ENTREPRENEURIAL SPAWNING AND FIRM CHARACTERISTICS *

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Abstract

We analyze the implications of entrepreneurial spawning for a variety of firm characteristics such as size, focus, profitability, and innovativeness. We distinguish between firm general and specialized resources and motivate spawning by the desire to achieve a fit between the specialized resource that is firm organization and the requirements for the successful management of a new product. Our model accounts for much of the empirical evidence relating to the relation between spawning and firm characteristics; it may help reconcile seemingly contradictory empirical findings. Firms that have higher patent quality spawn more, as do firms that have higher knowhow. Older firms spawn less, they are more diversified and less profitable. The relation among spawning frequency, focus, and profitability is positive and the relation between these characteristics and size negative where driven by organizational fit; the relation between focus and profitability is negative and the relation between size and profitability positive where driven by general resources.

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1 Introduction

Entrepreneurial spawning—the process whereby an existing firm gives birth to a new firm set up by one or more employees departed from the existing firm—is prevalent in many new industries. It is well-known, for example, that Fairchild Semiconductors has been the forebear of a great many Silicon Valley semiconductor firms, the "mother hen of the Northern California semiconductor industry" (Rogers, 1985, p. 24). In his history of the genesis of Silicon Valley, Hall (1998, p. 437) writes "about half of the eighty-five or so US semiconductor companies of the 1980s were direct spin-offs from the firm."[1] It is perhaps less well-known that similar statements can be made about many industries: disk drives (Agarwal, Echambadi, Franco, and Sarkar, 2004; Christensen, 1993; Franco and Filson, 2006), lasers (Klepper and Sleeper, 2005; Sherer, 2006), tires (Buenstorf and Klepper, 2009), and automobiles (Klepper, 2007).

The phenomenon of entrepreneurial spawning—also referred to as spinning off or spinning out—has been quite extensively studied. Less studied have been the implications of spawning for a variety of firm characteristics such as size, focus, profitability, and innovativeness. We believe that a better understanding of these implications can contribute towards a better understanding of the nature of the firm. Gompers, Lerner, and Scharfstein (2005) have studied empirically the relation of spawning with firm characteristics. We develop a model that does so theoretically. Its results generally coincide with Gompers, Lerner, and Scharsftein's findings.

As our results revolve around the nature and the extent of spawning, it is natural to ask what determines spawning: why should an employee that has developed a new product start a new firm rather than remain in his current employment? In order to answer this question, we appeal to the resource-based view of the firm, the distinction between general and specialized resources in particular. We motivate spawning by the desire to achieve organizational fit, that is, the fit between the specialized resource that is firm organization and the requirements for the successful management of the new product. In our model, spawning occurs where the firm at which the new product was developed and the employee who developed the new product choose to leave the commercialization of the product to a new firm with a new organization to be set up by the employee. This is because the product presents little fit with the organization of the firm at which the product was developed. Firm and employee bargain over the term of the employee's departure.

[1] Hall (1998) cites Hanson (1982, p. 110) who observes that "[[t]hroughout the sixties, bright young engineers spun out of Fairchild like so many enterprizing Minervas from the head of Zeus. New start-ups abounded: three new chip makers in 1966, another three in 1967, thirteen in 1968, eight more in 1969; their names a seemingly endless set of permutations on a few basic syllables — tech, tronic, inter, micro, ics, tron, etc."

The benefit of spawning is the choice of an organization better suited to the new product; its cost that of setting up the new organization. There is a threshold organizational fit: products whose fit with firm organization exceeds the threshold are retained within the original firm, those whose fit does not are spawned to new firms.

Spawning naturally has consequences for firm characteristics. *Ceteris paribus*, a firm that spawns more grows more slowly: products that otherwise would be retained within the firm are spawned to new firms. Spawning increases firm focus: as it is lesser fitting products that are spawned to new firms, a greater extent of spawning increases the average fit of those products retained within the firm, that is, it increases firm focus. As focus improves profitability, *ceteris paribus*, spawning increases firm profitability, too. Finally, spawning increases a firm's investment in innovation: a product spawned generally is more profitable, because it is sold by a new firm with organization better fitting the product. Greater product profitability increases the incentive to invest in innovation. This last result underlines the importance of the *ceteris paribus* qualification: larger incentives to innovate will lead to a greater number of new products that may increase firm size, despite the spawning of a larger fraction of these products; the relation between spawning and firm size is therefore ambiguous.

As time elapses and innovation proceeds, increased competition among more numerous products decreases per product profitability. The decrease in profitability affects all products, whether retained within the firm at which the products were developed or spawned to new firms, but its effect is larger on spawned products than on retained because of the fixed cost of setting up a new organization. The frequency of spawning therefore decreases over time. The decline in spawning naturally has implications for size, which increases over time; for focus, which decreases; for profitability, which decreases; and for innovativeness, which decreases.

Many of our predictions appear to be consistent with the available empirical evidence: firms that have higher patent quality and younger firms spawn more (Gompers, Lerner, and Scharfstein, 2005), as do firms that have higher knowhow (Franco and Filson, 2006). All of our predictions are induced by spawning, but some extend beyond spawning: older firms are also more diversified (Denis, Denis, and Sarin, 1997) and less profitable (Loderer and Waelchli, 2009). Some of our predictions are new and may help shed new light on issues perhaps still controversial. Consider for example the spawning-induced relation between focus and profitability. Our work suggests that these two endogenous firm characteristics are positively related where the relation is driven by organizational fit; they may be negatively related where the relation is driven by general resources. This may account for the somewhat mixed evidence regarding the relation between focus/diversification and performance/value.[2]

The paper proceeds as follows. Section 2 reviews the literature. Section 3 discusses resources and fit. Section 4 presents the model. Section 4.3 solves the model for firm value and the extent of spawning. Section 5 examines the firm characteristics of interest and derives their comparative statics. Section 5.6 examines the dynamics of spawning over time and their implications for the evolution of firm characteristics. Section 7 provides supporting empirical evidence and derives a number of testable implications. Finally, Section 8 concludes.

2 Literature Review

Our work is related to various strands of the literature. It is of course related to the literature on spawning, which has sought to explain when an innovation is retained to be implemented 'in-house' and when it is spawned to a new firm. It is also related to the literature on firm size and firm growth, that part of the literature in particular that has attributed a firm's growth to the firm's entry into new submarkets (Klepper and Thompson, 2006; Klette and Kortum, 2004; Sutton, 1998): our products are these papers' submarkets. Finally, it is related to the literature on firm focus and diversification, part of which has sought to explain why diversification might create value despite being associated with lower average firm value and performance.[3]

Where previous work has examined each of the issues mentioned above in much detail, our work attempts to tie these together in one single model which, as noted above, accounts for firm size, performance, focus, and innovativeness, and for the extent of spawning by the firm. What ties these together is organizational fit: fit i) determines individual product profitability, therefore determining the incentive to invest in the development of new products, i.e., innovativeness, ii) determines the products the firm introduces itself and those the firm leaves to the firms it spawns, thereby determining size, and iii) determines overall firm profitability through focus, that is, average organizational fit. Our focus on organizational fit follows Cassiman and Ueda (1996); it distinguishes our work from most previous work, which has attributed spawning to incentive and information considerations. Thus, Amador and Landier (2003) induce spawning by attributing greater contractual flexibility to external, venture capital financing than to internal financing.

[2]There is an extensive literature on the relation between diversification and performance, starting with the seminal work of Berger and Ofek (1995) and Lang and Stulz (1994). See for example Campa and Kedia (2002); Graham, Lemmon, and Wolf (2002); Maksimovic and Phillips (2002); Schoar (2002); Villalonga (2004); and Whited (2001).

[3]See for example Bernardo and Chowdhry (2002); Gomes and Livdan (2004); Maksimovic and Phillips (2002); Matsusaka (2001); and Matsusaka and Nanda (2002).

Anton and Yao (1995) and Hellmann (2007) make the decision to spawn revolve around the allocation of intellectual property rights and, in the case of Hellmann, the need to induce an employee to exert effort on a core task where the employee might otherwise be tempted to exert effort on another, innovative task. de Bettignies and Chemla (2008) analyze corporate venturing, a form of spawning which they ascribe to corporations' desire to retain 'star' managers in a 'competition for talent' with venture capitalists. Chatterjee and Rossi-Hansberg (2011) attribute spawning to the breakdown in trade that may occur under asymmetric information. Franco and Filson (2006) limit innovation to firms and employees to imitation; they induce spawning by requiring that an employee who wishes to innovate start his own firm. Gromb and Scharfstein (2005) see spawning as serving to improve managerial incentives by increasing the penalty of failure, greater in a start-up than in an established firm. Klepper and Thompson (2009) attribute the decision to spawn to disagreements between employer and employee. Although they do not consider spawning as such, Jovanovic and Nyarko (1995) and Mitchell (2000) attribute the limitations in firm scope that are cause and consequence of spawning to the greater cost of performing more diverse, less familiar tasks. We do not doubt the importance of incentive and information considerations, but believe our focus on organizational fit delivers new and valuable insights.

Chatterjee and Rossi-Hansberg (2011) explore the implications of spawning for the size distribution of firms. Gromb and Scharfstein (2005) establish the possibility of multiple entrepreneurship/spawning equilibria; they distinguish in particular between a low spawning equilibrium in which most new projects are undertaken by existing firms and a high spawning equilibrium in which new projects are undertaken by new firms. Where these authors have analyzed the implications of spawning for *industry* characteristics, we examine the implications of spawning for *firm* characteristics; in that sense as in many others, our work should be viewed as complementing existing work.

Klepper and Thompson (2009, p. 12) take issue with organizational fit-based rationales for spawning such as ours, based on incumbents' "limited ability or capacity to manage diverse projects." They view these explanations as being contradicted by the observations that i) most of the disagreements they report were central to spawning firms' missions and ii) better performing firms spawned more; the firms they spawned in turn performed better. We note that there need be no contradiction between limited ability or capacity and centrality once one recognizes that organizational fit applies as much to market or process as to product.[4] Consider for example Christensen's (1997) finding, reported by Cassiman and Ueda (2006, p. 271), that "two-thirds of the spin-offs

[4]This is not to dispute the importance of disagreements—or of mere corporate inertia—as a motivation for spawning.

in the hard disk drive industry entered new submarkets, which did not fit the established firms' existing customer base." An established hard disk drive manufacturer that had been presented the opportunity to develop a new disk drive for a new market segment might quite reasonably have concluded that it did not have the ability or capacity to service the new segment, despite disk drives being central to the manufacturer's mission. We establish the greater extent of spawning by better performing firms in Section 5.

In an interesting twist on the prevailing analysis of spawning, Gans (2011) analyzes the phenomenon of 'reverse spawning,' whereby an incumbent firm chooses to acquire an entrant that has developed a new product or, alternatively, to license the new product from the entrant. Gans focuses on dynamic innovation considerations, specifically the effect of acquisition or licensing on the probability of follow-on innovation. Our paper abstracts from dynamic innovation considerations; its dynamics instead stem from time-increasing competition.

3 Resources and Fit

As noted in the Introduction and in the Literature Review, our work ascribes spawning to the desire for fit between the specialized resource that is firm organization and the requirements for successful product management. Our analysis therefore begins with a brief discussion of the three central components of our model: resources, organization, and fit.

Resources have come to occupy a prominent place in management thinking.[5] Besanko, Dranove, and Shanley (1996, p. 543) define a firm's stock of resources as consisting of "firm-specific assets and factors of production, such as patents, brand-name reputation, installed base, and human assets;" they define the closely related concept of distinctive capabilities as "activities that the firm does especially well in comparison to its competitors." The RBV attributes a firm's ability to create value—to produce output with value in excess of that of inputs—to those resources and capabilities in the possession of the firm that have the twin properties of being scarce and imperfectly mobile.[6]

As recognized by Penrose early on, resources differ in versatility: some are quite general in that

[5]The Resource-Based View (RBV) of the firm can be said to have originated with Penrose's(1959) seminal analysis; it has been further developed by Wernerfelt (1984), Dierickx and Cool (1989), Barney (1991), and Peteraf (1993) among others.

[6]Scarcity and imperfect mobility—where protected by isolating mechanisms (Rumelt, 1984) that preclude competitors from replicating or neutralizing the firm's resources and capabilities—create limits to competition that make it possible for the firm to earn the 'supernormal' profits that reflect the creation of value.

they can create value in a wide variety of uses, others are specialized to some uses but not others.[7] An example of a general resource may be proficiency with the General Purpose Technologies (GPT) analyzed by Bresnahan and Trajtenberg (1996) and by Jovanovic and Rousseau (2005). Jovanovic and Rousseau (p. 1184) define GPT as "changes that transform both household life and the ways in which firms conduct business." They identify only two such technologies: electricity and information technology (IT).

An example of a specialized resource is firm organization, defined by Roberts (2004, p. 16) to be "the means through which [firm] activities are to be carried out and [firm] strategy is to be implemented." That firm organization is specialized to specific tasks and environments has long been recognized by management scholars: referring to Chandler's (1962) seminal work, Besanko et al. (1996, pp. 687-688) write that "the organizational structures of large vertically and horizontally integrated firms developed in response to the strategic choices their managers made. These choices, in turn, developed as the firm's managers responded to changes in its market and technological environment." More recently, Roberts (p. 11) writes that "there needs to be a fit between strategy and organization and between those and the technological, legal, and competitive environment." The preceding statements make clear the specialized nature of firm organization: specific tasks and environments call for specific organizations; specific organizations are suited only to specific tasks in specific environments.

How suitable a given organization is for a given task in a given environment defines organizational fit. Henderson and Clark (1990) provide empirical evidence in support of the importance of organizational fit: in a study of the photolithographic alignment equipment industry, they find that leading firms were unable to accommodate 'architectural innovations,' that is, "innovations that change the way in which the components of a product are linked together" (Henderson and Clark, p. 10). They ascribe their finding to leading firms' handicap due "a legacy of [organization-]embedded and *partially irrelevant* architectural knowledge" (Henderson and Clark, p. 18, emphasis added).[8] In the terminology of the present work, there was little fit between leading firms' organizations and

[7]Penrose (1995, p. 84) puts its very nicely when she writes "[l]et us imagine [that] productive services are A, B, C, D, E, F and G. F and G may be useful only in a particular firm, C, D and E only to a particular group of firms, B only in manufacturing industry, while A may be of such general character that it would be useful in any type of productive activity." Penrose distinguishes between resources and the services that resources can render. This is a distinction that the later, more recent literature has not maintained.

[8]Henderson and Clark's (1990) finding suggests that a firm cannot simply 'shake off' the legacy embedded in its organization. Evidence that organizational choice is to a large extent irreversible is provided by Carroll and Hannan (2000) and Jovanovic and Rousseau (2001): the organization chosen at birth is imprinted into the firm; corporate inertia makes subsequent organizational change extremely difficult.

the new products that incorporated architectural innovations relative to existing products.

4 The Model

4.1 The Firm

Consider an entrepreneur/principal, p, who starts a firm, f, in period t_f, $t_f \geq 0$. The firm has two purposes. The first purpose of the firm is to exploit the product, θ_f, with which the principal is endowed and over which he has full property rights. The firm must be organized for carrying out that task; setting up the requisite organization has cost κ, $\kappa \in \mathbb{R}^+$. Both products and organizations are represented by points on the real line, $\mathbb{R}$. Let m_f, $m_f \in \mathbb{R}$, be the organization chosen by p in period t_f. Organizational imprint and structural inertia (Carroll and Hannan, 2000; Jovanovic and Rousseau, 2001) combine to make that choice irreversible.

The second purpose of the firm is to develop further new products—to innovate. Innovation requires the principal, p, to allocate per-period resource, $c(.)$, to exploration by an agent, a, employed by the principal.[9] Let q_t be the probability that a is successful at innovating in period t, $t > t_f$. Assume that the relation between q_t and $c(.)$ is of the form

$$c(q_t) \quad = \quad \frac{1}{2} q_t^2 \ ; \tag{1}$$

the more resources, $c(q_t)$, principal p allocates to exploration by agent a, the greater the probability, q_t, that a successfully innovates in period t.

Let θ_i, $\theta_i \in \mathbb{R}$, denote the product developed by agent a if innovation should be successful. Assume θ_i is uniformly distributed over an interval of length 2δ centered at firm f's organization, m_f; $\theta_i \sim U[m_f - \delta, m_f + \delta]$: firm f's organization determines the range of possible new products. Define organizational fit $\omega_i \in [0, 1]$ to be the complement of the normalized distance between organization m_f and new product θ_f: $\omega_i \equiv 1 - \left| \frac{\theta_i - m_f}{\delta} \right|$. The fit is maximal ($\omega_i = 1$) where the product coincides with the organization, $\theta_i = m_f$; it is minimal ($\omega_i = 0$) where the product is most peripheral, $\theta_i = m_f \pm \delta$.

The fit between organization and product combines with firm resources to determine the per-period profit to firm f from exploiting product θ_i in period τ, $\tau > t$. Specifically,

$$\pi_{i,\tau} \quad = \quad (\alpha \ + \ \beta \, \omega_i) \, s_\tau \ . \tag{2}$$

[9] The terminology 'exploitation' and 'exploration' is borrowed from March (1991).

The parameter α measures the value of firm general resources; these resources are equally valuable for all new products agent a may develop. The parameter β measures the importance of organizational fit, ω_i: the larger β, the greater the profit $\beta\,\omega_t$ attributable to the fit between organization and product. The product $\beta\,\omega_i$ can therefore be viewed as the value of the specialized resource that is firm organization, as applied to the exploitation of product θ_i. Note that the value of firm organization would be zero if fit were zero ($\omega_i = 0$), however large β might be.

Both α and β are assumed to be constant over time; this is unlike the variable s_τ, which is intended to captures the per-period effect of product market competition on firm profits. Consider that the parameters α and β are are scaled such that $s_0 = 1$. Absent the pressure of product market competition, $s_\tau = 1$ for all $\tau \geq 0$. Product market competition decreases profits below $\alpha \ + \beta\,\omega_i$; the higher the pressure of competition, the lower s_τ, the lower are profits. As time elapses and the number of products on the market increases, competitive pressure increases as well; s_τ therefore decreases in τ. More specifically, we assume (i) $s_0 = 1$, (ii) $s_\tau \in [0; 1]$ for all $\tau \geq 0$ and (iii) $\partial\,\mathbb{E}\left[s_\tau\right]/\partial\tau \leq 0$ for all $\tau \geq 0$.[10]

Note that the principal p of firm f chooses $m_f = \theta_f$ in period t_f. This is immediate from the symmetry of both the profit function and the distribution of new products: both are functions of $|\theta_i - m_f|$.

4.2 Spawning and Firm Creation

Although the new product, θ_i, is developed by agent a employed by principal p at firm f, the product need not be exploited by firm f. Agent and principal may agree to leave the exploitation of the new product to a new firm, founded by agent a specifically for the purpose of exploiting the new product. We refer to such outcome as "entrepreneurial spawning:" agent a who developed the new product becomes an entrepreneur/principal, p^+, who starts a new firm, f^+; the new firm is spawned from the original firm, f. Principal p^+ sets up firm f^+'s organization, m^+, at cost κ.

Firm f^+ is assumed to inherit firm f's value of general resources, α, and its importance of fit, β.[11] The advantage of leaving the exploitation of a new product such as θ_i to the new firm

[10] The variable s_τ is assumed to be exogenously given. Although it should be possible to endogenize s_τ by postulating a process of spatial competition among products on $\mathbb{R}$, such endogenization would be beyond the scope of our analysis. Note that s_τ necessarily is a random variable: competitive pressure depends on the number of products developed, which in turn depends on the probability of successful innovation.

[11] Agarwal, Echambadi, Franco, and Sarkar (2004) provide strong evidence of inheritance by spawned from spawning firms.

is that the firm can have organization, m^+, perfectly fitting the new product: $m^+ = \theta_i$.[12] This increases the per-period profit from selling the new product from $(\alpha + \beta\,\omega_i)\,s_\tau$ to $(\alpha + \beta)\,s_\tau$.[13] It does, however, involve the cost, κ, of setting up the new organization.

There is a trade-off between fit and set-up cost, the former favoring spawning, the latter retention. This trade-off leads to the existence of a threshold fit ω_t^* such that the introduction of the new product is left to the new firm where $\omega_i \in [0; \omega_t^*)$ and to the original firm where $\omega_i \in [\omega_t^*; 1]$: a firm spawns those products that present a lesser fit with the firm's organization.[14]

Regardless of whether the new product is spawned or retained, and whether the agent who developed the product becomes a principal in his own right or remains an agent, the principal/agent, p^+/a, is assumed to be indispensable to the exploitation of the new product; so is principal p's agreement. This implies that, in any bargaining that takes place over the exploitation of the new product, default payoffs are zero for both p and p^+/a. Assume costless bargaining and denote γ, $\gamma \in [0, 1]$, the bargaining power of p^+/a in negotiation. That p^+/a is indispensable to exploitation of the new product implies that he can no longer engage in exploration at firm f, even if he should remain at that firm for the purpose of exploiting product θ_i. Firm f therefore employs a new agent, a^+, who succeeds a in exploration. The process then repeats itself.[15] Agents are assumed homogenous.

In the main part of our analysis, we assume that, unlike the case for the original product θ_f, the exploitation of a new product $\theta_i \neq \theta_f$ is unaccompanied by exploration. This implies that only at the original firm, f, is exploration engaged in; neither at firm f^+ nor at any subsequently founded firm is there any exploration. It further implies that the only exploration at firm f is that which accompanies the exploitation of the original product, θ_f. In short, there is only a single 'innovation process,' that associated with the original product θ_f; new products do not give rise to new innovation processes. This assumption is not necessary for our main result, but it makes possible the comparative statics analysis of Section 5. It is relaxed in Section 6.1.

[12] We assume that imprinting and inertia (Carroll and Hannan, 2000; Jovanovic and Rousseau, 2001) constrain the original firm's organization to remain fixed at the original $m_f = \theta_f$. The firm neither can alter its original organization nor can it set up a new division with divisional organization different from the original one. We therefore exclude the possibility for the original firm to set up a new division with divisional organization θ_i to exploit the new product.

[13] We assume that the new product always is exploited and that any cannibalization of existing products is reflected in the competitive pressure term, s_τ. These assumptions are made for simplicity; they do not alter the nature of our results.

[14] We establish the dependence of ω_t^* on t in Section 4.3.

[15] Specifically, agent a^+ engages in exploration of principal p's behalf; the agent is succeeded by a new agent upon successful innovation and himself becomes a principal in case of spawning.

We represent the sequence of events on the time-line in Figure 1. We divide period t, $t > t_f$ into two subperiods, starting at dates t and $t + \epsilon$, respectively. At date t, principal p of firm f invests resources $c(q_t)$ in exploration. At date $t + \epsilon$, agent a develops a new product θ_i with probability q_t. In case of successful innovation, agent a must abandon exploration for exploitation, because a is indispensable to the exploitation of the product he has developed. Agent a is replaced in exploration by a new agent, a^+. The new product is retained or is spawned; in the latter case, agent a departs to start a new firm, f^+.

4.3 Threshold Fit and Probability of Innovation

Consider a period t in which agent a is still engaged in exploration on behalf of principal p. Denote V_t^p and V_t^a the expected values at date t of future innovations, to principal p and agent a, respectively. Assume agent a develops a new product θ_i at date $t + \epsilon$. Note that $V_{t+1}^a = 0$ in such case: as noted in Section 4.2, the indispensability of an agent to the exploitation of the product he has developed implies the agent can no longer himself engage in exploration; as assumed in that section, that the exploitation of the new product is unaccompanied by exploration implies that the agent, unlike principal p, cannot hope to profit from exploration engaged in by others on his behalf.[16] Denote $v_{t+\epsilon}^{in}(\omega_i)$ the value of the new product if retained to be exploited within firm f at date $t + \epsilon$ and $v_{t+\epsilon}^{out}$ if spawned to a new firm, f^+.[17]

The threshold fit, ω_t^*, is that which leaves the parties indifferent between spawning the new product to a new firm, f^+, and retaining it within the original firm, f. Recalling that $V_{t+1}^a = 0$ and noting that costless bargaining implies that principal and agent will maximize their joint payoff, the equilibrium condition for the threshold fit is

$$v_{t+\epsilon}^{out} + \frac{V_{t+1}^p}{1+\rho} = v_{t+\epsilon}^{in}(\omega_t^*) + \frac{V_{t+1}^p}{1+\rho} , \tag{3}$$

where ρ, $\rho \in \mathbb{R}^+$, denotes the discount rate. The preceding condition naturally reduces to

$$v_{t+\epsilon}^{out} = v_{t+\epsilon}^{in}(\omega_t^*) . \tag{4}$$

The decision to spawn or to retain a new product, θ_i, depends only on the value of that product. It does not depend on the value of subsequently developed products, because that value is the same regardless of whether there is spawning or retaining: it is attributable only to the exploration that accompanies the exploitation of the original product, θ_f; it is therefore unaffected by whether the

[16] As noted in Section 4.2, this assumption is relaxed somewhat in Section ...

[17] Note the dependence of $v_{t+\epsilon}^{in}$ but not $v_{t+\epsilon}^{out}$ on ω_i, a natural consequence of the choice of organization perfectly fitting θ_i in the new firm.

new product, θ_i, is spawned or is retained. Given the parties' bargaining power γ and $1-\gamma$, and the zero default payoffs due the indispensability of the two parties, it is clear that the value of the new product, $\max\left[v_{t+\epsilon}^{out}, v_{t+\epsilon}^{in}(\omega_i)\right]$, is divided between the two parties in the proportions γ and $1-\gamma$.

We can now write

$$v_{t+\epsilon}^{in}(\omega_i) = \mathbb{E}\left[\sum_{\tau=t+1}^{\infty} \frac{(\alpha+\beta\,\omega_i)\,s_\tau}{(1+\rho)^{\tau-t}}\right] \;=\; \frac{(\alpha+\beta\,\omega_i)\,s_t^e}{\rho}\;, \tag{5}$$

and, recalling that spawning involves set-up cost κ,

$$v_{t+\epsilon}^{out} = \mathbb{E}\left[\sum_{\tau=t+1}^{\infty} \frac{(\alpha+\beta)\,s_\tau}{(1+\rho)^{\tau-t}}\right] \;-\;\kappa \;=\; \frac{(\alpha+\beta)\,s_t^e}{\rho} \;-\;\kappa\;. \tag{6}$$

The factor s_t^e captures the pressure of product market competition over the life of the product:[18]

$$s_t^e \;\equiv\; \sum_{\tau=t+1}^{\infty} \frac{\rho}{(1+\rho)^{\tau-t}}\;\mathbb{E}\left[s_\tau\right]\;. \tag{7}$$

We use equations (4), (5), and (6) to obtain

Lemma 1 *The threshold fit equals*

$$\omega_t^* = 1 - \frac{\rho\,\kappa}{\beta\,s_t^e}\;. \tag{8}$$

A new product is spawned to a new firm where the product presents little fit with the original firm's organization ($\omega_i < \omega_t^*$); the product is retained within the original firm otherwise.

We assume for simplicity that competitive pressure is never so strong as to preclude spawning. This requires $\lim_{t\to\infty} s_t > \frac{\kappa\,\rho}{\beta}$.

We now calculate the probability and values of innovation. We show in the Appendix

Lemma 2 *The probability of successful innovation in period t equals*

$$q_t \;=\; \frac{(1-\gamma)\,s_t^e}{\rho}\left[\alpha+\beta\left(\frac{1+\omega_t^{*2}}{2}\right)\right]\;. \tag{9}$$

We discuss the comparative statics of the threshold fit and the probability of successful innovation in Section 5, along with those of other firm characteristics such as size, focus, and profitability.

[18] The factor s_t^e is such that

$$\frac{(\alpha+\beta\,\omega_i)}{\rho}\,s_t^e \;=\; \sum_{\tau=t+1}^{\infty}\frac{(\alpha+\beta\,\omega_i)\,\mathbb{E}\left[s_\tau\right]}{(1+\rho)^{\tau-t}}\;.$$

The properties of s_τ in Section 4.1 imply $s_t^e \in [0;1]$ and $\partial\, s_t^e/\partial t \le 0$ for all $t \ge 0$.

5 Firm Characteristics

In this section, we consider a number of firm characteristics such as the frequency of spawning, the probability of successful innovation, size, focus, and profitability. We then derive their comparative statics; these will be seen to revolve around the frequency of spawning, represented by the threshold fit, ω_t^*. The results of Propositions 1, 2, 3, 4, and 5 below are summarized in Table 1.

5.1 Frequency of Spawning

The frequency of spawning is the threshold fit, ω_t^* in (8); this is immediate from the observation that a new product, θ_t, has fit, ω_t, uniformly distributed over the unit interval, $[0,1]$, and that spawning occurs where $\omega_t < \omega_t^*$. We have

Proposition 1 *The frequency of spawning decreases in set-up cost, κ, and competitive pressure, $1/s_t^e$; it increases in the importance of fit, β; it is unaffected by the value of general resources, α, and the bargaining power of the agent, γ.*

The results are intuitive. A higher set-up cost decreases the attractiveness of spawning, for it is borne only in case of spawning. Higher competitive pressure decreases the attractiveness of spawning, for it impedes the recovery of the set-up cost borne only in case of spawning. The attractiveness of spawning naturally increases in the importance of fit, for only in case of spawning can there be perfect fit between firm organization and new product. The value of general resources does not affect the attractiveness of spawning, for general resources have no differential effect on the value of the product spawned or retained. The same holds true of the bargaining power of the agent.

5.2 Innovativeness

We refer to the probability of successful innovation, q_t in (9), as innovativeness. We have

Proposition 2 *Innovativeness increases in the value of general resources, α, and the importance of fit, β; it decreases in the bargaining power of the agent, γ, competitive pressure, $1/s_t^e$, and the set-up cost, κ.*

Innovativeness naturally increases in the value of general resources and the importance of fit: the more profitable is a new product, the more is invested in exploration, the larger is the probability of developing a new product. Note that there are two effects of the importance of fit on innovativeness: a direct effect apparent in (9) and an indirect effect through the threshold fit, ω_t^*. These two effects combine to increase innovativeness; the indirect effect does so by increasing spawning, which increases the profitability of a new product through perfect fit.

Competitive pressure is similar to the importance of fit in having both a direct and an indirect effect on innovativeness. The direct effect of competitive pressure is to decrease the profits attributable to a new product; the indirect effect is to decrease the threshold fit, thereby decreasing spawning and precluding perfect fit. Direct and indirect effects combine to decrease innovativeness by decreasing new product profitability.

The set-up cost has only an indirect effect on innovativeness: increased set-up cost decreases the threshold fit; it thereby decreases spawning and precludes perfect fit; imperfect fit decreases new product profitability, investment in exploration, and innovativeness.

Finally, the bargaining power of the agent has only a direct effect on innovativeness. In a model such as ours where investment in exploration is decided upon by the principal, the lesser payoff to the principal that is a consequence of increased agent bargaining power decreases the principal's incentive to invest in exploration; it thereby decreases innovativeness.

5.3 Firm Size

Denote $\mathcal{I}_t$ the portfolio of products exploited by firm f at date t; these are the products developed by the firm in periods τ, $0 < \tau < t$, which the firm chose to retain rather than to spawn. Denote $I_t \equiv |\mathcal{I}_t|$ the number of products in $\mathcal{I}_t$ and let I_t proxy firm size. The expected size of firm f at date t equals

$$\mathbb{E}\left[I_t\right] = 1 + \sum_{\tau=1}^{t-1} q_\tau \left(1 - \omega_\tau^*\right). \tag{10}$$

The firm in period τ develops a new product with probability q_τ; the new product is retained with probability $1 - \omega_\tau^*$. Firm size starts at 1, as the firm is born with a single product. We have

Proposition 3 *Firm size increases in the value of general resources, α, and the set-up cost, κ; it decreases in the importance of fit, β, where $\alpha > \beta/4$, in competitive pressure, $1/s_t^e$, and in the bargaining power of the agent, γ.*

The greater innovativeness due to more valuable general resources ($dq_t/d\alpha > 0$) increases firm size ($d\mathbb{E}\left[I_t\right]/d\alpha > 0$): more new products developed means more new products retained where spawning frequency remains unchanged ($d\omega_t^* / d\alpha = 0$); more new products retained to be exploited in turn means larger size. What is true of the value of general resources is not necessarily true of the importance of fit: the increase in spawning frequency due to more important fit ($d\omega_t^* / d\beta > 0$) may offset the concurrent increase in innovativeness ($dq_t / d\beta > 0$); the net effect is indeterminate. A sufficient condition for the former effect to dominate and for size to decrease in the importance of fit ($d\mathbb{E}\left[I_t\right] / d\beta < 0$) is that the value of general resources not be 'too small' relative to the importance of fit, $\alpha > \beta/4$: if α is not 'too small' and q_t is not 'too small,' the marginal effect of an increase in the importance of fit ($-q_t d\omega_t^* / d\beta < 0$) dominates the infra-marginal effect ($(1 - \omega_t^*) dq_t / d\beta > 0$). We shall assume the condition holds in our discussion of the empirical evidence and the testable implications in Section 7.

The opposing effects of decreased spawning frequency ($d\omega_t^* / d\kappa < 0$) and decreased innovativeness ($dq_t / d\kappa < 0$) also apply in the case of increased set-up cost, but the former effect always dominates in such case: the set-up cost has a greater effect on spawning frequency than on innovativeness in our model; size increases in set-up costs ($d\mathbb{E}\left[I_t\right] / d\kappa > 0$). The same opposing effects are at work where considering competitive pressure ($1/s_t^e$), but dominance is reversed: competitive pressure has a greater effect on innovativeness than on spawning frequency; size decreases in competitive pressure ($d\mathbb{E}\left[I_t\right] / ds_t^e > 0$). These results are no doubt model-specific; that they are quite intuitive—firms are larger where setting up new firms is costlier; firms are smaller where competitive pressure depresses the gains to developing new products—suggests the model is well-specified.

Agent bargaining power has a similar but opposite effect to the value of general resources: greater agent bargaining power decreases innovativeness ($dq_t / d\gamma < 0$), lower innovativeness decreases firm size where spawning frequency is unchanged ($d\omega_t^* / d\gamma = 0$); size decreases in agent bargaining power ($d\mathbb{E}\left[I_t\right] / d\gamma < 0$).

5.4 Firm Focus

We wish to measure firm f's focus at date t, that is, the similarity or diversity of the products in the firm's portfolio at that date. One possible measure of focus is the average distance between the firm's organization, m_f, and the products exploited by the firm at date t: the smaller is that distance, the more focused is the firm. As organizational fit is the complement of the normalized distance between product and organization (see Section 4.1), a natural measure of focus is then the average fit between firm f's organization and the products in its portfolio, $\mathcal{I}_t$,

$$\bar{\omega}_t \equiv I_t^{-1} \sum_{i \in \mathcal{I}_t} \omega_i \ . \tag{11}$$

The larger is average fit, the more focused is the firm.

Let a history h_t register a given sequence of innovation and spawning that has taken place over the time period $1 \leq \tau \leq t-1$; let H_t denote the set of all possible histories h_t. Let $i(h_t)$ be the subset of periods in h_t during which new products are retained; let its complement $h_t \backslash i(h_t)$, with t is the set of all time periods, be the subset of period in which there was either no new product or there was spawning. Finally, let $I(h_t) = |i(h_t)|$ be the number of new products retained by firm f in the course of history h_t. The expected focus of firm f at a date t equals

$$\mathbb{E}[\bar{\omega}_t] = \sum_{h_t \in H_t} \left[I(h_t)^{-1} \sum_{\tau=1}^{t} i_\tau(h_t) \left(\frac{1+\omega_\tau^*}{2} \right) \prod_{\tau=1}^{t} \left(q_\tau (1-\omega_\tau^*)^{i_\tau(h_t)} (1 - q_\tau (1-\omega_\tau^*))^{1-i_\tau(h_t)} \right) \right]. \quad (12)$$

Firm focus equals 1 at birth, as the single product with which the firm is born determines the firm's organization, $m_f = \theta_f$. We have

Proposition 4 *Firm focus decreases in the value of general resources, α, the set-up cost, κ, and competitive pressure, $1/s_t^e$; it increases in the importance of fit, β if $\beta < 4\alpha$, and it increases in the bargaining power of the agent, γ.*

Focus decreases in the value of general resources ($d\mathbb{E}[\bar{\omega}_t]/d\alpha < 0$), a consequence of increased innovativeness ($dq_t/d\alpha > 0$): the new products developed by a firm generically differ from that firm's organization; more new products imply greater difference, that is, less focus. This effect is offset by increased spawning frequency ($d\omega_t^*/d\beta > 0$) in the case of an increase in the importance of fit: focus increases in the importance of fit ($d\mathbb{E}[\bar{\omega}_t]/d\beta > 0$). The dominant effect of spawning frequency extends to the case of the set-up cost: focus decreases in set-up costs ($d\mathbb{E}[\bar{\omega}_t]/d\kappa < 0$), a consequence of decreased spawning frequency ($d\omega_t^*/d\kappa < 0$). The same holds true of competitive pressure: focus decreases in competitive pressure ($d\mathbb{E}[\bar{\omega}_t]/ds_t^e > 0$), a consequence of decreased spawning frequency ($d\omega_t^*/ds_t^e > 0$). As was the case for firm size, agent bargaining power has a similar but opposite effect to the value of general resources: focus increases in agent bargaining power ($d\mathbb{E}[\bar{\omega}_t]/d\gamma > 0$), a consequence of decreased innovativeness ($dq_t/d\gamma < 0$)

5.5 Profitability

We proxy the profitability of firm f at date t by the average profit per product exploited by the firm at that date. As average profit per product is the ratio of total profit to the number of products, and as the number of products proxies firm size in our model (see Section 5.3), average profit per product is akin to the firm's return on assets, ROA. The expected profitability of firm f_0 at date t

equals

$$\mathbb{E}\left[ROA_t\right] \equiv \mathbb{E}\left[\sum_{i\in\mathcal{I}_t} \pi_{i,t}\ I_t^{-1}\right] \quad = \quad (\alpha + \beta\,\mathbb{E}\left[\bar{\omega}_t\right])\ s_t\ . \tag{13}$$

Profitability equals $\alpha + \beta$ at birth, as focus then equals 1 and $s_0 = 1$. We have

Proposition 5 *Profitability increases in the importance of fit, β, and the bargaining power of the agent, γ; it decreases in the set-up cost, κ, and competitive pressure, $1/s_t^e$; profitability may increase or decrease in the value of general resources, α.*

Changes in profitability due to changes in the bargaining power of the agent, the set-up cost, and competitive pressure are due entirely to the effects of these variables on firm focus: profitability increases in the bargaining power of the agent because focus increases in this variable; profitability decreases in the set-up cost and in competitive pressure because focus decreases. Changes in profitability due to changes in the importance of fit have two effects, an indirect effect through focus and a direct effect through the profit function. Both effects combine to increase profitability in response to an increase in the importance of fit. In contrast, the indirect effect of the value of general resources through focus counters its direct effect: focus decreases in the value of general resources but the profit function increases; the net result is indeterminate.[19]

5.6 Evolution of Firm Characteristics

We now examine spawning dynamics and the evolution of firm characteristics over time.

Proposition 6 *Spawning frequency and innovativeness decrease in age, t, as do focus and profitability; size increases in age.*

Age only has an indirect effect through competitive pressure, $1/s_t^e$, on spawning frequency and innovativeness: as times elapses and competitive pressure increases, spawning frequency declines because of the greater difficulty of recovering the set-up cost borne only in case of spawning; innovativeness declines because less is invested in exploration where new products are less profitable.[20] In contrast, age has a direct effect on size, focus, and profitability, in addition to the indirect effect through competitive pressure. Keeping competitive pressure constant, size increases in age as the

[19] We show in the Appendix that profitability increases in the value of general resources, α, for that value greater than some minimum value α^*: $d\mathbb{E}\left[ROA_t\right]/d\alpha > 0$ for $\alpha > \alpha^*$. This is because the direct through the profit function is linear whereas the indirect effect through focus is or eventually becomes concave.

[20] Formally, we have $\Delta\omega_t^* \equiv \omega_t^* - \omega_{t-1}^* = -\frac{\rho\,\kappa}{\beta}\left(\frac{1}{s_t^e} - \frac{1}{s_{t-1}^e}\right) < 0$, because $s_t^e < s_{t-1}^e$.

firm adds new products to the single product with which it was born; focus decreases in age as innovations accumulate that are generically different from firm organization; finally, profitability decreases in age because focus does. Combining the direct and indirect effects of age on size, focus, and profitability, it is clear that focus and profitability decrease in age, as the direct effect of age is compounded by its indirect effect through competitive pressure. Size too increases in age, despite the increase in competitive pressure; this is because greater competitive pressure slows down but does not altogether stop the development of new products that causes firm growth. In short, older firms' larger and more disparate product portfolios decrease firm focus and profitability and increase firm size. Age's direct effect on firm focus and profitability, is compounded by its indirect effect through increased competitive pressure.

Proposition 6 reproduces Gompers, Lerner, and Scharfstein's (2005) finding that spawning decreases in firm age: older firms tend to be active in older industries (Loderer, Neusser, and Waelchli, 2010), in which competitive pressure is greater; these firms develop fewer new products, of which a smaller fraction is spawned; the combined effect is to decrease spawning by older firms. Similarly to older firms' lower profitability, older firms' lesser spawning need not be associated with some form of decline (Loderer and Waelchli, 2009); it is instead the reflection of greater competitive pressure in more mature industries.

6 Extensions

6.1 Additional Innovation Processes

In this subsection, we consider that new products lead to an increased creation of future innovations, in contrast to our baseline model introduced in Section 4.2. We now assume that the introduction of each new product $\theta_i \neq \theta_f$ leads also to an additional exploration effort; hence each new product emerging in the industry becomes itself a new source of future innovations. More precisely, we assume that each new product will generate a new innovation process with the same innovation-generating capacity as the original product θ_f. In this way, the model does not assume any hard-wired time profile about the innovation-generating capacity of early versus late products or firms. Also, to introduce additional innovation processes, it is clearly essential the model ensures that when it is decided to exploit an innovation in firm f_0, *as many* additional innovation processes are created in firm f as would be created in firm f^+ if the innovation was implemented in a spawned firm f^+ instead. With this assumption, we avoid imparting any built-in advantage to either parent firm or spawned firm that would biais the results on the desirability of spawning; the new innovation processes created with each new product are the same regardless of whether the product is spawned or is exploited within the parent firm.

Each product, therefore, carries an exploitation and an exploration activity. It needs two agents, one for each of these activities. The innovator is assumed to be inseparable from the exploitation of the product he invented and will become its exploitation agent and manager, as in the baseline model. As in the baseline model, the parent firm will hire a new exploration agent to replace him. In addition, it will now also hire a new exploration agent a^+ will for each new product θ_i that it keeps within the firm. If the innovation θ_i is spawned, then a new exploration agent will also be hired in the new firm created to exploit θ_i. Thus, for each innovation θ_i, two agents will be employed, one for exploration, one for exploitation, and two two new exploration agents will be hired (one at the parent firm, one at the new product θ_i), regardless of whether θ_i remains in the parent firm or is spawned.

Assume that the innovating agent is in a position to fully appropriate the additional value created by the new innovation-generating process if the innovation θ_i is spawned. That is, the innovating agent who then becomes the owner of the new firm, fully appropriates the value of the newly created innovation process. The same will be true for any later generation entrepreneur.[21] Therefore, as a result of the bargaining between innovating agent and parent firm (his current employer), the innovating agent will leave and set up his own firm until he is fully compensated for the option value of the newly created innovation-generating process.

We obtain for the threshold fit and the innovation frequency, as in Lemmas 1 and 2:

$$\omega_t^* = 1 - \frac{\rho\,\kappa}{\beta\, s_t^e}\ , \tag{14}$$

$$q_t = \frac{(1-\gamma)\, s_t^e}{\rho}\left[\alpha + \beta\left(\frac{1+\omega_t^{*2}}{2}\right)\right]\ . \tag{15}$$

The formula for firm size and focus differ. Since firm grow at an expected rate of $q_t\,(1-\omega_t^*)$ every period, and all products are now equally productive in generating future innovation, the expected size of firm f at date t equals

$$\mathbb{E}\left[I_t\right] = \prod_{\tau=1}^{t-1}\left(1 + q_\tau\,(1-\omega_\tau^*)\right). \tag{16}$$

[21] This simplifying assumption helps to make the effort decision q_t tractable. The main structure of the model would be unchanged if the innovating agent were to own part or all of the property rights of the new innovastion generating process, for example as a consequence of weak property rights. But the effort decision q_t cannot then be sufficiently characterized to reproduce all comparative statics results.

For focus, we can in similar fashion describe any history $h_t \in H_t$ by the sequence $(i_\tau^+(h_t))_t$ that indicates the number of in-house innovations realized in each period $\tau \leq t$. Let $I(h_t) = \sum_{\tau=1}^{t} i_\tau^+(h_t)$ denote the number of in-house products realized in h_t, and $I_\tau(h_t) = \sum_{s=1}^{\tau} i_s^+(h_t)$ denote the number of in-house products realized in h_t up to period $\tau \leq t$. The expected focus of firm f_0 at a date t becomes

$$\mathbb{E}[\bar{\omega}_t] = \sum_{h_t \in H_t} \left[I(h_t)^{-1} \sum_{\tau=1}^{t} i_\tau^+(h_t) \left(\frac{1+\omega_\tau^*}{2} \right) \prod_{\tau=1}^{t} \binom{I_\tau(h_t)}{i_\tau^+(h_t)} \left(q_\tau (1-\omega_\tau^*)^{i_\tau^+(h_t)} (1 - q_\tau (1-\omega_\tau^*))^{I_\tau^+(h_t) - i_\tau^+(h_t)} \right) \right]. \quad (17)$$

We can show that comparative statics results are unaffected:

Proposition 7 *If each innovation generates a new inovating-generating process of the same intensity as that of the first innovation, and if the innovating agent can fully apropriate its value, then the comparative statics and results detailed in Propositions 1 to 5 of the baseline model also apply to this case.*

6.2 Labor market constraint

In this Subsection, we consider the possibility that the growing labor demand stemming from the fact that the recruitment of new agents at such innovation creation leads at some point to full employment of the skilled labor supply. [**to be completed**]

6.3 Endogenizing competition

In this Subsection, we briefly consider how the spawning decision would be altered if the variable s_t was a direct function of the spawning decision. Thus would be the case if the spawning of a new firm directly alters the competitive landscape and makes ach agent ... [**to be completed**]

7 Empirical Evidence and Testable Implications

We discuss some supporting empirical evidence and derive a number of testable implications. We first examine the relations between the endogenous variables that are spawning, focus, and profitability and the exogenous variables that are age, set-up costs, the value of general resources, and the importance of fit. We start with age (t). Gompers, Lerner, and Scharfstein (2005) find that older firms spawn fewer new firms; Denis, Denis, and Sarin (1997) find that older firms are more diversified and Loderer and Waelchli (2009) find that they are less profitable. All three findings are consistent with the predictions of our model. The extent of spawning at date t is the product $q_t\,\omega_t^*$; we know both terms of that product to be decreasing in t indirectly through κ; the extent of spawning therefore decreases in t. We also know focus, $\mathbb{E}[\bar{\omega}_t]$, and profitability, $\mathbb{E}[ROA_t]$, to be decreasing in t.

Gompers, Lerner, and Scharfstein (2005) find that firms that have higher patent quality spawn more; Franco and Filson (2006) find that firms that have higher knowhow spawn more. These two findings are consistent with the predictions of our model, regardless of whether patent quality and knowhow are viewed as being primarily in the nature of general resources, α, or in that of fit, β: q_t, and ω_t^* are increasing in α and in β.[22]

We now turn to examining the relations among the various endogenous variables that are spawning, focus, and profitability. The nature of such relations depends crucially on the specific exogenous variable driving the relations. Consider for example the relation between spawning and focus. From the results in Section 5 that spawning frequency (ω_t^*), the frequency of innovation (q_t), and focus ($\mathbb{E}[\bar{\omega}_t]$) increase in the importance of fit (β), we conclude that more focused firms spawn more when spawning is driven by the importance of fit. Such is not the case where spawning is driven by the value of general resources (α), for spawning increases whereas focus decreases in that value.[23] Thus, empirical tests that examine the relation between spawning and focus may find contrasting results depending on whether the relation is driven primarily by the importance of fit or the value of general resources.

Our model predicts the following. Where spawning is driven primarily by the importance of fit, smaller, more innovative, and more focused firms spawn more and are more profitable. Where the driving force is the value of general resources and profitability increases in that value, larger, more diversified firms innovate and spawn more and are more profitable. Where profitability decreases in the value of general resources, larger, more diversified firms innovate and spawn more but are less profitable. These predictions may help reconcile otherwise contradictory empirical evidence.

Consider for example the relation between size and profitability or, more generally, value. Recent

[22] An obvious question is how empirically to measure the value of general resources and the importance of fit. An example of a proxy for not entirely general resources is Gompers, Lerner, and Scharfstein's (2005) citation-based value of patents; fit on the other hand could e.g. be proxied by Brynjolfsson, Hitt, and Yang's (2002) measure of organizational capital.

[23] Although spawning *frequency* is unaffected by the value of general resources, spawning increases in that value because of increased innovativeness.

studies document a negative relation between these two endogenous variables.[24] Yet, this has not always been so: Hall and Weiss (1967) document a positive such relation for the time period 1956-1962. The distinction between the value of general resources and the importance of fit may help reconcile these contrasting results, if profitability should be increasing in the value of general resources ($d\mathbb{E}[ROA_t]/d\alpha > 0$): it is conceivable that the relation between size and profitability was driven in earlier periods primarily by the value of general resources; the importance of fit only later may have become of primary importance, accounting for the reversal of the relation.

The same distinction may help account for the contrasting evidence regarding the relation between focus and profitability or value. Most studies have documented a positive relation, but a few a have documented a negative relation. In particular, an argument has been made that related diversification creates value.[25] Suppose that the decision to remain focused is driven primarily by the importance of fit, that to diversify by the value of general resources. Both resources and fit increase profitability where profitability increases in the value of general resources ($d\mathbb{E}[ROA_t]/d\alpha > 0$), but fit keeps focus high whereas resources decrease it. The relation between focus and profitability is therefore positive where driven by the importance of fit, negative where driven by the value of general resources. To the extent that there are few truly general resources, and that a diversifying firm's resources may be more directly applicable to related than to unrelated industries, the value of not entirely general resources may account for the positive relation between related diversification and profitability/value.

8 Conclusion

Entrepreneurial spawning is the process whereby an existing firm gives birth to a new firm set up by one or more employees departed from the existing firm. Although the phenomenon of spawning itself has been quite extensively studied, its implications for firm characteristics such as size, focus, profitability, and innovativeness have received little attention. Our paper aims at filling this gap.

We motivate spawning by the desire to achieve organizational fit, that is, the degree to which a firm's organization is adapted to the needs of its product portfolio. Spawning occurs where an employee who develops a new product finds it beneficial to start a new firm to commercialize that product, because the product presents little fit with the organizational form of the firm at which the employee originally is employed. There is a trade-off between organizational fit and the cost to

[24] See most recently Loderer and Waelchli (2009).
[25] See Montgomery (1994) and Villalonga (2004).

setting up a new firm.

From this basic trade-off, we derive the implications of spawning for firm size, profitability, focus, and innovativeness. We analyze how the value of firm general resources and the importance of organizational fit, the cost of setting up a new firm, firm age, and the bargaining power of innovating employees affect the aforementioned firm characteristics. Firms that have more valuable general resources spawn more, as do firms that have more important organizational fit. As firms mature, they spawn less and devise fewer innovations, they are less profitable and more diversified. Focus and profitability are positively related where spawning is driven by the importance of organizational fit; they may be negatively related where spawning is driven by the value of firm general resources.

Our model accounts for much of the empirical evidence on the relation between spawning and firm characteristics; it suggests new empirical tests based upon the distinction between the value of general resources and the importance of fit.

Appendix

Proof of Lemma 2: The expected value at date t of an innovation successfully devised at date $t+\epsilon$ is

$$v_t \equiv \int_0^{\omega_t^*} v_{t+\epsilon}^{out}\, d\,\omega_i \;+\; \int_{\omega_t^*}^1 v_{t+\epsilon}^{in}(\omega_i)\, d\,\omega_i \;. \tag{18}$$

Evaluating v_t in (18), we obtain

$$v_t = \frac{s_t^e\,(\alpha+\beta)}{\rho} \;-\; \kappa \;-\; (1-\omega_t^*)\left[\frac{s_t^e\,\beta}{\rho}\left(\frac{1-\omega_t^*}{2}\right) \;-\; \kappa\right] \;. \tag{19}$$

From (8), we have $\kappa = \frac{s_t^e\,\beta}{\rho}(1-\omega_t^*)$. Substituting κ into (19), yields

$$v_t = \frac{s_t^e}{\rho}\left[\alpha + \beta\left(\frac{1+\omega_t^{*2}}{2}\right)\right] \;. \tag{20}$$

From the point of view of the principal p, the unit-period choice of cost of resources, $c(q_t)$, earns $q_t\,(1-\gamma)\,v_t$ in expectation. Extending to all dates, the expected value at date t, to the principal p, of all future innovations devised by successive agents is therefore

$$V_t^p \equiv \max_{q_t}\left\{-\,\frac{1}{2}\;(q_t)^{\,2} \;+\; q_t\,(1-\gamma)\,v_t \;+\; \frac{V_{t+1}^p}{1+\rho}\right\} \;. \tag{21}$$

The period t choice of q_t, does not affect V_{t+1}^a as innovation probabilities are independent across time. Differentiating with respect to q_t, we have

$$\frac{\partial\,V_t^a}{\partial\,q_t} = -\,q_t \;+\; (1-\gamma)\,v_t \;. \tag{22}$$

The principal p's optimal q_t solves the f.o.c. $\frac{\partial\,V_t^a}{\partial\,q_t} = 0$, which gives

$$q_t = (1-\gamma)\,v_t \;\;. \tag{23}$$

Replacing q_t in (23) in (21), we obtain

$$V_t^p = \frac{q_t^2}{2} \;+\; \frac{V_{t+1}^p}{1+\rho} \;. \tag{24}$$

The expected value at date t, to agent a, of devising an innovation (in period t or in the future) is

$$V_t^a \equiv q_t\,\gamma\,v_t \;+\; (1-q_t)\,\frac{V_{t+1}^a}{1+\rho} \;, \tag{25}$$

Replacing, q_t in (23), (25) can be written

$$V_t^a = \frac{\gamma}{1-\gamma}\,q_t^2 \;+\; (1-q_t)\,\frac{V_{t+1}^a}{1+\rho} \;. \tag{26}$$

Proof of (10): A new product is introduced at date $\tau+\epsilon$ with probability $q_\tau\,(1-\omega_\tau^*)$ by the innovating firm. Aggregating products introduced over time yields $\mathbb{E}\,[I_t] = 1 + \sum_{\tau=t_f+1}^{t-1} q_\tau\,(1-\omega_\tau^*)$.

Proof of (12): Define the expected mean of focus in history h_t as

$$\bar{\omega}\,(h_t) \equiv I\,(h_t)^{-1}\;\sum_{\tau=1}^{t} i_\tau\,(h_t)\left(\frac{1+\omega_\tau^*}{2}\right) \;. \tag{27}$$

The probability of history h_t is

$$\Pr(h_t) = \prod_{\tau=1}^{t} \left(q_\tau \left(1-\omega_\tau^*\right)^{i_\tau(h_t)} \left(1-q_\tau\left(1-\omega_\tau^*\right)\right)^{1-i_\tau(h_t)} \right). \tag{28}$$

Taking expectations over all histories and using (27), the expected focus $\mathbb{E}_{H_t}[\bar{\omega}_t] = \sum_{h_t \in H_t} \Pr(h_t)\,\bar{\omega}(h_t)$, is

$$\mathbb{E}[\bar{\omega}_t] = \sum_{h_t\in H_t} \left(I(h_t)^{-1} \sum_{\tau=1}^{t} i_\tau(h_t) \left(\frac{1+\omega_\tau^*}{2}\right) \prod_{\tau=1}^{t} \left(q_\tau\left(1-\omega_\tau^*\right)^{i_\tau(h_t)} \left(1-q_\tau\left(1-\omega_\tau^*\right)\right)^{1-i_\tau(h_t)} \right) \right). \tag{29}$$

Proof of Proposition 2: Using q_t in (9) and ω_τ^* in (8), we have

$$q_t = \frac{s_t^e}{\rho} \left[\alpha + \frac{\beta}{2} \left(1 + \left[1 - \frac{\rho\kappa}{\beta\, s_t^e} \right]^2 \right) \right] . \tag{30}$$

It is immediate that $\frac{dq_t}{d\alpha} > 0$, $\frac{dq_t}{d\beta} > 0$, $\frac{dq_t}{d\kappa} < 0$, $\frac{dq_t}{d\rho} < 0$, $\frac{dq_t}{ds_t^e} > 0$, and $\frac{dq_t}{d\varepsilon} < 0$.

Proof of Proposition 3: Substitute ω_τ^* in (8) into $q_\tau(1-\omega_\tau^*)$ to obtain

$$q_\tau(1-\omega_\tau^*) = \kappa \left[\frac{\alpha}{\beta} + \frac{1}{2}\left(1+\omega_\tau^{*2}\right) \right] . \tag{31}$$

For $\Xi \in \{\alpha, \beta, \rho, \kappa, s_t^e\}$, substituting $q_\tau(1-\omega_\tau^*)$ in (31) into $\mathbb{E}[I_t] = 1 + \sum_{\tau=1}^{t-1} q_\tau\left(1-\omega_\tau^*\right)$ we have

$$\frac{d\mathbb{E}[I_t]}{d\Xi} = \sum_{\tau=1}^{t-1} \left(\kappa \frac{d(\alpha/\beta)}{d\Xi} + \kappa\,\omega_\tau \frac{d\omega_\tau^*}{d\Xi} + \frac{d\,\kappa}{d\Xi} \left[\frac{\alpha}{\beta} + \frac{1}{2}\left(1+\omega_\tau^{*2}\right) \right] \right) . \tag{32}$$

– For $\Xi = \alpha$: $\frac{d(\alpha/\beta)}{d\alpha} = \frac{1}{\beta}$, $\frac{d\omega_\tau^*}{d\alpha} = 0$ and $\frac{d\,\kappa}{d\alpha} = 0$. So, $\frac{d\mathbb{E}[I_t]}{d\alpha} > 0$.
– For $\Xi = \beta$: $\frac{d(\alpha/\beta)}{d\beta} = \frac{-\alpha}{\beta^2} < 0$, $\frac{d\omega_\tau^*}{d\beta} = \frac{\rho\,\kappa}{\beta^2\, s_t^e} = \frac{1-\omega_\tau^*}{\beta} > 0$ and $\frac{d\,\kappa}{d\beta} = 0$. So,

$$\frac{d\,\mathbb{E}[I_t]}{d\,\beta} = \sum_{\tau=1}^{t-1} \frac{\kappa}{\beta} \left[-\frac{\alpha}{\beta} + (1-\omega_\tau^*)\,\omega_\tau^* \right] . \tag{33}$$

Therefore, $\frac{d\mathbb{E}[I_t]}{d\beta} < 0$ iff $-\alpha/\beta + (1-\omega_\tau^*)\,\omega_\tau^* < 0$ for all τ. The sufficient condition $\alpha/\beta > 1/4$ is obtained by noting that $(1-\omega_\tau^*)\,\omega_\tau^*$ is maximized at $\omega_\tau^* = 1/2$.
– For $\Xi = \rho$: $\frac{d\,(\alpha/\beta)}{d\,\rho} = 0$, $\frac{d\,\omega_\tau^*}{d\,\rho} = \frac{-\kappa}{\beta\, s_t^e} < 0$ and $\frac{d\,\kappa}{d\rho} = 0$. So, $\frac{d\,\mathbb{E}[I_t]}{d\,\rho} < 0$.
– For $\Xi = \kappa$: $\frac{d\,(\alpha/\beta)}{d\,\kappa} = 0$, $\frac{d\omega_\tau^*}{d\,\kappa} = \frac{-\rho}{\beta\, s_t^e} = \frac{-(1-\omega_\tau^*)}{\kappa}$ and $\frac{d\,\kappa}{d\,\kappa} = 1$. So,

$$\frac{d\mathbb{E}[I_t]}{d\,\kappa} = \sum_{\tau=1}^{t-1} \left(\frac{\alpha}{\beta} - (1-\omega_\tau^*)\,\omega_\tau + \frac{1}{2}\left(1+\omega_\tau^{*2}\right) \right) = \sum_{\tau=1}^{t-1} \left(\frac{\alpha}{\beta} + \omega_\tau^{*2} + \frac{1}{2}\left(1-\omega_\tau\right)^{*2} \right) > 0 . \tag{34}$$

– For $\Xi = s_t^e$: $\frac{d\,(\alpha/\beta)}{d\,s_t^e} = 0$, $\frac{d\,\omega_\tau^*}{d\,s_t^e} = \frac{\rho\,\kappa}{\beta\,(s_t^e)^2} > 0$ and $\frac{d\,s_t^e}{d\,\kappa} = 0$. So, $\frac{d\,\mathbb{E}[I_t]}{d\,s_t^e} > 0$.

Proof of Proposition 4:

Insert here proof of comparative statics of focus.

Proof of Proposition 5: We have $\frac{d\mathbb{E}[\bar{\omega}_t]}{d\alpha} < 0$ and $\frac{d\mathbb{E}[ROA_t]}{d\alpha} = \left(1 + \beta\,\frac{d\mathbb{E}[\bar{\omega}_t]}{d\alpha}\right) s_t$. Let α^* be the level of α such that $\frac{d\mathbb{E}[\bar{\omega}_t]}{d\alpha}|_{\alpha=\alpha^*} = \frac{-1}{\beta}$. Then, $\frac{d\mathbb{E}[ROA_t]}{d\alpha} < 0$ for all $\alpha < \alpha^*$, and $\frac{d\mathbb{E}[ROA_t]}{d\alpha} \geq 0$ for all $\alpha \geq \alpha^*$.

From $\frac{d\mathbb{E}[\bar{\omega}_t]}{d\beta} > 0$, we have, $\frac{d\mathbb{E}[ROA_t]}{d\beta} = \left(\beta \frac{d\mathbb{E}[\bar{\omega}_t]}{d\beta} + \mathbb{E}\left[\bar{\omega}_t\right]\right) s_t > 0$. From $\frac{d\,\mathbb{E}[\bar{\omega}_t]}{d\,\rho} < 0$, we have $\frac{d\,\mathbb{E}[ROA_t]}{d\,\rho} = \beta \frac{d\,\mathbb{E}[\bar{\omega}_t]}{d\,\rho}\, s_t < 0$. From $\frac{d\mathbb{E}[\bar{\omega}_t]}{d\,\kappa} < 0$, we have $\frac{d\mathbb{E}[ROA_t]}{d\,\kappa} = \beta \frac{d\mathbb{E}[\bar{\omega}_t]}{d\,\kappa}\, s_t < 0$. From $\frac{d\,\mathbb{E}[\bar{\omega}_t]}{d\,s_t^e} > 0$, we have $\frac{d\,\mathbb{E}[ROA_t]}{d\,s_t^e} = \beta \frac{d\,\mathbb{E}[\bar{\omega}_t]}{d\,s_t^e}\, s_t + (\alpha + \beta\,\mathbb{E}\left[\bar{\omega}_t\right])\, \frac{d\,s_t}{d\,s_t^e} > 0$.

Proof of Proposition 6: We have $\Delta\mathbb{E}\left[I_t\right] \equiv \mathbb{E}\left[I_t\right] - \mathbb{E}\left[I_{t-1}\right] = \kappa_{t-1}\frac{\alpha}{\beta} + \frac{\kappa_{t-1}}{2}\left(1 + \omega^{*\,2}_{t-1}\right) > 0$.
Insert here proof of $\Delta\mathbb{E}\left[\bar{\omega}_t\right] < 0$.
Denoting $\Delta\mathbb{E}\left[ROA_t\right] \equiv \mathbb{E}\left[ROA_t\right] - \mathbb{E}\left[ROA_{t-1}\right]$, given that $s_t \leq s_{t-1}$, we have $\Delta\mathbb{E}\left[ROA_t\right] \leq \beta\,\Delta\mathbb{E}\left[\bar{\omega}_t\right] < 0$.

Proof of (14) and (15): The threshold fit, ω_t^*, is that which leaves the parties indifferent between spawning the new product to a new firm, f^+, and retaining it within the original firm, f. Costless bargaining implies that principal and agent will maximize their joint payoff, the equilibrium condition for the threshold fit is

$$v_{t+\epsilon}^{out} + w_t + \frac{V_{t+1}^p + V_{t+1}^a}{1+\rho} = v_{t+\epsilon}^{in}(\omega_t^*) + w_t + \frac{V_{t+1}^p + V_{t+1}^a}{1+\rho} \,, \tag{35}$$

where w_t denotes the future value of the newly created innovation process when an innovation occurs. w_t is here fully appropriated by the agent. Hence the point of indifference between spawning and retaining, ω_t^*, is again such that $v_{t+\epsilon}^{out} = v_{t+\epsilon}^{in}(\omega_i)$.

Given that the principal does not appropriate any fraction of w_t, the expected value at date t, to the principal p, of all future innovations devised by successive agents (as in the proof of Lemma 2) is

$$V_t^p = \max_{q_t}\left\{-c(q_t) + q_t\,(1-\gamma)\,v_t + \frac{V_{t+1}^p}{1+\rho}\right\} \,, \tag{36}$$

where v_t is as defined in (18) and has value given in (20). Solving the f.o.c. $\frac{\partial\,V_t^p}{\partial\,q_t} = 0$, gives the same principal p's optimal q_t:

$$q_t = (1-\gamma)\,v_t \,. \tag{37}$$

The expected value at date t, to agent a, of devising an innovation (in period t or in the future) is

$$V_t^a \equiv q_t\,(\gamma\,v_t + w_t) + (1-q_t)\,\frac{V_{t+1}^a}{1+\rho} \,. \tag{38}$$

References

Agarwal, R., R. Echambadi, A.M. Franco, and M.B. Sarkar, 2004, Knowledge Transfer Through Inheritance: Spin-Out Generation, Growth, and Survival, *Academy of Management Journal* 47, 501–522.

Agarwal, R. and M. Gort, 1996, The Evolution of Markets and Entry, Exit and Survival of Firms, *Review of Economics and Statistics* 78, 489-498.

Amador, M. and A. Landier, 2003, Entrepreneurial Pressure and Innovation, Mimeo, Graduate School of Business, Stanford University.

Anton, J. J. and D. A. Yao, 1995, Start-Ups, Spin-Offs, and Internal Projects, *Journal of Law, Economics, and Organization* 11, 362-378.

Berger, P. G. and E. Ofek, 1995, Diversification's Effect on Firm Value, *Journal of Financial Economics* 37, 39-65.

Bernardo, A.E. and B. Chowdhry, 2002, Resources, Real Options, and Corporate Strategy, *Journal of Financial Economics* 63, 211-234.

De Bettignies, J. and G. Chemla, 2008, Corporate Venture Capital: The Upside of Failure and Competition for Talent, *Management Science*, 54, 505-21.

Brynjolfsson, E., L.M. Hitt, S. Yang, 2002, Intangible Assets: Computers and Organizational Capital, *Brookings Papers on Economic Activity*, 137-181.

Buenstorf, G. and S. Klepper, 2009, Heritage and Agglomeration: The Akron Tyre Cluster Revisited, *Economic Journal* 119, 705-733.

Campa, J.M. and S. Kedia, 2002, Explaining the Diversification Discount, *Journal of Finance* 57, 1731-1762.

Carroll, G.R. and M.T. Hannan, 2000, *The Demography of Corporations and Industries*, Princeton University Press, Princeton.

Cassiman, B. and M. Ueda, 2006, Optimal Project Rejection and New Firm Start-Ups, *Management Science* 52, 262–275.

Chatterjee, S. and B. Wernerfelt, 1991, The Link Between Resources and Type of Diversification: Theory and Evidence, *Strategic Management Journal* 12, 33-48.

Christensen, C.M., 1993, The Rigid Disk Drive Industry: A History of Commercial and Technological Turbulence, *Business History Review* 67, 531-588.

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

Coad, A., 2009, The Growth of Firms: A Survey of Theories and Empirical Evidence, *New Perspectives on the Modern Corporation*, Elgar, Cheltenham.

Denis, D.J., D.K. Denis, and A. Sarin, 1997, Agency Problems, Equity Ownership, and Corporate Diversification, *Journal of Finance* 52, 135-160.

Fluck, Z. and A.W. Lynch, 1999, Why Do Firms Merge and Then Divest? A Theory of Financial Synergy, *Journal of Business* 72, 319-346.

Franco, A. and D. Filson, 2006, Spin-Outs: Knowledge Diffusion Through Employee Mobility, *Rand Journal of Economics* 37, 841-860.

Gertner, R.H., Scharfstein, D.S., and J.C. Stein, 1994, Internal versus External Capital Markets, *Quarterly Journal of Economics* 109, 1211-1230.

Gomes, J. and D. Livdan, 2004, Optimal Diversification: Reconciling Theory and Evidence, *Journal of Finance* 59, 507-535.

Gompers, P., J. Lerner and D. Scharfstein, 2005, Entrepreneurial Spawning: Public Corporations and the Genesis of New Ventures, 1986 to 1999, *Journal of Finance* 60, 577-614.

Graham, J.R., Lemmon, M.L., and J.G. Wolf, 2002, Does Corporate Diversification Destroy Value? *Journal of Finance* 57, 695-720.

Gromb, D. and D. Scharfstein, 20012, Entrepreneurial Activity in Equilibrium, Mimeo, Massachusetts Institute of Technology, Boston.

Hall, P., 1998, *Cities in Civilization*, Pantheon, New-York.

Hall, M. and L. Weiss, 1967, Firm Size and Profitability, *Review of Economics and Statistics* 49, 319-331.

Hanson, D., 1982, *The New Alchemists: Silicon Valley and the Microelectronics Revolution*, Little Brown, Boston.

Hellmann, T., 2007, When Do Employees Become Entrepreneurs?, *Management Science* 53, 919-933.

Jovanovic, B. and P.L. Rousseau, 2001, Vintage Organization Capital, NBER WP 8166.

Klepper, S., 1996, Entry, Exit, Growth, and Innovation over the Product Life Cycle, *American Economic Review* 86, 562-583.

Klepper, S., 2002, The Capabilities of New Firms and the Evolution of the US Automobile Industry, *Industrial and Corporate Change* 11, 645-666.

Klepper, S., 2007, Disagreements, Spinoffs, and the Evolution of Detroit as the Capital of the U.S. Automobile Industry, *Management Science* 53, 616-631.

Klepper, S. and S. Sleeper, 2005, Entry by Spin-Offs, *Management Science* 51, 1291–1306.

Klepper, S. and P. Thompson, 2006, Submarkets and the Evolution of Market Structure, *Rand Journal of Economics* 37, 861-886.

Klepper, S. and P. Thompson, 2009, Disagreements and Intra-industry Spinoffs, mimeo, Carnegie Mellon University and Florida International University.

Klette, T.J. and S. Kortum, 2004, Innovating Firms and Aggregate Innovation, *Journal of Political Economy* 112, 986-1018.

Lang, L. H. P. and R. M. Stulz, 1995, Tobin's q, Corporate Diversification, and Firm Performance, *Journal of Political Economy* 102, 1248-1280.

Laux, J.M., 1976, *In First Gear: The French Automobile Industry to 1914*, McGill-Queen's University Press, Montreal.

Loderer, C. and U. Waelchli, 2009, Firm Age and Performance, mimeo, University of Bern.

Loderer, C., K. Neusser, and and U. Waelchli, 2010, Firm Age and Survival, mimeo, University of Bern.

Maksimovic, V. and G. Phillips, 2002, Do Conglomerate Firms Allocate Resources Inefficiently Across Industries? Theory and Evidence, *Journal of Finance* 57, 721-767.

Matsusaka, J.G., 2001, Corporate Diversification, Value Maximization, and Organizational Capabilities, *Journal of Business* 74, 409-431.

Matsusaka, J.G. and V. Nanda, 2002, Internal Capital Markets and Corporate Refocusing, *Journal of Financial Intermediation* 11, 176-211.

Montgomery, C.A., 1994, Corporate Diversification, *Journal of Economic Perspectives* 8, 163-178.

Penrose, E., 1995, *The Theory of the Growth of the Firm*, Oxford University Press (First Ed., 1959).

Rajan, R., Servaes, H., and L. Zingales, 2000, The Cost of Diversity: The Diversification Discount and Inefficient Investment, *Journal of Finance* 55, 35-80.

Roberts, J., 2004, *The Modern Firm: Organizational Design and Performance for Growth*, Oxford University Press, Oxford.

Rogers, E.M., 1985, *The High Technology of Silicon Valley*, Institute for Urban Studies Monograph 4, University of Maryland.

Schoar, A., 2002, Effects of Corporate Diversification on Productivity, *Journal of Finance* 57, 2379-2403.

Sherer, J., 2006, Entrepreneurial Innovation: Evidence From the American Laser Industry, Mimeo, Carnegie Mellon University.

Sutton, J., 1997, Gibrat's Legacy, *Journal of Economic Literature* 35, 40-59.

Sutton, J., 1998, *Technology and Market Structure*, MIT Press, Cambridge, MA.

Villalonga, B., 2004, Diversification Discount or Premium? New Evidence From the Business Information Tracking Series, *Journal of Finance* 59, 475-502.

Wernerfelt, B., 1984, A Resource-Based View of the Firm, *Strategic Management Journal* 5, 171-180.

Whited, T.M., 2001, Is It Inefficient Investment That Causes the Diversification Discount? *Journal of Finance* 56, 1667-1691.

Figure 1: Time Line

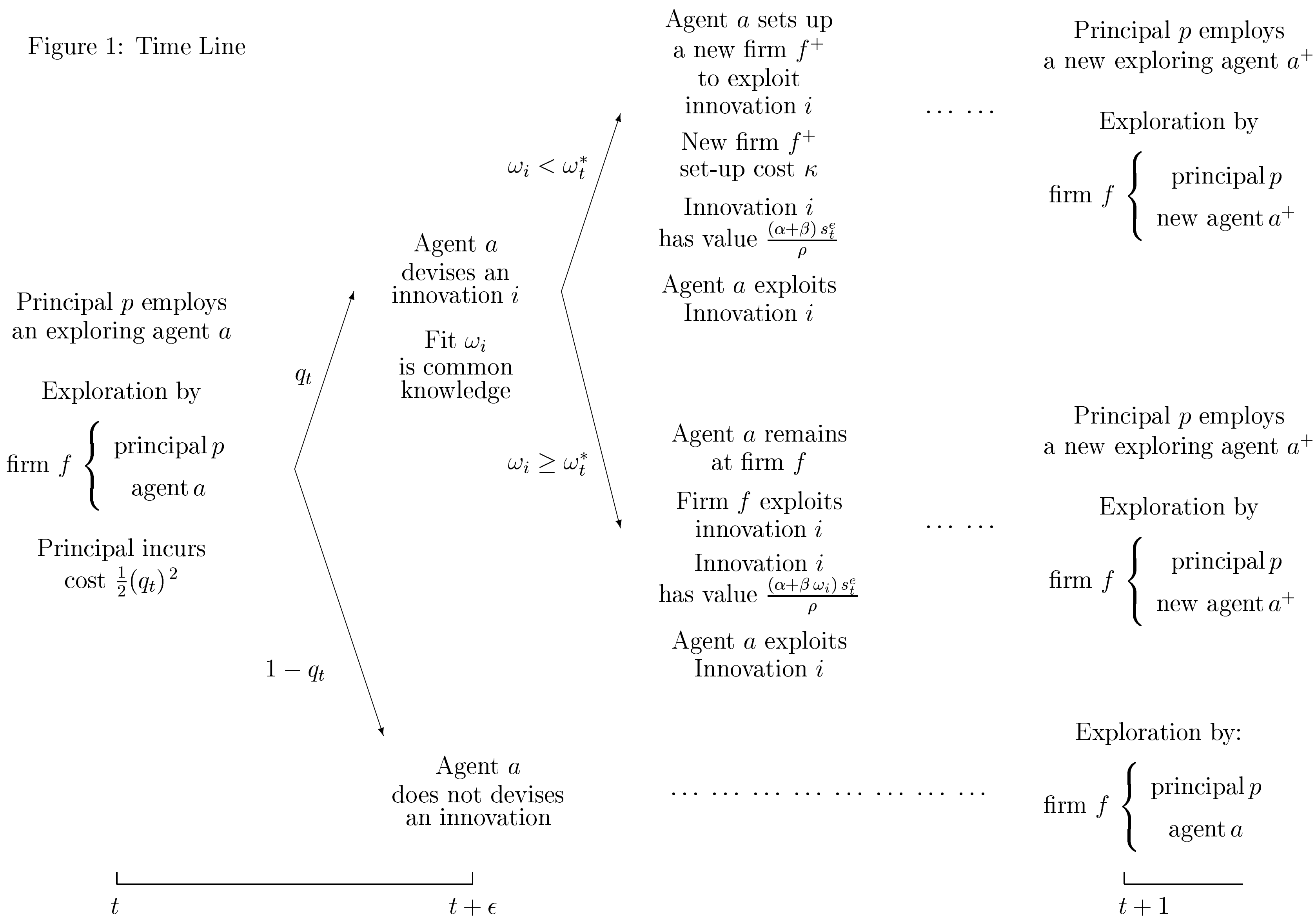

Table 1: Comparative Statics

	Spawning Frequency ω_t^*	Probability of Innovation p_t	Firm Size $E[I_t]$	Firm Focus $E[\bar{\omega}_t]$	Return on Assets $E[ROA_t]$
α	0	+	+	−	−/+ †
β	+	+	−*	+	+
κ	−	−	+	−	−
q_t^∞	+	+	+	+	+
ρ	−	−	−	−	−

* if $\alpha/\beta > 1/4$.

† $\exists \alpha^*$ such that − if $\alpha < \alpha^*$ and + if $\alpha > \alpha^*$.