasible, the idea can be developed inside or outside the firm, or else it can be shelved. All returns accrue at date 3. All parties are risk-neutral profit maximizers. There is no discounting. For convenience, Table EC.1 in the online appendix provides a time line and Table EC.2 summarizes the notation used in the paper.

Let us begin with the idea exploration stage at date 1. As part of her regular job activities, the employee may serendipitously get a new idea that falls outside her main task. Let λ be the probability that she obtains such an idea. When she gets an idea, she can choose to ignore or explore it. We model this as a multitask problem, where she can focus either on Project A or B.

Project A denotes the assigned employment task, which may include a large variety of activities that improve the firm's current core businesses. If successful, the assigned task generates a value a for the firm. At the time of receiving the idea, the employee also receives a private signal about the likelihood of success: Either the prospects for the assigned task are "strong," so that success is certain; or they are "weak," so that the probability of success is given by $\phi \in (0, 1)$. The probability that the core prospects are strong is denoted by $\gamma \in (0, 1)$.[7]

Project B represents exploring a new idea. There are two stages to turning an idea into a successful venture: exploring the idea and developing the innovation. If the employee explores her idea, she finds out, at date 2, whether it is feasible (which occurs with probability p) or not. If it is not feasible, all parties receive zero utility. If it is feasible, we call the idea an innovation. A development effort is then required to generate value from the innovation.[8] The employee is indispensable for development.[9]

If the employee has an idea, she has to choose between focusing on her assigned task (A) or exploring her idea (B). We distinguish three levels of exploration:

σ^-: No exploration (employee never explores ideas)
σ^*: Efficient exploration (employee explores ideas only if core prospects weak)
σ^+: Excessive exploration (employee explores ideas irrespective of core prospects)

Condition (1) below justifies the use of the word "efficient" and "excessive."

Consider now the events at date 2. If the employee has chosen A, then nothing happens until date 3. If the employee has chosen to pursue an idea that turns out to be feasible, there are three possible development choices:

δ^0: No Development (Shelving)
δ^y: Internal Development (Internal ventures)
δ^x: External Development (Start-ups, Spin-offs)

If the innovation is not developed (δ^0), there are no returns. If the innovation is developed internally (δ^y), it generates a total utility y. If the innovation is developed externally (δ^x), it generates a total utility x. We assume that x and y are exogenous and symmetrically known.[10]

The utilities x and y include not only financial returns, but also any private benefits that the employee derives from developing her innovation. Private benefits might represent an increase in the value of the employee's human capital, and/or the satisfaction of developing her innovation, as well as monetary returns that the employee is always able to extract.[11] Private benefits allow us to capture the notion that employees are attracted to exploring ideas, rather than performing core tasks. This introduces a natural source of disagreement between the employee and the firm. Let β_x be the fraction of the total utility x that constitutes a private benefit, i.e., $\beta_x x$ is the expected (nontransferable) private benefit and $(1 - \beta_x)x$ is the expected (transferable) financial return. It is the same for β_y. For expositional convenience, we focus on the

[7] We assume that λ and γ are independent. In an earlier version of the paper we found that relaxing this assumption generated the same results, but made the analysis less transparent.

[8] We assume that a successful innovation does not cannibalize, nor complement, the firm's other profits. Adding such effects to the model is straightforward, but generates few additional insights.

[9] This assumption eliminates the issue of whether the idea leads to the creation of one or two ventures. Anton and Yao (1994, 1995) provide an extensive analysis of this problem.

[10] Section 3 discusses the literature that compares the efficiency of internal and external ventures. This literature focuses on differences in information, incentives, the availability of complementary assets inside the firm, the risk of appropriation outside the firm, and a variety of other aspects. Here we do not derive underlying differences between x and y, but instead focus on how such differences affect the generation and development of innovations. We also do not provide an explicit model of the development process, but note that x and y represent general expected utilities of this process.

[11] The notion of private benefits is broad. It includes the usual nonmonetary benefits, such as satisfaction of doing a venture, etc. (Incidentally, these benefits can be unrelated to the ultimate success of the venture, i.e., the employee may enjoy private benefits from development alone.) Moreover, private benefits can also represent nontransferable financial returns. These are financial returns that the employee can always extract, such as through efficiency wages, information rents, or hold-up power. They are not transferable because the employee is wealth constrained, and cannot commit not to extract them once development has been initiated. An earlier version of the paper explicitly modeled private benefits as a hold-up rent, but the current specification is more general.

case where $\beta_x = \beta_y$. The online appendix shows that relaxing this assumption changes very little in the model.

We want to focus on the parameter constellation where there can be either too much or too little exploration. For this, we assume that it is efficient to explore if the core prospects are weak, but not when they are strong. Formally, this means

$$\phi a < py < a. \tag{1}$$

We are now in a position to describe the contractual choices at date 0. We assume that all value realizations at date 3 are verifiable, so that contracts can be made contingent on them. Contracts are complete in the sense that we allow our contracting parties to use all verifiable information. If the employee generates value in the core, the firm may reward this with w_a. If she generates value from an internal development, the firm may reward this with w_y.[12] The firm can also set a reward w_x if the employee develops an innovation externally. The employee is wealth constrained. This imposes an important constraint on the set of contracts that the firm can offer, namely $w_a, w_y, w_x \geq 0$.[13]

There are two regimes of IP rights: the employee-friendly regime (denoted by EIP) where innovations belong to the employee, and the firm-friendly regime (denoted by FIP) where innovations belong to the firm. The legal regime is exogenous, and we assume that the firm and the employee cannot privately reallocate property rights.[14]

We are interested in how firm policies affect the process of innovation. For this, we consider the two polar cases where the firm is either able or unable to commit itself. We can think of commitment as a deliberate policy of top management, and/or a corporate culture among middle management (who may be responsible for development decisions) that is sanctioned by top management. For simplicity, we treat the ability to commit as exogenous, but one can use standard economic reasoning to derive commitment endogenously from a reputation condition in an infinitely repeated game. The firm is able to commit to a policy as long as the long-term benefit of maintaining its reputation outweighs the short-term benefit of reneging on its commitment. Long-term benefits are higher, the greater the number of employees, and the lower the firm's discount rate.[15] For the commitment case, the firm can specify at date 0 how it will behave at date 2. If the firm owns the IP, it can commit to choose either δ^0, δ^y, or δ^x. If the employee owns the IP, then the firm can only make a commitment about whether or not to do an internal development δ^y.[16]

2.2. The Employee-Friendly Regime

We begin our analysis with the case in which the employee owns the IP. We first focus on the case of $x < y$, where start-ups are inefficient compared to internal ventures. Even though one might expect no start-ups to arise under these circumstances, we will see otherwise.

Consider an employee with an innovation at date 2. If she leaves the firm, she obtains x, which includes the financial value as well as private benefit. Because leaving is inefficient for $x < y$, the firm may try to retain her with an offer w_y, giving her a utility of $\beta_y y + w_y$. For $x < \beta_y y$ the firm sets $w_y = 0$, but for $x > \beta_y y$ the firm needs to offer $w_y = x - \beta_y y$. The employee's utility of staying with the firm is thus given by $z \equiv \text{Max}[\beta_y y, x]$.

Consider now the multitask choice at date 1. The employee's motivation for pursuing an idea includes not only financial returns, but also private benefits. By contrast, the motivation for performing the assigned task is purely financial. If the employee has an idea, she explores it whenever $pz > w_a$ for a strong core, and whenever $pz > \phi w_a$ for a weak core. This assumes that the firm makes an offer for internal venturing. If the firm has a policy of no internal ventures, the employee explores her idea whenever $px > w_a$ for a strong core, and whenever $px > \phi w_a$ for a weak core. These four equations constitute the employee's incentive constraints.

The firm has two levers for influencing the employee's choice. First, to encourage the employee to focus more on her assigned task, the firm can increase w_a. Unfortunately, this increases the compensation of all employees, including all those with no ideas, so it can become expensive for the firm. Intuitively, increasing w_a works well for higher values of λ, but becomes costly for lower values of λ.

[12] Note that in this model it makes no difference whether the payment w_y is made at date 2 or date 3. That is, it makes no difference whether the contract is made contingent on the outcome y or on the development decision δ^y. It is the same for w_x. Note also that if the employee generates no value at date 3, the firm could reward this with w_0. It is easy to see that the firm never benefits from rewarding the employee for doing nothing, so that $w_0 = 0$ is always optimal.

[13] One may wonder if the employee cannot relax the wealth constraint by pledging some of the returns from the innovation. For an internal venture, all of the employee's wealth comes from w_y, so that $w_y \geq 0$ remains valid. If the development is external, then the firm cannot bond its employees, implying $w_x \geq 0$.

[14] Note that even if reallocation were allowed, it might not occur because of the employee's wealth constraint. An earlier working paper examined this in greater detail.

[15] Simon (1951) and Kreps (1990) argue that an employment relationship can be thought of as an infinitely repeated game, where the firm is a long-run player, facing successive generations of employees who are short-term players.

[16] The firm could also "bribe" the employee to shelve the innovation. It is easy to show that this is never optimal in this model.

The firm's second lever is its development policy, specifically, whether or not to engage in internal ventures. Ex post (i.e., at date 2), internal venturing is profitable because the firm receives a profit of $y - z$. Ex ante (i.e., at date 1), however, it may encourage too much idea exploration. For higher values of x, there is no ex ante incentive effect to internal venturing. Specifically, for $x > \beta_y y$, we have $z = x$, so that the employee gets the same utility irrespective of whether he stays or leaves. For lower values of x, namely for $x < \beta_y y$, the employee prefers internal venturing. A policy of refusing internal ventures therefore has the ex ante effect of discouraging idea exploration. Intuitively, the ex ante incentive effect is stronger for lower values of x, because the refusal leaves the employee with a weak outside option. It is stronger for higher β_y, because the employee enjoys internal ventures. Moreover, the firm cares more about focus if core prospects are strong, so that the incentive effect matters more for higher values of γ.

This provides an intuitive overview of the firm's choices. We can now turn to the more formal derivation of the firm's optimal policies. As a benchmark, consider the case where the firm is unable to commit to inefficient ex post actions. In this case, its development policy is always δ^y (for $x < y$). At date 1, the employee chooses σ^- if $pz \le \phi w_a$; chooses σ^* if $\phi w_a \le pz \le w_a$; and chooses σ^+ if $w_a < pz$. To implement (σ^-, δ^y) as an equilibrium, the firm chooses the lowest w_a that satisfies $pz \le \phi w_a$, given by $w_a = pz\phi^{-1}$. This gives the firm an ex ante utility of

$$U(\sigma^-, \delta^y) = (\gamma + \bar{\gamma}\phi)(a - pz\phi^{-1}). \tag{2}$$

Throughout the paper, a bar above a probability parameter denotes its complement, i.e., $\bar{\gamma} = 1 - \gamma$. To implement (σ^*, δ^y), the firm sets $w_a = pz$ so that

$$U(\sigma^*, \delta^y) = \lambda\bar{\gamma}(py - pz) + (\gamma + \bar{\lambda}\bar{\gamma}\phi)(a - pz). \tag{3}$$

To implement σ^+, the firm simply sets $w_a = 0$ so that

$$U(\sigma^+, \delta^y) = \lambda(py - pz) + \bar{\lambda}(\gamma + \bar{\gamma}\phi)a. \tag{4}$$

Straightforward calculations reveal that $U(\sigma^*, \delta^y) > U(\sigma^-, \delta^y)$, i.e., (σ^-, δ^y) is a dominated policy. Moreover, after transformations we obtain $U(\sigma^+, \delta^y) > U(\sigma^*, \delta^y) \Leftrightarrow \lambda < (\gamma + \bar{\gamma}\phi)pz/(\gamma(a - py) + (\gamma + \bar{\gamma}\phi)pz)$. We want to focus on the model where this condition holds for all values of x. We therefore introduce the following parameter restriction:

$$\lambda < \hat{\lambda} \equiv \frac{(\gamma + \bar{\gamma}\phi)p\beta_y y}{\gamma(a - py) + (\gamma + \bar{\gamma}\phi)p\beta_y y}.$$

This condition simply says that it is sufficiently rare that employees get ideas outside of their assigned task. The assumption reflects our emphasis on ideas that are unconventional and unplanned (see also §3.1). In the online appendix we discuss what happens when we relax this condition. We have thus derived our first proposition.

Proposition 1. *Suppose that $x < y$, $\lambda < \hat{\lambda}$, and that the employee owns the IP.*

- *If the firm is unable to commit to a development policy, the intrapreneurial equilibrium (σ^+, δ^y) obtains. The employee excessively explores her ideas, and the firm makes the best of it by developing the innovations internally.*

Proposition 1 provides a benchmark for all subsequent propositions. It says that in the absence of commitment, the firm accepts that the employee likes to explore ideas. The firm makes the best of it through internal ventures. In equilibrium there is excessive exploration, i.e., the employee explores her ideas even if the core prospects are strong. We call this the intrapreneurial equilibrium.

Now consider the case in which the firm can commit to a development policy. As discussed above, the firm may adopt a policy of no internal ventures to improve ex ante incentives. The employee's remaining option is to do a start-up. This corresponds to a development decision δ^x. The firm can still use bonuses to affect the employee's choices. The employee chooses σ^- if $px \le \phi w_a$, chooses σ^* if $\phi w_a \le px \le w_a$, and chooses σ^+ if $w_a \le px$. To implement (σ^-, δ^x), the firm sets $w_a = px\phi^{-1}$, which gives

$$U(\sigma^-, \delta^x) = (\gamma + \bar{\gamma}\phi)(a - px\phi^{-1}). \tag{5}$$

To implement (σ^*, δ^x), it sets $w_a = px$ so that

$$U(\sigma^*, \delta^x) = (\gamma + \bar{\lambda}\bar{\gamma}\phi)(a - px). \tag{6}$$

To implement σ^+, it simply sets $w_a = 0$ so that

$$U(\sigma^+, \delta^x) = \bar{\lambda}(\gamma + \bar{\gamma}\phi)a. \tag{7}$$

We immediately note that $U(\sigma^+, \delta^y) > U(\sigma^+, \delta^x)$, i.e., (σ^+, δ^x) is a dominated policy. With this, we proceed to Proposition 2. The proof in the online appendix derives the critical values $\hat{x}_1$, $\hat{x}_2$ (where $0 < \hat{x}_1 < \hat{x}_2 < y$) and $\hat{\gamma}_1$ (where $0 < \hat{\gamma}_1 < 1$).

Proposition 2. *Suppose that $x < y$, $\lambda < \hat{\lambda}$, $\gamma > \hat{\gamma}_1$, that the employee owns the IP, and that the firm is able to commit to a development policy.*

- *With a weak external environment $(x < \hat{x}_1)$ the focused equilibrium (σ^-, δ^x) obtains; the firm refuses internal venturing; the employee never explores her ideas.*
- *With an intermediate external environment $(\hat{x}_1 < x < \hat{x}_2)$ the stubborn equilibrium (σ^*, δ^x) obtains; the firm refuses internal venturing; the employee explores ideas if the core prospects are weak; if she finds an innovation she becomes an entrepreneur, even though internal venturing would be preferred.*
- *With a strong external environment $(\hat{x}_2 < x < y)$ the intrapreneurial equilibrium (σ^+, δ^y) obtains; the firm welcomes internal ventures; the employee explores her*

ideas, even if the core prospects are strong; if she finds an innovation she becomes an intrapreneur.

- *The critical boundary $\hat{x}_1$ is increasing in a and ϕ, and decreasing in p. The critical boundary $\hat{x}_2$ is increasing in a and decreasing in p.*

Proposition 2 shows that the equilibrium outcome is affected by the external environment. We distinguish between three outcome regions. Consider first an environment where the employee faces weak outside options in terms of doing a start-up. In this case, the firm's refusal to implement internal ventures puts a real damper on the employee's desire to explore new ideas. We call (σ^-, δ^x) the focused equilibrium, because the firm's refusal has the intended effect that the employee always focuses on her assigned task. In addition to refusing internal ventures, the firm also provides a bonus of $w_a = px\phi^{-1}$ for the core task. The focused equilibrium works well for the firm as long as the external environment constitutes a low threat.

As x rises, the cost of providing a bonus for the core task becomes too onerous. At this point, the firm switches to a slightly different policy: It continues to refuse internal ventures, but resigns itself to the fact that some employees will explore their ideas, namely, when they face poor prospects on their assigned core task. In order not to further encourage idea exploration, the firm sticks to its commitment not to engage in internal ventures. As a result, the employee does a start-up, even though she would prefer to do an internal venture. This is an important and perhaps surprising result. We call (σ^*, δ^x) the stubborn equilibrium because the firm stubbornly refuses to do internal ventures, even though in equilibrium it loses out on internally generated opportunities. While the firm may appear to be too inflexible, its policy of refusing some of the internally generated opportunities is actually part of an optimal policy of encouraging employees to focus on their core activities.

As x rises further, even the stubborn policy becomes too costly for the firm. For $x > \hat{x}_2$ the firm no longer wants to stem the flow of entrepreneurial ideas, but instead decides to go with the flow. It lets the employee pursue all her ideas, and develops her innovations through internal ventures. Note that this is the same as in Proposition 1.

The comparative statics of the equilibrium regions are very intuitive. A higher return on core activities (higher a) increases the ranges of the focused and stubborn equilibria. This is because a higher return encourages the firm to focus its employees. Better odds of idea exploration (higher p) have the exact opposite effect. If the odds in the case of a weak core become more favorable (higher ϕ), this increases the range of the focused equilibrium. Note that this is the only equilibrium where the employee refrains from exploring ideas with a weak core.

Proposition 2 also uses the condition $\gamma \geq \hat{\gamma}_1$, which requires that strong core prospects occur sufficiently often. We already noted above that for higher values of γ the firm cares more about focusing its employees. The model with higher values of γ characterizes a firm that needs to deal with the fact that employees occasionally face poor prospects on their assigned task. The model with small γ characterizes a less-fortunate situation where employees have badly designed jobs in the first place, in the sense that their assigned task has a poor chance of success most of the time. This is probably a less realistic case, and we discuss it in the online appendix.

2.3. The Firm-Friendly Regime

So far, we have assumed that the employee owns the IP. If the firm owns the IP, it has an additional policy at its disposal, namely, to shelve an innovation (i.e., not to develop it at all). The traditional motive for shelving an innovation, cannibalization, is purposely assumed away in this model. Instead, here the motive is that shelving may improve ex ante incentives. The threat of shelving is much more powerful than the refusal to do internal ventures, because shelving implies that an employee who explores an idea always obtains zero utility. This makes it easy for the firm to prevent idea exploration. In addition, the firm hardly needs to pay a bonus for the core activity. Any arbitrarily small bonus ($w_a \to 0$) keeps the employee focused on her assigned task, irrespective of whether core prospects are strong or weak. We denote this policy as (σ^-, δ^0), and note that it simply yields

$$U(\sigma^-, \delta^0) = (\gamma + \bar{\gamma}\phi)a.$$

For the next proposition, the online appendix derives the critical value $\hat{\gamma}_2$, and shows that $\hat{\gamma}_2 < \hat{\gamma}_1$.[17]

Proposition 3. *Suppose $x < y$, $\lambda < \hat{\lambda}$, $\gamma > \hat{\gamma}_2$, and that the firm owns the IP.*

- *If the firm is unable to commit to a development policy, then the intrapreneurial equilibrium (σ^+, δ^y) obtains.*
- *If the firm is able to commit to a development policy, then the focused equilibrium (σ^-, δ^0) obtains. The firm threatens to shelve all innovations, so the employee never explores her ideas.*

Proposition 3 constitutes a simple but powerful result. First, if the firm cannot commit, then the equilibrium is always intrapreneurial, just as in Proposition 1.[18] The power to shelve innovations is useless for the firm if it cannot commit to use this power.

[17] In fact, the online appendix shows that for some parameter values we have $\hat{\gamma}_2 < 0$, in which case the condition $\gamma > \hat{\gamma}_2$ is never binding anyway.

[18] There is one minor difference, namely, that the firm now always sets $w_y = 0$, whereas in Proposition 1, it had to offer $w_y = x - \beta_y y$ for $\beta_y y < x < y$.

With commitment, however, giving the firm the IP dramatically changes the equilibrium. The key intuition is that the external environment no longer constitutes a threat to the firm. The firm finds it easy to implement a focused equilibrium. It commits to shelve all employee innovations. This discourages idea exploration, so that employees always focus on the core business.

Why does the firm choose such an extreme policy? In principle it would like its employees to pursue new ideas when the core is weak, but not when the core is strong. The problem is that inducing such a separating outcome (σ^*) is costly to the firm, because it requires paying a bonus for the core task, even when the employee doesn't have an idea. If ideas are sufficiently rare ($\lambda < \hat{\lambda}$), and ex ante incentives matter sufficiently ($\gamma > \hat{\gamma}_2$), then the firm prefers to forgo the benefits of innovation by refusing any type of development (δ^0).

Proposition 3 (for the FIP model) calls the equilibrium focused, just as in Proposition 2 (for the EIP model). This is because in both cases the employee never explores her ideas. The only difference is that in the EIP model the firm offers a bonus $w_a = px\phi^{-1}$, whereas in the FIP model the firm doesn't even need to do that, i.e., $w_a = 0$. Note that for $x \to 0$, the two policies become identical.

Comparing Propositions 2 and 3, we recognize that the allocation of IP rights can have a dramatic effect both on the generation and development of innovations. In terms of a social welfare comparison, one may be inclined to argue that the firm-friendly regime is less desirable because it undermines innovation. However, a comparison of the two regimes requires that we also take into account the value of core tasks. It is easy to verify that neither regime Pareto-dominates the other: The employee is always better off under EIP, and the firm is always better off under FIP. An earlier working paper (Hellmann 2005) provides a full comparison of the two regimes using the standard welfare criterion of maximizing the sum of the employee's and the firm's utilities. The main finding is that neither regime clearly dominates the other, precisely because there is a nonobvious trade-off between favoring innovation in the EIP regime versus favoring value creation from core activities in the FIP regime.

Our model focuses on the two polar cases where either the employee or the firm owns the IP. The earlier working paper version also examined a model with imperfect IP rights. Even if the firm owns the IP in principle, the employee can "go alone," i.e., leave and develop the innovation without formally owning the IP. The imperfect IP rights model convexifies the two models, so that outcomes converge to the EIP (FIP) model for sufficiently high (low) returns of pursuing a go-alone policy. In this model, the firm may also want to decrease the returns to a go-alone, such as by committing to sue departing employees.[19]

2.4. When External Development Is Better Than Internal

We now turn to the analysis where the external environment dominates internal venturing ($x > y$). In this case, external venturing constitutes not only a potential threat, but also an opportunity. The online appendix derives a critical value $\hat{x}_3$ that satisfies $\hat{x}_3 > y$. With this we obtain the following results.

Proposition 4. *Suppose $x > y$, $\lambda < \hat{\lambda}$, and $\gamma > \hat{\gamma}_2$.*

- *If the employee owns the IP, the entrepreneurial equilibrium (σ^+, δ^x) obtains, irrespective of whether the firm is able or unable to commit.*
- *If the firm owns the IP and is unable to commit, the entrepreneurial equilibrium (σ^+, δ^x) obtains.*
- *If the firm owns the IP and is able to commit, then the focused equilibrium (σ^-, δ^0) obtains for $x < \hat{x}_3$, and the entrepreneurial equilibrium (σ^+, δ^x) obtains for $x > \hat{x}_3$. The critical boundary $\hat{x}_3$ is increasing in a and ϕ, and decreasing in p.*

If the employee owns the IP, she simply leaves the firm every time she has an innovation. We call this the entrepreneurial equilibrium. The firm finds it too costly to provide incentives against idea exploration, and resigns itself to the fact that the employee explores excessively. In this case, the external environment is all threat and no opportunity for the firm. Because the firm's optimal policy does not involve any inefficient ex post decisions, the optimal policy is the same with or without commitment.

This result depends on the allocation of IP rights. If the firm owns the IP, preventing idea exploration is easier. Indeed, for $x < \hat{x}_3$, the firm's optimal policy remains the same as in Proposition 3: The firm threatens not to develop any innovations (δ^0), which convinces the employee not to explore her ideas (σ^-). For larger values of x, however, the external environment becomes so attractive that the opportunity cost of the focused equilibrium becomes too high. For $x > \hat{x}_3$ the firm changes its optimal policy. It welcomes all idea exploration, even if the core prospects are strong. It makes the best use of employee innovations by ensuring their external development. We call this an entrepreneurial equilibrium, but note that there is an important difference between the EIP and the FIP model. In the EIP model, the employee leaves to do a start-up, without sharing any of the financial rewards with her employer. In the FIP model, the

[19] Jackson (1998) describes how Intel takes an aggressive approach of protecting its IP, harassing departing employees with frivolous lawsuits.

Figure 1 Overview of Equilibria

Panel A: Equilibrium outcomes

External environment	Weak	Intermediate	Strong	Slightly superior	Strongly superior
Employee-friendly IP	Focused	Stubborn	Intrapreneurial	Entrepreneurial	
Firm-friendly IP	Focused				Entrepreneurial
No commitment case	Intrapreneurial			Entrepreneurial	

Panel B: Equilibrium properties

Equilibrium	Focused	Stubborn	Intrapreneurial	Entrepreneurial
Bonus for success with core task	High under EIP None under FIP	Moderate	None	None
Firm stance on internal ventures	Refuse	Refuse	Encourage	External ventures dominate internal ventures
Employee exploration level	None	Efficient	Excessive	Excessive
Equilibrium venturing activities	None	"Inefficient" start-ups	Internal ventures	Start-ups under EIP Spin-offs under FIP

firm hires the employee to manage a spin-off. The employee enjoys the private benefits $\beta_x x$, but does not reap any of the transferable financial returns $(1-\beta_x)x$.

The comparative statics of $\hat{x}_3$ are intuitive. A higher return on core activities (higher a, higher ϕ) increases the range of the focused equilibrium, while better odds for idea exploration (higher p) has the opposite effect.

The policy of deterring idea exploration requires commitment not to develop profitable innovation. Without commitment, the firm's threat to shelve innovations is not credible. In this case the entrepreneurial equilibrium obtains for all x with $x > y$.

2.5. Key Insights and Robustness

Propositions 1 through 4 constitute the core of our theoretical analysis. To provide a better overview, Figure 1 summarizes these key results. Panel A shows how the equilibrium changes as a function of the external environment, the allocation of IP rights, and commitment. Panel B provides a description of the properties of the four types of equilibria.

In §3 we will discuss how our results relate to a variety of literatures. As a preamble, it is useful to summarize the key insights of the model and discuss how robust they are.

This paper proposes the multitask incentive problem as a framework for analyzing firm policies towards employee innovation. Within this framework the model generates the following key insights.

(1) A firm may discourage employee innovation in order to focus its employees on their core task.

(2) To focus its employees, a firm may refuse to implement profitable employee innovations. In equilibrium, employees with innovations may leave to do start-ups, even if they would prefer to do internal ventures.

(3) Allocating IP rights to the employee instead of the firm leads to more innovation, more internal ventures, and more start-ups.

(4) The effect of the external environment is as follows:

- If the employee owns the IP, then a better external environment encourages employees to generate more innovations and develop them as internal ventures or start-ups.
- If the firm owns the IP, then it prefers to focus its employees on their core tasks unless the external

environment is very strong, in which case it supports employee innovation through spin-offs.

(5) If a firm is unable to commit to an innovation policy, then the allocation of IP rights is irrelevant for the outcome. The firm supports all employee innovations, developing them internally or externally, whichever way is more profitable.

How general are these key insights? We would argue that the first insight is very general, and survives many model permutations. It captures a fundamental trade-off that emerges in a multitask environment. In §3.1 we explain how the multitask model captures a bottom-up perspective for understanding the process of innovation.

The second insight may seem model specific at first, but we would argue that the result is fairly general. In terms of the underlying intuition, all that is required is that the firm cares more about ongoing (ex ante) incentives of its employees, rather than the one-time (ex post) opportunity of pursuing an employee innovation. In terms of a formal model, the simplification that there are only two core states—strong ($\tilde{\phi} = 1$) and weak ($\tilde{\phi} = \phi$)—understates the generality of the stubborn equilibrium. In a more general model where $\tilde{\phi}$ is a random variable distributed over $[0, 1]$, it is easy to see that for any finite bonus w_a there always exist some employees who explore ideas, namely, those with $\tilde{\phi} w_a < px$. As long as the firm wants to focus its employees, it will refuse to implement those employee's innovations, and they will leave to do their own start-ups.

The third and fourth insights are interrelated. Their basic insight is also quite general. The key is that if the firm owns the IP, the external environment constitutes an opportunity, but never a threat. The firm has an easy way of focusing its employees, namely, by shelving all innovations. Without the IP, however, the external environment also constitutes a threat for the firm, which forces it to be more accommodating towards employee innovation.

The fifth key insight about the role of commitment is also fairly general. The main issue is that without commitment, the firm cannot have a deliberate policy on employee innovation. Our analysis suggests that IP rights matter precisely because they influence the firm's commitment to inefficient development decisions. Without commitment, the full force of the Coase theorem comes back, predicting efficient development decisions.[20]

[20] In the online appendix we note one exception to this. For $\beta_x > \beta_y$ there is a small region around y, where the employee prefers to do a start-ups if she owns the IP, but the firm prefers to do an internal venture if it owns the IP. IP rights matter here because the employee's wealth constraint prevents renegotiation to the jointly optimal outcome. A similar argument applies for $\beta_x < \beta_y$.

This verbal analysis suggests that the main intuitions of the model are quite general. The online appendix also contains a discussion of how our formal analysis depends on several parameter restrictions.

3. Discussion of Model

The previous section explains the theoretical model. In this section we discuss how the model contributes to a variety of theoretical and empirical literatures. We interpret the main results of the model, and derive a variety of empirical implications. Some of the empirical predictions relate to existing work in the literature, others are essentially new and will hopefully provide stimulus for future research. Rather than breaking out the interpretation of the model, the literature review, and the empirical predictions into separate sections, we discuss them jointly. We structure our discussion around a number of themes.

3.1. How Do Firms Structure Incentives for Employee Innovation?

At the core of our model is the firm's choice about what kind of incentives it wants to provide to its employees. Aghion and Tirole (1994) use an incomplete contracts model, where both the employee and employer make relationship-specific investments. Similar to Grossman and Hart (1986), their model focuses on the ex post hold-up problem, and examines how the allocation of property rights might affect efficiency. The use of an incomplete contracts model excludes firm policies such as incentive compensation, because, by assumption, only property rights are ex ante contractible.

Following Aghion and Tirole, a small literature examines under what circumstances firms are better than independent financiers (such as venture capitalists) at financing innovations. Anand and Galetovic (2000), Anand et al. (2004), and Gans and Stern (2000, 2003) emphasize hold-up problems in the presence of weak property rights, while Hellmann (2002) emphasizes incentive conflicts with the firm's core business. All of this literature assumes that the employee already has a well-defined project, and asks how to finance it optimally. De Bettignies and Chemla (2006) consider a task allocation problem, where core tasks have a low elasticity of effort, but innovative tasks have a high elasticity of effort. They show that for better employee outside options, the firm is more interested in internal ventures, which have a higher effort elasticity. In their model, it is the firm, not the employee, who decides on the employee's choice of project.

We focus on a multitask incentive problem, where the employee chooses what activities to focus on (Holmström and Milgrom 1994). At the core of our multitask problem is a trade-off between exploration

and exploitation (March and Olsen 1991). Exploitation refers to the pursuit of profits in the core business, while exploration concerns the generation of new business opportunities. The most common way of thinking about this trade-off is to take a "top-down" perspective, where senior management decides on the optimal mix of exploration and exploitation. Instead, our model proposes a bottom-up perspective, where the employee's choices ultimately determine what the firm does. That is, the multitask model allows us to focus on how employees determine firm activities. Top-down firm policies continue to matter, because employees respond to the firm's incentive environment.

Our multitask model appears to differ from the abovementioned single-task models in one important way. The single-task literature typically finds that the employee innovates too little, whereas in our model the firm's problem is that the employee wants to explore too much. Casual observation might also suggest that many firms would like their employees to be more innovative. Our multitask approach prompts us to go deeper and ask what type of innovations firms want: innovations that fit with the firm's core activities and generate rents for the firm, or innovations that fall outside of the firm's core activities and mostly generate rents for the employee? The single-task literature implicitly allows only for the first type of innovation. Our multitask model classifies the first type as part of the assigned core task (i.e., part of the employee's job is to come up with improvements for doing the assigned task), and distinguishes it from the second type of innovation, which the firm considers a distraction.

This distinction between different types of innovations builds on the ethnographic studies of Burgelman (1983, 2002) and Burgelman and Sayles (1986). This line of research emphasizes the coexistence of a planned and an unplanned innovation process. It shows how many important innovations emerge from bottom-up "skunks work," where employees explore unconventional ideas before having their research sanctioned by senior management. Burgelman emphasizes that firms face important choices as to how much they tolerate this unplanned process. His most prominent example is Intel, which greatly benefited from tolerating unplanned innovation: In fact, this is how Intel found its way into the semiconductor business. However, when Intel's semiconductor business was doing particularly well (under the leadership of the enigmatic Andy Grove), the company became extremely focused, and lost its tolerance for unplanned innovation. The work of Burgelman is consistent with our approach. In particular, it validates the importance of a bottom-up model, where employees choose whether to explore their ideas versus remaining focused on their assigned tasks. Moreover, Intel's experience is consistent with the model prediction that firms become less tolerant towards exploration when they face a boom in their core activities.[21]

3.2. Why Do Innovative Employees Leave?

An interesting question is why employees sometimes leave their employer to do a start-up, rather than developing their innovation as an internal venture. Some prior work points out why firms should be investing in their employees' ideas. The work of Teece (1986) explains why firms may have a comparative advantage at developing and commercializing their employees' innovations, focusing on the importance of complementary assets. Bankman and Gilson (1999) explain that firms may have tax advantages relative to outside financiers. This makes it all the more surprising when firms reject their employees' ideas.

A seminal theory paper on whether employees with innovations leave or stay is Pakes and Nitzan (1983). Their model is essentially a neoclassical cost-benefit analysis of cannibalization. In their model, the employee leaves if and only if leaving is the efficient decision. Lewis and Yao (2001) also provide an efficiency explanation for employee departures. They argue that a firm may deliberately embrace mobility of its employees in order to be considered an attractive employer. Cassiman and Ueda (2006) provide a dynamic model that also has the feature that the employee leaves if and only if leaving is efficient. Their model assumes that a firm has limited capacity for internal ventures. The firm trades off the returns of an employee's innovation not only against cannibalization, but also against the option value of waiting for better projects in the future. In their environment, it may look like the firm rejects a profitable project, yet there is no inefficiency. The firm does not look at the employee's project in isolation, but instead looks at it from the perspective of optimizing a dynamic project portfolio.

Our model abstracts from cannibalization, not because it is not important, but because this allows us to focus on a different rationale for why firms reject employee innovations. In the stubborn equilibrium, employees depart involuntarily, in the sense that they would have preferred to develop their innovation as an internal venture. We believe that this is a novel result in the literature. To understand its significance, let us examine some of the puzzling evidence about the frustrations experienced by departing

[21] The legal literature also makes a clear distinction between innovations that come out of planned R&D activities versus unplanned innovations. If an employee is hired to invent, then an innovation is considered part of regular output and belongs to the firm. This is not necessarily true for ideas that are largely unrelated to the task for which the employee was hired.

employees. While there is no systematic measure for whether employees depart voluntarily or not, there is anecdotal evidence that suggests that entrepreneurs often offer their innovations to their employer, and decide to start their own companies only after being rejected by their employer. A famous example is Gene Amdahl, who proposed his venture to his employer (IBM). After being rejected by IBM several times, he reluctantly started his company (Amdahl Computer). The founders of Data General also offered their project to their employer (Digital Equipment Corporation (DEC)) in vain before venturing out on their own.

There are several reasons why employees may become frustrated with the firm. Amador and Landier (2003) note that while the employee may be optimistic about the prospects of the innovation, the firm may not share that optimism. They consider an employee with optimistic beliefs about the success of an innovation, and show that a firm with less optimistic beliefs might be unwilling to finance the venture at terms that would be acceptable to the employee. In a related vein, employees may worry that the employer will steal their ideas. Anton and Yao (1995) examine a model where employees leave because their employer cannot commit not to appropriate ideas upon disclosure.

In our model, the frustration of departing employees stems from the fact that the firm forgoes a profitable opportunity for reasons of strategic commitment. This can be interpreted more broadly as rigidity, which prevents the firm from pursuing opportunities outside its defined core business. This is related to the notion of a narrow business strategy, as in Rotemberg and Saloner (1994). One may also interpret the stubbornness of the firm as organizational inertia, where middle managers are not encouraged to venture beyond accepted boundaries.[22]

Our model shows that employees are more likely to leave when bonuses for the assigned task are low. Subramanian (2005) reaches a similar conclusion in a model that bears some similarities to ours. He considers a dynamic model of innovation, where the employee always owns the IP and the firm is never able to commit. Of particular interest here is his empirical finding. He finds that firms that have high levels of employee departures also have relatively lower levels of employee stock options.

3.3. What Explains the Level of External Venturing Activity?

Our theory makes predictions about when employee ideas are developed outside the firm's boundary. Unlike the previous two themes, this is a theme that has benefited from considerable empirical work. In our theory we make a clear distinction between start-ups, where the employee owns the IP, and spin-offs, where the employer owns the IP and maintains some financial interest. Unfortunately, the empirical literature typically does not make that distinction, neither in the data, nor in the use of terms. To avoid further confusion, we maintain our distinction between start-ups and spin-offs, and use the term "external ventures" for both.

Our model predicts that external ventures occur for opportunities that do not fit well with the firm's current core activities. Klepper and Sleeper (2005) provide detailed evidence on external ventures in the laser industry. They show that the external ventures were often based on technologies similar to those of their parent companies. At first sight, this appears inconsistent with our model. However, these external ventures typically targeted different customer segments than those of their parent companies. This finding echoes earlier work by Christensen (1997), who argues that firms develop blind spots to new opportunities when the new customers are different from the firm's current customer base. Upon closer examination, Klepper and Sleeper's evidence thus supports the notion that external ventures typically do not fit with their parents' strategic vision.

Gompers et al. (2005) provide further evidence on the question of how external venturing relates to parent characteristics. They examine venture capital-backed companies in a broad cross section of industries, and link them to their founder's prior employers. They find that parent companies spawn more external ventures when they pursue a more focused business strategy. This is consistent with our stubborn equilibrium, where employees leave because their parent firms pursue a narrow business strategy.

Our model predicts more external ventures when a company is facing weaker prospects in its core business. Gompers et al. (2005) provide two pieces of evidence on this: First, firms with higher earnings spawn less, and second, spawning increases when a company's performance declines. Both of these findings are consistent with our theory.[23]

One of the questions that has preoccupied empirical researchers is whether firms with better technology also spawn more external ventures. Franco and Filson (2006) find that better technical and market know-how increase the external venturing rate.

[22] See also Milgrom and Roberts' (1990) work on influence activities. In addition, note that firm inertia is ex ante optimal in this model. This contrasts with some of the sociological theories, where inertia is an aspect of evolutionary behavior (Hannan and Freeman 1984).

[23] In an unpublished manuscript, Brittain and Freeman (1986) examine external venturing in the semiconductor industry. They also find that slower growth for a parent company increases its spawning rate.

Klepper and Sleeper (2005) find that firms with more patents have more external ventures. At first glance, these results seem to contradict the previous results that better-performing firms generate fewer external ventures. However, better technologies may give rise not only to a stronger core performance, but also to greater potential for innovation. Better technology may thus increase the value of both exploitation and exploration. One paper that is particularly helpful here is Agarwal et al. (2004), who study the disk-drive industry. They distinguish between technological know-how and what they call market-pioneering know-how, which essentially measures a first-mover advantage in the product market. They find that firms that are strong in both types of know-how generate fewer external ventures than firms with strength in only one of the two types of know-how. This is consistent with the notion that technology know-how raises the opportunities for new ideas, but that firms with strong market opportunities rein in their employees' idea exploration in order to focus them on the opportunities in the core business.[24]

Our analysis suggests some venues for further empirical work. With the exception of Agarwal et al. (2004), the empirical literature is silent on how often (and how!) parents participate in external ventures. Our model suggests that spin-offs occur mainly when the firm has strong property rights and the external environment is strong ($x > x_3$). By contrast, start-ups occur when the firm has weaker property rights, and they may occur in considerably weaker external environments (such as $x_1 < x < x_2$).

3.4. What Role Do IP Rights Play?

Our model challenges two widely held beliefs about IP rights. The first is that IP rights predetermine the type of development, so that one should always observe internal ventures if the firm has the IP rights, and external ventures when the employee has the rights. Our model contradicts this notion, because we can get internal ventures when the employee has the rights, and spin-offs when the firm has the rights. The second widely held belief is based on the Coase theorem and holds that the allocation of IP rights is irrelevant. In our model, the Coase theorem applies when there is no commitment. In this case the equilibrium always has excessive idea exploration (σ^+), and the firm always chooses the ex post efficient type of development (internal ventures for $x < y$ and external ventures for $x > y$). However, the Coase theorem no longer applies when the firm is able to commit. Commitment may lead to inefficient ex post outcomes, such as in the stubborn equilibrium. Moreover, the threat of an inefficient ex post decision affects the ex ante incentives. Importantly, the optimal use of commitment power depends on the allocation of IP rights. Indeed, one of the most striking results of the model is that giving the IP rights to the employee dramatically increases the range of external environments (x) for which the employee engages in idea exploration.

How do these predictions stack up against prevailing views in the legal literature? On the normative side, Sterk (1993) argues that the law should not impose restrictions on the types of contracts that an employer can offer, including restrictions that preclude firms from owning the IP generated by their employees. Sterk's argument is based on an efficient market perspective that believes in the supremacy of private contracting over legal restrictions. Talley (1998) counters that informational asymmetries can lead to market inefficiencies, showing how legal rules can help with the generation and disclosure of employee innovations. Merges (1999) further elaborates on the trade-off between employee-friendly and employer-friendly legal regimes, emphasizing bargaining imperfections and hold-up problems.

Turning to the positive legal literature, Gilson (1999) explains how California law favors employees by refusing to enforce noncompete agreements (except in a limited set of circumstances).[25] Gilson proceeds to argue that Silicon Valley's high level of entrepreneurial activity and labor mobility is partly explained by this legal setting. Hyde (1998) provides a complementary analysis of how California courts take an employee-friendly stance in trade-secret cases.

In their empirical studies, Gompers et al. (2004) and Klepper and Sleeper (2005) include a control for whether the parent company is based in California or not. Both papers find significantly higher spawning rates in California. These studies, however, cannot disentangle the effect of IP law from a variety of other California-specific effects. Stuart and Sorenson (2003) propose a novel identification strategy. Their empirical design is slightly different in that they examine how entrepreneurial activity responds to disruptive shocks, notably, acquisitions and IPOs of biotechnology companies. They find evidence of more entrepreneurial activity as a response to shocks, not only in California, but in all U.S. states that have a legal treatment of noncompete clauses similar to that of California.

[24] The empirical literature also examines performance differences among the various types of ventures (internal, start-up, spin-off, etc.), both at the level of the venture and the parent company. Because the theoretical model avoids modeling heterogeneity among parent firms and external ventures, it is not well suited to make predictions about performance differences.

[25] Strictly speaking, noncompete agreements pertain to employment law rather than IP law, but they have a similar effect, because they limit an employee's ability to leave and start a new firm.

One interesting area for future research is how legal rules affect firm policies. Is there any evidence that employee-friendly laws induce firms to adopt less-restrictive policies? Do multilocation firms choose different policies in different legal constituencies? And do IP laws affect where firms locate different employment activities?

3.5. How Does the External Environment Affect Employee Innovation?

Our model shows how the firm's optimal policies towards employee innovation change with external circumstances. The external environment poses both a threat and an opportunity for the firm. Conceptually, the parameter for the external environment (x) measures the returns that can be made from external venturing. Empirically, this may depend on a large number of factors. One factor is the ease of setting up a new company. Djankov et al. (2002) document cross-country differences in how cumbersome it is to start a new business, just from a bureaucratic standpoint. The work of Anton and Yao (1994, 1995), Gans and Stern (2000, 2003), and Gans et al. (2002) emphasizes the appropriation problem in external ventures. Other important factors are the availability of money (e.g., venture capital), management, qualified employees, assets, etc.

There obviously exists a broad literature on how and why different locations witness different levels of entrepreneurial activities. Our model is partly inspired by Saxenian (1994), who notes that one of the important differences between Silicon Valley and Boston's Route 128 was that established Silicon Valley companies, such as HP, had more open cultures, whereas Massachusetts' established companies, such as DEC, tended to have more closed cultures. Saxenian attributes the success of Silicon Valley to these differences in firm behavior and firm culture. Obviously, all of these factors interact with each other, so that it is difficult to separate endogenous and exogenous drivers.

Endogeneity may be a thorn in the empiricist's eye, but can cause a gleam in the theorist's eye. For the purpose of the main model we take the external environment as given, but in the working-paper version we also developed an extension that endogenizes it. For this we considered a model where venture capitalists make endogenous decisions about whether to locate in certain geographical areas, or to develop expertise in certain technological areas. The main insight from endogenizing the presence of venture capital is that there may be multiple equilibria. If employees rarely leave firms, few venture capitalists take interest in that location or technology sector. This makes it harder for employees to leave the firm, and easier for firms to focus their employees; as a consequence, employees rarely leave. This is a self-enforcing low-entrepreneurship equilibrium. There also exists a self-enforcing high-entrepreneurship equilibrium, where there are many employees who leave their firms, and many venture capitalists to finance their innovations.

This model extension is related to the work of Landier (2005), who develops a multiple-equilibria model based on a stigma of failure. If few competent individuals are willing to take entrepreneurial risks, then entrepreneurial failure signals incompetence, which justifies why competent individuals avoid entrepreneurship. This is the low-entrepreneurship (high stigma of failure) equilibrium. However, if failure is not perceived as a negative signal, then competent individuals take entrepreneurial risks, and in equilibrium failure no longer signals incompetence. Gromb and Scharfstein (2001) examine a related model that introduces the firm as an alternative governance mechanisms. In their model, intrapreneurial activity emerges when the entrepreneurial labor market fails because of a stigma of failure. This contrasts with our model, where intrapreneurial activity may increase with greater external entrepreneurial activity. In a related vein, Hellmann and Perotti's (2006) model also has the feature that innovations inside firms complement external entrepreneurial activity.

4. Conclusion

This paper starts with the observation that many entrepreneurs receive their ideas while working for firms in related industries. It builds a model that explains when employees become entrepreneurs. A critical step of the analysis is to recognize that firms may respond to their employees' innovations in a variety of ways. Some firms want to co-opt their employees' innovations through internal ventures or spin-offs, whereas other firms want to discourage development. Some firms may seem too inflexible when they lose out on the opportunities of their departing employees, but the model suggests that this may be the outcome of an optimal firm policy. This is because firms face a trade-off between focusing employees on their core tasks versus providing them with incentives for innovative ideas. The analysis also highlights the importance of IP rights and the entrepreneurial environment. The paper thus provides a theory for the supply of entrepreneurial activity that incorporates a role for established companies. Further exploring the interactions between the policies of established firms and the process of entrepreneurial firm creation remains a fruitful topic for future research.

5. Electronic Companion

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

Acknowledgments

The author gratefully acknowledges financial support from the Stanford Center for Entrepreneurial Studies, the W. Maurice Young Entrepreneurship and Venture Capital Research Centre at the University of British Columbia, and Social Sciences and Humanities Research Council of Canada. He thanks the anonymous associate editor, three anonymous referees, Wouter Dessein, Denis Gromb, Hans Hvide, Kevin Murdock, John Roberts, Garth Saloner, Kathy Spier, Scott Stern, Dennis Yao, Michael Waldman, Julie Wulf, and seminar participants at Cornell University (Johnson School), Dartmouth University (Tuck), London School of Economics (FMG), NBER (Organizational Economics), Northwestern University (Kellogg), Stanford University (GSB), Stockholm (SIFR), University of British Columbia (Vancouver), University of New South Wales (Sydney), and University of Pennsylvania (Wharton) for their helpful comments. All errors are the author's.

References

Agarwal, R., R. Echambadi, A. M. Franco, M. B. Sarkar. 2004. Knowledge transfer through inheritance: Spin-out generation, growth, and survival. *Acad. Management J.* **47**(4) 501–522.

Aghion, P., J. Tirole. 1994. The management of innovation. *Quart. J. Econom.* **109** 1185–1209.

Allen, J. W. 1998. Capital markets and corporate structure: The equity carve-outs of Thermo Electron. *J. Financial Econom.* **48** 99–124.

Amador, M., A. Landier. 2003. Entrepreneurial pressure and innovation. Mimeo, Graduate School of Business, Stanford University, Stanford, CA.

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

Anand, B., A. Galetovic, A. Stein. 2004. Incentives versus synergies in the market for talent. Mimeo, Harvard Business School, Boston, MA.

Anton, J., D. Yao. 1994. Expropriations and inventions: Appropriable rents in the absence of property rights. *Amer. Econom. Rev.* **84** 190–209.

Anton, J., D. Yao. 1995. Start-ups, spin-offs, and internal projects. *J. Law, Econom. Organ.* **11**(2) 362–378.

Bankman, J., R. Gilson. 1999. Why start-ups. *Stanford Law Rev.* **51** 289–308.

Bartlett, C. A., A. Mohammed. 1995. 3M: Profile of an innovating company. HBS Case No. 9-395-016, Harvard Business School, Boston, MA.

Bhidé, A. 1994. How entrepreneurs craft strategies that work. *Harvard Bus. Rev.* **72**(2) 150–161.

Brittain, J., J. Freeman. 1986. Entrepreneurship in the semiconductor industry. Mimeo, University of California–Berkeley, Berkeley, CA.

Burgelman, R. 1983. A process model of internal corporate venturing in the diversified major firm. *Admin. Sci. Quart.* **28**(2) 223–244.

Burgelman, R. 2002. Strategy as vector and the inertia of coevolutionary lock-in. *Admin. Sci. Quart.* **47**(2) 325–357.

Burgelman, R., L. Sayles. 1986. *Inside Corporate Innovation*. The Free Press, New York.

Cassiman, B., M. Ueda. 2006. Optimal project rejection and new firm start-ups. *Management Sci.* **52**(2) 262–275.

Chesbrough, H. 2002. Graceful exits and forgone opportunities: Xerox's management of its technology spin-off organizations. *Bus. Hist. Rev.* **76**(4) 803–838.

Christensen, C. 1997. *The Innovator's Dilemma: When New Technologies Cause Great Firms to Fail*. Harvard Business School Press, Boston, MA.

Cooper, A. 1985. The role of incubator organizations in the founding of growth-oriented firms. *J. Bus. Venturing* **1** 75–86.

de Bettignies, J., G. Chemla. 2006. Corporate venture capital: The upside of failure and competition for talent. Mimeo, University of British Columbia, Vancouver, British Columbia.

Djankov, S., R. La Porta, F. Lopez-De-Silanes, A. Shleifer. 2002. The regulation of entry. *Quart. J. Econom.* **117**(1) 1–37.

Franco, A., D. Filson. 2006. Spin-outs: Knowledge diffusion through employee mobility. *RAND J. Econom.* Forthcoming.

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

Gans, J., S. Stern. 2003. The product market and the "market for ideas:" Commercialization strategies for technology entrepreneurs. *Res. Policy* **32**(2) 333–350.

Gans, J., D. Hsu, S. Stern. 2002. When does start-up innovation spur the gale of creative destruction? *RAND J. Econom.* **33** 571–586.

Gilson, R. 1999. The legal infrastructure of high technology industrial districts: Silicon Valley, Route 128, and covenants not to compete. *New York Univ. Law Rev.* **74**(3) 575–629.

Gompers, P., J. Lerner, D. Scharfstein. 2005. Entrepreneurial spawning: Public corporations and the genesis of new ventures: 1986–1999. *J. Finance* **60**(2) 577–614.

Gromb, D., D. Scharfstein. 2001. Entrepreneurial activity in equilibrium. Mimeo, Massachusetts Institute of Technology, Boston, MA.

Grossman, S., O. Hart. 1986. The costs and benefits of ownership: A theory of lateral and vertical integration. *J. Political Econom.* **94**(4) 691–719.

Hannan, M., J. Freeman. 1984. Structural inertia and organizational change. *Amer. Sociol. Rev.* **49**(2) 149–164.

Hellmann, T. 2002. A theory of strategic venture investing. *J. Financial Econom.* **64**(2) 285–314.

Hellmann, T. 2005. Why do employees become entrepreneurs? Working paper version, mimeo, University of British Columbia, Vancouver, British Columbia, http://strategy.sauder.ubc.ca/hellmann/.

Hellmann, T., E. Perotti. 2006. The circulation of ideas: Firms versus markets. Mimeo, University of British Columbia, Vancouver, British Columbia.

Holmström, B., P. Milgrom. 1994. The firm as an incentive system. *Amer. Econom. Rev.* **84**(4) 972–991.

Hyde, A. 1998. Silicon Valley's high-velocity labor market. *J. Appl. Corporate Finance* **11**(2) 28–37.

Jackson, T. 1998. *Inside Intel*. Penguin Putnam Inc., New York.

Klepper, S., S. Sleeper. 2005. Entry by spin-offs. *Management Sci.* **51**(8) 1291–1306.

Kreps, D. M. 1990. Corporate culture and economic theory. J. Alt, K. Shepsle, eds. *Rational Perspectives on Political Economy*, Cambridge University Press, Cambridge, UK, 90–143.

Landier, A. 2005. Entrepreneurship and the stigma of failure. Mimeo, New York University, New York.

Lewis, T., D. Yao. 2001. Innovation, knowledge flow, and worker mobility. Mimeo, Wharton School, University of Pennsylvania, Philadelphia, PA.

March, J., J. Olsen. 1991. Exploration and exploitation in organizational learning. *Organ. Sci.* **2** 71–78.

Merges, R. 1999. The law and economics of employee inventions. *Harvard J. Law Tech.* **13**(1) 1–63.

Milgrom, P., J. Roberts. 1990. The efficiency of equity in organizational decision processes. *Amer. Econom. Rev.* **80**(2) 154–159.

Pakes, A., S. Nitzan. 1983. Optimum contract for research personnel, research employment, and the establishment of rival enterprises. *J. Labor Econom.* **1**(4) 345–365.

Rotemberg, J., G. Saloner. 1994. Benefits of narrow business strategy. *Amer. Econom. Rev.* **84**(5) 1330–1349.

Saxenian, A. 1994. *Regional Advantage: Culture and Competition in Silicon Valley and Route 128*. Harvard University Press, Cambridge, MA.

Simon, H. 1951. A formal theory of the employment relationship. *Econometrica* **19** 293–305.

Smith, D., R. Alexander. 1999. *Fumbling the Future: How Xerox Invented, Then Ignored the First Personal Computer*. William Morrow & Company, New York.

Sterk, S. 1993. Restraints on alienation of human capital. *Virginia Law Rev.* **79** 383–460.

Stuart, T., O. Sorenson. 2003. Liquidity events and the geographic distribution of entrepreneurial activity. *Admin. Sci. Quart.* **48** 175–201.

Subramanian, N. 2006. The economics of intrapreneurial innovation. *J. Econom. Behav. Organ.* **58**(4) 487–510.

Talley, E. 1998. Turning servile opportunities to gold: A strategic analysis of the corporate opportunities doctrine. *Yale Law J.* **108** 277–375.

Teece, D. 1986. Profiting from technological innovation: Implications for integration, collaboration, licensing and public policy. *Res. Policy* **15** 285–305.