Professional Reputation, Cash, and Transition to Entrepreneurial Activity*

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Abstract

We analyze the role of professional reputation in the transition to entrepreneurial activity when credit is rationed. We study an employee’s willingness to allow the market to learn information about talent by choosing more or less informative projects. This choice impacts the employee’s incentives to exert effort, which determines the wage, and in turn the cash to be invested in the business venture. We show that reputation and cash are substitutes in overcoming credit rationing. However, maintaining a good reputation conflicts with accumulating cash. Hence, employees adopt a different strategy depending on their initial reputation. Besides, starting a business venture early can in expectation be easier than waiting in order to build a reputation and accumulate cash.

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I. Introduction

According to a 1989 International Social Survey Programme, self-employment was a goal for 63% of Americans, 48% of British people and 49% of Germans (Blanchflower and Oswald, 1990). However, only a mere 15% of those surveyed achieve the objective of running their own company. Respondents to this survey emphasize that a major roadblock to their goal is the difficulty in obtaining funding. In this paper, we analyze how credit rationing affects the transition from being a wage-earner to entrepreneurial activity. We restrict our attention to industries where human capital is particularly valuable, for example, biotechnology, information technology, law, accountancy, and consultancy. We address several key questions. Can professional reputation in the labor market help to establish an entrepreneurial firm? Is professional reputation a substitute for cash resources, and therefore a solution to the credit rationing problem? Is improving or preserving professional reputation compatible with maximizing cash resources? When these two objectives conflict, which alternative should a prospective entrepreneur favor? Finally, we analyze the trade-off between starting a firm early in a career versus delaying this goal to establish a good professional reputation and accumulate financial resources.

We utilize the followings to obtain our results. Consider a risk-neutral, cash-poor, professional, for example a scientist, who is endowed with a business idea and human capital. A financial investment is required to determine whether this business idea, based on a new technology, can be transformed into a feasible project. Innovation and the associated profits last one period since other firms can enter the market or adopt the same production process. There is a moral hazard problem since the scientist can pursue personal objectives that hurt the profitability of the business. This moral hazard problem induces credit rationing so that a positive-NPV idea is not necessarily funded. Alternatively, the scientist can use an existing technology with less potential but which does not require further financial investment. However, running the existing technology requires additional personal effort that is not observable, and
requires managerial decisions that are not observable when made, but are observable ex post although not verifiable\(^1\). More specifically, the prospective entrepreneur faces the choice of whether to undertake an action that is more or less informative about his talent. Examples are abundant (see Hirshleifer, 1993, for a discussion): Ventures whose outcomes are resolved soon rather than in the distant future are informative actions: In the latter case, the outcome that arrives at an interim date is a very noisy measure of the final outcome. Taking part to a transversal project whose success depends on a team’s capability rather than on an individual’s sole performances is an opaque action. Advancing the arrival of news regarding the success of a product by increasing the expenditures that enable the development of the product is more informative an action than increasing basic research activity\(^2\).

Both the output from using an existing technology and the scientist’s output as a developer of new technology depend on the level of the scientist’s talent. This level of talent is unknown, that is, information is incomplete but symmetric. Nevertheless, the labor market forms priors about talent, for example, by taking into account education, so that the scientist has a reputation. The new idea is profitable whatever the scientist’s assessed talent if the scientist maximizes profits. Scientists can be employed either as wage earners or entrepreneurs. Wages earners receive a fixed salary, whereas entrepreneurs are residual claimants of the cash-flows they generate.

In the absence of moral hazard problem, the scientist would maximize profits, would be able to obtain financing on the credit market and would be indifferent to being a wage earner versus an entrepreneur. The scientist would exert the first-best level of effort in the second period when the formerly-new technology becomes an existing technology. This constitutes our benchmark.

The presence of moral hazard has an important impact on the results. We show that becoming an entrepreneur allows the scientist to obtain an additional gain relative to what he would earn as an

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\(^1\)This assumption is in line with Hermalin (1993). Alternative assumptions are discussed in the last section of the paper.

\(^2\)In other contexts, ventures whose outcomes are outside the manager’s control, for example a foreign investment subject to political risk, are opaque actions. Indeed, such projects tend to provide less resolution of uncertainty about the talent of the manager than projects whose outcomes depend less on external factors than on the manager’s talent.
employee, since the scientist now has more powerful incentives as a residual claimant to maximize cash-flows. We show that a scientist has the opportunity to start a business venture in the first period with sufficient reputation. This case stands in contrast to the benchmark case where reputation is irrelevant since projects are profitable per se. The reason for this difference is that the better the scientist’s reputation, the larger the difference in revenue between pursuing personal objectives and maximizing profits, which fosters incentives.

A scientist can alternatively start a business venture in the second period provided that his updated reputation at the end of the first period is adequate and that he has sufficient financial resources from saving first-period salary for the business venture. Indeed, reputation and cash make it easier to satisfy the incentive compatibility constraint when starting a business venture. Professional reputation and cash resources appear to be substitutes. However, while all scientists share the same objectives of enhancing their reputation, (i.e., they have career concerns) and their first-period salary, these two goals can conflict. Opting for the less informative action prevents the market from updating reputation efficiently, which lowers the incentives to exert effort. Thus, choosing the less informative action reduces the scientist’s output, his wage rate, and in turn the potential financial contribution he can make to the future business venture. We identify different behaviors that depend on the scientist’s initial reputation. When reputation is high, the scientist is induced to maintain this reputation, that is undertaking the less informative action at the expense of accumulating more resources. The scientist cannot commit to work hard and thus receives a low wage. In contrast, a scientist with a lower reputation benefits from choosing the more informative action. This more informative action helps the market to update its views of the scientist’s talent and induces the scientist to work more, and thus to accumulate more financial resources, which facilitates future access to credit. Finally, even though waiting allows the scientist to accumulate cash, we show that starting a business venture early can be easier than waiting for the second period. It disciplines the scientist by internalizing the second-period gains of using a
technology since the scientist is residual claimant of the cash-flows.

There are several bodies of literature that relate to the paper. The first one is research on entrepreneurship, although there is little consensus about the term entrepreneur. Some empirical studies use business ownership to define entrepreneurs (Cargetti and De Nardi, 2001; Gentry and Hubbard, 2001), whereas others use self-employment (Evans and Leighton, 1989; Evans and Jovanovic, 1989; Blanchflower and Oswald, 1998; Fairlie, 1999), or both criteria (Meyer, 1990; Quadrini, 1999; Hurst and Lusardi, 2004). We do not make the distinction between the two criteria so that in our study, the entrepreneur is self-employed and owns the business. There also exists a debate about the functions an entrepreneur performs. The controversy dates to Knight (1921) and Schumpeter (1934). Knight, and later Kihlstrom and Laffont (1979), view the entrepreneur as performing the “peculiar twofold function of (a) exercising responsible control and (b) securing the owners of productive services against uncertainty and fluctuation in their incomes.” In contrast, Schumpeter asserts that “the entrepreneur is never a risk bearer,” but an innovator. Baumol (1986) views entrepreneurs as individuals who respond to the opportunities of creating new products. The pursuit of business opportunities is stressed by Rosen (1983) who considers entrepreneurship as “exploiting the new opportunities that inventions provide, more in the form of marketing and developing them for the widespread use in the economy than developing the knowledge itself.” This view is developed further by Holmes and Schmitz (1990) who investigate the incentives to invest in entrepreneurial skills. Entrepreneurs can be contrasted with specialists (Lazear, 2002) since they may have a comparative disadvantage in a single skill, but more balanced talents that span a variety of different skills. Recently, entrepreneurs have been viewed as different from other individuals because of their optimism (Amador and Landier, 2003, and Landier and Thesmar, 2004).

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3 Considering Schedule C in US federal income tax returns is another possibility (e.g., Holtz-Eakin, Joulfaian and Rosen, 1994).

4 Kihlstrom and Laffont (1979), page XX.

5 Quoted by Kihlstrom and Laffont (1979) on page XX.
In our paper, an entrepreneur is the residual claimant of the cash-flows generated, whereas an employee receives a fixed wage and thus bears no risk. However, this is the consequence of the inability to write employment contracts contingent on output, rather than of a desire to protect workers from fluctuations in their incomes, since all participants are risk-neutral in our setting. The entrepreneur is neither optimistic nor pessimistic and all individuals are sufficiently innovative and capable of observing business opportunities and exploiting them profitably. Such individuals are responsible for conceiving the basic product, hiring the initial team, and obtaining financing, but their lack of reputation or personal resources can prevent them from undertaking this entrepreneurial activity. In focusing on reputation as a tool to relax credit constraints, we restrict our attention to the case of industries where human capital is particularly crucial, and can be transferred from employee activity to entrepreneurial activity.

One stream of entrepreneurship literature focuses on the transition from wage earner activity to entrepreneurial activity. In our model, the motive for the transition is that the scientist enjoys an additional gain compared to what would be earned as a wage worker once a business opportunity is discovered that is worth exploiting. However, several non-pecuniary reasons also explain the desire to become an entrepreneur (Blanchflower and Oswald, 1990; Hamilton, 2000; Moskowitz and Vissing-Jorgensen, 2002). In addition to the psychological satisfaction from making important decisions, that is, being one’s boss, entrepreneurship satisfies ego as it enhances social status. Embracing an entrepreneurial career also has private benefits such as the ability to control one’s work schedule, and other perks. Our results apply provided that the transition to entrepreneurship creates a discontinuity in the employee’s revenue function, irrespective of the reasons that motivate the employee to become an entrepreneur.

A central feature of our model is the role of personal financial assets. In this respect, our paper is related to the literature on credit rationing. It has been widely documented that having cash
resources is helpful in overcoming the credit rationing problem for would-be entrepreneurs (Evans and Jovanovich, 1989; Evans and Leighton, 1989; Meyer, 1990; Blanchflower and Oswald, 1990; Holtz-Eakin, Joulfaian and Rosen, 1994, or Audretsch and Vivarelli, 1995). Theoretical arguments are also abundant (Holmström and Tirole, 1997). Cash resources are usually in the form of inheritance or family assets, and wages saved. Most of the above empirical literature focuses on inheritance and family assets which are viewed as exogenous positive liquidity shocks and thus represent a form of natural experiment, facilitating the interpretation of the results concerning the transition to entrepreneurship. In contrast, we focus on wages since they are determined endogenously and interact with the other variable of interest, reputation. Also, higher wages increase the likelihood that wage workers become entrepreneurs (Holtz-Eakin, Joulfaian and Rosen, 1994), although Evans and Jovanovich (1989) report that wage workers receiving low salaries are more likely to become entrepreneurs because lower wages increase the attractiveness of entrepreneurship. However, it is important to note that the above studies consider a broad range of industries, whereas we focus on activities where reputational capital is important.

Our paper is also related to the literature that studies how to build a reputation, and the impact of current reputation on managerial or firm choices (Hirshleifer, 1993). Within the context of this paper, we consider professional reputation and not reputation as a borrower (Diamond, 1989). The asymmetric information literature investigates how managers (or firms) with superior information undertake financial or real investment decisions, and how the timing of these decisions influences market perceptions (Trueman, 1986; Brennan, 1990; Hirshleifer and Chordia, 1992; Zwiebel, 1995; Prendergast and Stole, 1996; or Breeden and Viswanathan, 1998). The career concerns literature studies similar issues but assumes that managers (or firms) and the market possess the same information about managerial talent and firm characteristics. Managers exert effort to inflate their output (Holmström, 1982, 1999), alter the accuracy of the information that accrues to the market by herding (Scharfstein and Stein, 6). We refer the reader to Dewatripont, Jewitt and Tirole (1999, part I) for a very general and extensive treatment of career concerns.
1990), hedging (DeMarzo and Duffie, 1995), choosing the risk of the project they realize (Holmström, 1982, 1999; Hermalin, 1993), avoiding projects that would reveal information about their talent (Holmström and Ricart I Costa, 1986), or by increasing short-term profits at the expense of long-term profits (Narayanan, 1985). Here, we focus on career concerns, and assume that information is symmetric about talent. Our paper differs from this literature since information is symmetric in order to study the interaction between effort and project (or actions) choices, and between reputation and cash.

The paper is organized as follows. In Section II, we introduce the model and discuss assumptions. In Section III, we determine the conditions under which a scientist can establish a firm in the first or in the second period, and investigate the solutions. In Section IV, we discuss robustness issues, derive implications and propose extensions of our work. Concluding remarks follow.

II. The Model

We consider a two-period model with a competitive labor market consisting of firms and scientists, and a competitive credit market. All parties are risk-neutral and protected by limited liability. At the beginning of the first period, each scientist is endowed with an idea (a new product or a new process) but has no personal wealth ($A = 0$). The scientist’s precise talent $\theta$ is unknown to market participants, including the scientist himself. It is common knowledge that $\theta$ is drawn from the distribution $\mathcal{N}(\mathbb{E}(\theta); \sigma^2_\theta)$, where $\mathbb{E}(\theta) \geq 0$ represents the scientist’s initial reputation.

If the scientist is employed by a firm (Figure 1), then either the firm’s existing technology is used or a business venture is started based on the new idea. If the scientist is self-employed, the business venture must be started based on the new idea. Laws protecting intellectual property prevent stealing the firms’ existing technologies.

II.A. Employee versus Self-employed Activity
Whether an employee or self-employed, the scientist generates cash-flows observable by everyone. However, we do not use this observable output in employer-employee formal compensation contracts for several reasons. First, implicit incentives are powerful, even in the presence of explicit contracts so that it is worth studying implicit incentives per se (Gibbons and Murphy, 1992). Second, even though the use of explicit incentives is widespread (Murphy, 1998; Gibbons and Murphy, 1992), the explicit incentives that confront executives in large firms are weak (Jensen and Murphy, 1990). Indeed, there exist restraints on the use of explicit incentives, in particular the difficulty of verifying the output of each employee. Finally, some regulated industries, government agencies (notably those in charge with developing military innovations), and universities (which house scientific laboratories) are prevented from or avoid resorting to explicit incentive schemes. Since an employee’s wage cannot be contingent on observed output, the employee is paid a fixed wage $W_i$ at the end of period $i$ (with $i = 1, 2$). This wage is fixed at the beginning of the period.

A self-employed scientist is a residual claimant of the cash-flows generated so that his period $i$ revenue directly depends on his period $i$ output.

**Figure 1: Transition to entrepreneurial activity and choice of technology.**

![Figure 1: Transition to entrepreneurial activity and choice of technology.](image-url)
II.B. New Idea versus Existing Technology

Using existing technology yields

\[ \pi_i(\theta, r_{a_i}, e_i) = \theta + r_{a_i} + e_i, \]  

(1)

where \( \theta \) is the scientist’s talent, \( r_{a_i} \) denotes the cash-flows resulting from action \( a_i \) undertaken during period \( i \), and \( e_i \) is the effort exerted by the scientist during this period. The scientist faces two decisions. First, the scientist must choose an action in the set \( \{T, O\} \), where \( O \) stands for opaque and \( T \) stands for transparent. Whatever period is considered, action \( T \) yields some cash-flows, \( r_T \), drawn from the distribution \( N(0; \sigma_T^2) \), while action \( O \) yields \( r_O \sim N(0; \sigma_O^2) \), with \( \sigma_O^2 > \sigma_T^2 \). Hence, actions have no direct impact on the expected cash-flows. The action selected is not observable by the market at the time the decision is made, but is observable, although not verifiable, by the market at the end of the period. This assumption, substantiated by Hermalin (1993), implies that no contract is written contingent on the scientist’s decision. The scientist chooses the level of effort \( e_i \) to exert which translates into cash-flows \( e_i \) for any period under consideration, and costs \( \psi(e_i) \), with \( \psi' > 0 \) and \( \psi'' > 0 \).

Starting a business venture based on a new idea requires a financial investment \( I \). This investment, for example R&D, is necessary to learn whether the idea will result in a feasible business project. Let \( \Delta \) represent the attractiveness of the new product or process, with \( \Delta > \bar{\Delta} \), as specified in the Appendix. The cash-flows are equal to

\[ \Pi_i(\theta, \Delta) = \theta + \Delta \text{ if the project is feasible} \]

\[ = 0 \text{ if the project is not feasible.} \]  

(2)

The scientist influences the probability that the project is feasible. If the scientist pursues personal objectives (for example, by not allocating time properly across different tasks, or by hiring family
members with poor qualifications), the probability of feasibility is \( q \) (with \( q < 1 \)) while the scientist receives a non-monetary and non-transferable private benefit \( B \) as is standard (see Holmström and Tirole, 1997). In contrast, if the scientist pursues profit maximization, the probability of feasibility is \( 1^7 \). We assume that talent aside, the starting of a business venture requires profit maximization in order to be profitable, so that

\[
\Delta - I > 0 > q\Delta - I + B. \tag{3}
\]

When feasible, the new idea yields \( \Delta \) during one period only. In the next period, there is competition and other firms enter the same market or adopt the same process so that \( \Delta \) falls to zero. Thus, the “new” idea becomes an “existing” technology, the output of which is given by (1). If unsuccessful in exploiting the idea in period 1, the scientist is employed by a firm in the next period, runs the firm’s existing technology, and earns \( W_2 \).

To simplify matters, a would-be entrepreneur only contracts with investors over one period, i.e., there cannot be any long-term contract.

III. Starting a Business Venture

We first establish our benchmark in the absence of any moral hazard problem. Then, we derive the conditions under which a scientist can start a business venture in the first period and in the second period when moral hazard problems are present. We then compare these two cases.

III.A. The Benchmark

If actions, choices and efforts are contractible, but information about talent incomplete, a scientist would start a business venture based on new technology in the first period, and run the formerly new

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\(^7\)This is without loss of generality: Since scientists are protected by limited liability, inducing them to maximize the cash-flows requires the design of an incentive mechanism even if the fact that the project turns out not to be feasible perfectly reveals that the scientist shirked. Indeed, the latter cannot be sent to jail.
now-existing technology in the second period. The first-period expected gains would be \( [\mathbb{E}(\theta) + \Delta - I] \) (see (2)) and the second-period expected gains \( [\mathbb{E}(\theta) + e^{FB} - \psi(e^{FB})] \) (see (1)), where \( e^{FB} \) denotes the first-best level of effort.\(^8\) Naturally, \( e^{FB} \) satisfies \( \psi'(e^{FB}) = 1 \). The choice of action would be irrelevant since on average actions yield the same cash-flows. Using an existing technology during the two periods would yield less, on average \( 2 \times [\mathbb{E}(\theta) + e^{FB} - \psi(e^{FB})] \), since \( \Delta > \bar{\Delta} \). Observe that the scientist is indifferent between starting the business venture as an entrepreneur and as an employee.

III.B. Starting a Business Venture in the First Period

Suppose that the scientist is considering starting a business venture immediately. We first restrict our attention to the case where maximizing cash-flows is necessary to have a positive NPV so that the scientist’s incentive compatibility constraint must be satisfied. This requires that the expected gains over the two periods when the scientist maximizes profits must be greater than the gains obtained when there is a private benefit. In the former case, the new idea turns out to be feasible with certainty. Thus, in expectation, the scientist receives \( \mathbb{E}(\theta) + \Delta \) in the first period, but pays \( D \) to the provider of funds in exchange for the financial investment, \( I - A \). In the second period, the scientist runs the formerly new now-existing technology and is a residual claimant of the cash-flows generated. Hence, the scientist exerts the first-best level of effort \( e_2^{FB} \) and accordingly incurs disutility \( \psi(e_2^{FB}) \). The choice of action is irrelevant since there are no career concerns and actions yield the same expected cash-flows.

If the scientist pursues personal objectives, the probability of obtaining the above gains decreases to \( q \). With probability \( 1 - q \), the idea turns out not to be feasible and the scientist terminates the business venture. In the next period, the scientist is hired by a firm to run an existing technology as an employee. In this case, the scientist exerts no effort as career concerns are absent in the second period.

For the same reason, the choice of action is irrelevant. Hence, the scientist earns \( \mathbb{E}(\theta) \) in expectation.

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\(^8\)Delaying the start of the venture to the second period would overall yield the same gains, but in an inverted order. When indifferent between starting immediately and waiting, we consider that the scientist opts for the first solution. This result can be obtained by assuming that there is a discount factor.
As a consequence, the scientist’s incentive compatibility constraint reduces to

$$\mathbb{E}(\theta) + \Delta - D + e^2FB - \psi(e^2FB) \geq \frac{B}{1 - q}.$$  \hspace{1cm} (4)

Competitive investors will provide funds if

$$D = I - A.$$  \hspace{1cm} (5)

Combining (4) and (5), given \(A = 0\) since the scientist has no initial wealth, reduces to

$$\mathbb{E}(\theta) \geq I - \Delta + \frac{B}{1 - q} - [e^2FB - \psi(e^2FB)].$$  \hspace{1cm} (6)

Equation (6) shows that contributing human capital is essential to overcoming the credit rationing problem when \(I - \Delta + \frac{B}{1 - q} - [e^2FB - \psi(e^2FB)] > 0\). The intuition for this result is that the higher the scientist’s reputation, the larger the difference in his revenue between pursuing personal objectives versus maximizing profits, which fosters incentives. This result is in contrast to the case where choices, efforts, and actions are contractible, the benchmark in which professional reputation is useless since the business venture is profitable \textit{whatever} the scientist’s expected talent.

Overall, the scientist is richer as an entrepreneur receiving \([\mathbb{E}(\theta) + \Delta - I] + [\mathbb{E}(\theta) + e^2FB - \psi(e^2FB)]\) in expectation, rather than \textit{deciding} to remain an employee of a firm using an existing technology. In such a case, the first-period gain is equal to the wage set by the competitive labor market at \(E(\theta) + e^*_1\), where \(e^*_1\) denotes the first-period equilibrium level of effort, minus the cost of effort \(\psi(e^*_1)\), while the second-period gain is equal to the wage \(E(\theta)\). Since \(I < \Delta\), and the level of effort does not correspond to the first-best in the latter case, \([\mathbb{E}(\theta) + \Delta - I] + [\mathbb{E}(\theta) + e^2FB - \psi(e^2FB)] > [E(\theta) + e^*_1 - \psi(e^*_1)] + E(\theta)\).

The scientist is also better off starting a business venture immediately rather than waiting for the second period.

Note that a scientist could also start a business venture as an employee. By definition in our model, an employee’s salary is fixed. Hence, the scientist would not maximize profits. As a consequence, the expected NPV would be \(q[(\mathbb{E}(\theta) + \Delta)] - I\). This NPV is positive, and the business venture could be
started by the employee, to the extent that the employee’s updated reputation is higher than \( \frac{I}{q} - \Delta \).

Observe that the same condition holds for a scientist willing to become an entrepreneur but who pursues personal goals. However, since \( q\Delta - I + B < 0 \) (see the second part in (3)), the scientist is better off running the existing technology. The next proposition summarizes these results.

**Proposition 1** *A scientist starts a business venture based on a new technology in the first period as an entrepreneur if the scientist’s initial reputation satisfies

\[
\mathbb{E}(\theta) \geq I - \Delta + \frac{B}{1 - q} \left[ e^{FB}_2 - \psi(e^{FB}_2) \right].
\]

Otherwise, the scientist remains an employee running an existing technology.*

In the next section, we consider a scientist who delays the transition to entrepreneurial activity to the second period.

**III.C. Starting a Business Venture in the Second Period**

We now focus on a scientist who waits until the second period to try to implement a new idea in order to accumulate cash and keep or enhance his reputation. Depending on reputation, and working backward, we determine the level of effort and derive the action opted for. Finally, we compare the difficulty of starting a business venture early versus later.

**1. Reputation and Cash**

Let \( \mathbb{E}(\theta \mid \pi_1, e^*_1, a_1) \) represent the scientist’s updated reputation, that is, the assessment that the market makes about the scientist’s talent by taking into account the information that accrues at the end of the first period, i.e., the observed output as an employee, \( \pi_1 \), the anticipated first-period equilibrium effort, \( e^*_1 \), and the first-period observed action, \( a_1 \). Note that in the second period, the scientist’s financial contribution to the business venture is strictly positive: Although the scientist had no initial
wealth, he earns $W_1$ while serving as an employee. Since investors are competitive, the scientist can start a business venture provided that

$$\mathbb{E}(\theta \mid \pi_1, a_1, e_1^*) \geq I - \Delta + \frac{B}{1 - q} - W_1. \quad (7)$$

Thus, when $W_1 < I - \Delta + \frac{B}{1 - q}$, contributing financial capital only is not compatible with starting a business venture. Again, reputation is necessary when important informational issues arise, whereas it is useless in the benchmark case.

Interestingly, (7) shows that reputation and cash are substitutes. When the mix of the two is high enough, the scientist is induced to maximize profits and the business venture can be funded. This leads to the following proposition.

**Proposition 2** Reputation and cash are substitutes in overcoming the credit rationing problem.

We now detail the scientist’s first-period choices when working as an employee.

**2. The Scientist’s First-Period Choice of Effort as an Employee**

Since effort is costly, unobservable, and does not increase the first-period wage (which is fixed at the beginning of the period), the scientist exerts $e_1$ solely to favorably influence the learning process regarding talent, and in turn second-period gains. However, as in traditional models of career concerns (Holmström, 1982, 1999), the market anticipates these efforts in equilibrium and draws the correct inference about talent from the observed output. Denote $\overline{\theta}$ as the threshold above which the scientist’s updated reputation allows him to start a business venture. Then, the gains in expectation are equal to the sum of two components. First, the product of the probability $\Pr(\mathbb{E}(\theta \mid \pi_1, a_1, e_1^*) \geq \overline{\theta})$ that the scientist can start a business venture and the expected gains in such a case, $[\mathbb{E}[\mathbb{E}(\theta \mid \pi_1, a_1, e_1^*)] + (\Delta - I)].$

Note that the first expectation in $\mathbb{E}[\mathbb{E}(\theta \mid \pi_1, a_1, e_1^*)]$ is with respect to $\pi_1$ while the second expectation is with respect to $\theta$. Second, the product of the probability that the scientist remains an employee running an existing technology, $[1 - \Pr(\mathbb{E}(\theta \mid \pi_1, a_1, e_1^*) \geq \overline{\theta})]$, and the expected wage in such a case,
\(\mathbb{E}[\mathbb{E}(\theta \mid \pi_1, a_1, e_{1}^{*})]\), net of the cost of the effort. Observe that the employee-scientist is indifferent between the two actions in the second period for the same reason as he exerts no effort: Career concerns are then absent. Overall, the scientist’s second-period gains are

\[
\mathbb{E}[\mathbb{E}(\theta \mid \pi_1, a_1, e_{1}^{*})] + \Pr (\mathbb{E}(\theta \mid \pi_1, a_1, e_{1}^{*}) \geq \bar{\theta}) \times (\Delta - I). \tag{8}
\]

Suppose that the market anticipates the equilibrium effort \(e_{1}^{*}\). The scientist chooses \(e_1\) so as to maximize the second-period expected gains given by (8) minus the first-period cost of effort, \(\psi(e_1)\). Assuming an interior solution, the first-order condition for an equilibrium satisfies

\[
\frac{\sigma_{\theta}^{2}}{\sigma_{\theta}^{2} + \sigma_{a_1}^{2}} + \frac{1}{\sqrt{2\pi}} \left( \frac{1}{2} \frac{(\bar{\theta} - \mathbb{E}(\theta))^2 (\sigma_{\theta}^{2} + \sigma_{a_1}^{2})}{\sigma_{\theta}^{4}} \right) \times (\Delta - I) = \psi'(e_{1}^{*}). \tag{9}
\]

The first term in the left-hand side of (9) is the marginal return to effort due to the incentives related to the profits \(\pi_1\) through the updating process. The second term represents the marginal return to effort due to the expected additional revenue the scientist earns when starting a business venture\(^9\).

Equation (9) has a major implication: The higher \(\sigma_{a_1}^{2}\), the variance in the cash-flows related to an action, the lower the level of effort exerted by the scientist. Indeed, the updating process is impaired when \(\sigma_{a_1}^{2}\) increases in the sense that the variance of performance becomes less informative about talent so that exerting effort has a less positive impact on the scientist’s updated reputation. It induces the scientist to undertake a lower level of effort when opting for \(O\) rather than for \(T\).

**Lemma 1** The equilibrium level of effort \(e_{1}^{*}\) is decreasing in \(\sigma_{a_1}^{2}\).

As a consequence, the scientist earns a lower wage when choosing the opaque action, which diminishes the cash resources the scientist can contribute to the business venture in the next period. This effect is reinforced by \((\Delta - I)\). In other words, the wage gap between the two actions is widened by the attractiveness of the new idea.

\(^9\)The impact of the opportunity to create a firm is that the scientist in our model always exerts more effort than the manager in Holmström’s (1982, 1999) model does.
Combining (7) and (9) allows us to characterize the minimum updated reputation that the scientist must have in order to start the business venture. Besides, the scientist is better off becoming an entrepreneur rather than remaining an employee running the existing technology. In such a case, the scientist receives a wage equal to the second-period expected output, $E(\theta \mid \pi_1, a_1, e_1^*)$. This wage is lower than the revenue he would have as an entrepreneur since $I < \Delta$. The scientist could also start a business venture as an employee or be willing to become an entrepreneur pursuing personal goals. However, as above, the scientist is then better off running the existing technology. This leads to the following proposition.

**Proposition 3** A scientist starts a business venture based on new technology in the second period as an entrepreneur provided that the scientist’s updated reputation satisfies

$$E(\theta \mid \pi_1, a_1, e_1^*) \geq \bar{\theta},$$

where $\bar{\theta}$ is the smallest value of $x$ which verifies

$$x = I - \Delta + \frac{B}{1 - q} - \mathbb{E}(\theta) - \psi^{-1}\left(\frac{\sigma_\theta^2}{\sigma_\theta^2 + \sigma_{a_1}^2} + \frac{\Delta - I}{\sqrt{2\pi}(\sigma_\theta^2 + \sigma_{a_1}^2)^{1/2}} \exp\left[-\frac{1}{2} \frac{(x - \mathbb{E}(\theta))^2}{\sigma_\theta^2 + \sigma_{a_1}^2}\right]\right).$$

Otherwise, the scientist remains an employee running an existing technology.

Importantly, $\bar{\theta}$ depends on the scientist’s first-period choice of action. Since the scientist receives a higher wage by choosing the more informative action rather than the less informative action (cf. Lemma 1), the scientist has more money to put up-front in the second period in the former case, so that less reputation is needed to start a business venture. We summarize this result in the next corollary.

**Corollary 1** A scientist needs a lower reputation to start a business venture based on new technology in the second period as an entrepreneur when opting for the more informative action in the first period: $\bar{\theta}_T < \bar{\theta}_O$.

We now derive the scientist’s choice of action.
3. The Scientist’s First-Period Choice of Action as an Employee

Deriving the scientist’s choice of action allows us to distinguish between three cases, depending on initial reputation. Suppose first that the scientist’s initial reputation is such that \( E(\theta) \geq \bar{\theta}_O \). Then, the scientist is able to start a business venture if the status quo persists. Thus, choosing \( O \) and being paid \( W_O \) is an equilibrium, that we denote \( (O, W_O) \). Indeed, opting for \( O \) maximizes the probability to start a business venture since the updating process is impaired by more extraneous noise than if the scientist opts for \( T \), and also implies that less effort is exerted. Choosing \( T \) and being paid \( W_T \) cannot be an equilibrium. Indeed, if the employers anticipate that the scientist opts for \( T \), and pay \( W_T \), the relevant benchmark would be \( \bar{\theta}_T \) with \( \bar{\theta}_T < \bar{\theta}_O \), which is good for the scientist. However, since the salary is already fixed, the scientist would opt for \( O \) rather than for \( T \) since the former choice would imply revealing less information, which increases the likelihood of starting a business venture, and working less. Here, the scientist is induced to preserve reputation rather than increasing his resources.

Next, suppose that the scientist’s initial reputation verifies \( \bar{\theta}_T < E(\theta) < \bar{\theta}_O \). Then, \( (T, W_T) \) cannot be an equilibrium for the same reason as above. Now, imagine that the employers anticipate that the scientist will opt for \( O \), and pay \( W_O \) so that the relevant benchmark is \( \bar{\theta}_O \). Then, provided that the attractiveness of establishing a company is high, the scientist faced with a salary of \( W_O \) would opt for \( T \) so that \( (O, W_O) \) would not be an equilibrium. Since the labor market is competitive, the scientist is paid the highest wage, denoted \( W_T^{E(\theta)<\bar{\theta}_O} \), such that \( E(\theta) < \bar{\theta}(W_T^{E(\theta)<\bar{\theta}_O}) \) and the scientist actually selects \( T \). Then, the scientist can simultaneously increase reputation and maximize cash resources.

Finally, suppose that the scientist’s initial reputation is such that \( E(\theta) \leq \bar{\theta}_T \). Then, \( (T, W_T) \) is an equilibrium. Indeed, let the employers anticipate that the scientist will opt for \( T \), and thus pay \( W_T \) so that the benchmark is \( \bar{\theta}_T \). Choosing \( O \) would prevent the market from efficiently updating the scientist’s reputation. It would be detrimental to the scientist as the status quo implies that the
business venture cannot be started. As $\Delta$ is high, this negative effect more than offsets the gain derived from exerting less effort. Hence, the scientist opts for $T$. Building a good reputation and accumulating as many cash resources as possible is compatible. The above results are summarized below.

**Lemma 2** The scientist chooses

(i) Action $O$ when $E(\theta) \geq \bar{\theta}_O$;

(ii) Action $T$ when $E(\theta) < \bar{\theta}_O$.

The next proposition details the relation between reputation and cash.

**Proposition 4** Preserving reputation does not allow the scientist to accumulate as many cash resources as building reputation.

Interestingly, it can be easier to start a business venture immediately rather than, on average, wait for the second period. In expectation, (7) can be rewritten as

$$E(\theta) + [E(\theta) + e_1] \geq I - \Delta + \frac{B}{1 - q}.$$ \hspace{1cm} (10)

This expression is to be compared with (6). Equation (9) shows that when $\sigma^2_\theta$ is close to zero, that is, when there is little uncertainty about the scientist’s talent, $e_1$ is also close to zero. If, simultaneously, $E(\theta)$ is low, then the left-hand side of (10) can be lower than the left-hand side of (6). There are two effects operating here. The “discipline” effect favors starting the business venture immediately: The second-period gain when the idea turns out to be feasible helps to discipline the scientist. The “cash” effect favors waiting for the second period. Hence, the following proposition.

**Proposition 5** On average, it is easier to start a business venture in the first period rather than in the second period provided that $\sigma^2_\theta$ and $E(\theta)$ are low.

This result may explain Evans and Leighton’s (1989) findings that the probability of funding a firm is independent of age and experience.
In the next section, we first discuss robustness issues, and derive implications of our work. Finally, we examine some possible extensions of our model.

IV. Robustness Issues, Implications and Extensions

- **Continuous investment.** We investigate the case where the level of investment $I$ is fixed. Our results would remain qualitatively similar if the firm’s size were continuous provided that the project to be undertaken has a break-even point, e.g., there exists a lower bound on the level of investment for the idea to be profitable. This lower bound would imply the same type of discontinuity in the revenue function of the scientist as in our fixed-investment model. Though Holtz-Eakin, Joulfaian, and Rosen (1994) empirically find that entrepreneurs are credit rationed in the sense that they cannot obtain the amount of resources they would like to have to fully exploit the potential of their idea when they can start their business venture, they also show that would-be entrepreneurs are credit rationed in the sense that a lack of funds prevent them from starting a business venture in the first place.

- **Optimism.** Recent literature on entrepreneurship (Amador and Landier, 2003, and Landier and Thesmar, 2004) considers that entrepreneurs are optimistic, that is, they overestimate the probability of success of the new idea or their talent. In terms of the model, scientists endowed with these psychological characteristics would be more willing to allow the market to learn information about their ability, that is, they would favor transparent actions. However, postulating that entrepreneurs are optimistic would not modify the conclusion that when choosing between two actions of varying transparency, scientists take into account their position with respect to the reputation benchmarks we have identified.

- **Commitment.** In our framework, a scientist with a good initial reputation is forced to keep that reputation rather than accumulating cash since the scientist cannot commit to select the
transparent action once the wage is fixed. Consider the situation where the choice of action precedes the date when the salary is set. For example, the scientist can choose a job (or firm), and jobs (or firms) differ by their degree of exposure in the business press (e.g., firms listed on the New York Stock Exchange and included in a Dow Jones Index versus private firms). Then, in choosing a job (or firm), the scientist commits to a degree of transparency. The consequence is that the scientist faces a trade-off between preserving reputation and increasing cash resources.

- **Unobservable choice of action.** Suppose that the labor market anticipates one type of action. If actions are observable and the scientist deviates from the equilibrium, the market changes the benchmark against which the scientist is evaluated. This is not the case when the action that is selected is unobservable. Then, the scientist only considers the impact of the action in terms of additional information released to the market when deciding whether to deviate from the equilibrium. The scientist does not take into account the cost of exerting more or less effort as occurs when the type of action opted for is observable. The consequence is that the scientist unambiguously chooses the action characterized by a low variance in the cash-flows when his reputation is high, i.e., the scientist is conservative, and the action characterized by the higher variance in the cash-flows when initial reputation lies below the higher benchmark, i.e., the scientist gambles for resurrection.

- **Inheritance.** We have so far assumed that the scientist has no wealth at the beginning of the first period. Alternatively, we can consider the case where the scientist has personal funds to contribute to the project. Inheritances, for instance, constitute exogenous positive liquidity shocks. Thus, they represent a natural experiment and allow the researcher to investigate empirically the effect of an increase in initial wealth on the likelihood of establishing a firm. In this case, the impact for a scientist who considers starting the business venture immediately is a reduction in the level of reputation required. For a scientist who waits until the second period, the impact is a reduction
in both reputation benchmarks. This wealth can alter his relative position in terms of reputation vis-a-vis the benchmarks. For instance, a scientist who initially falls between the two benchmarks can end up above these benchmarks after inheriting some wealth. Then, the scientist selects the opaque action in lieu of the transparent one. Overall, this implies that two scientists with the same reputation can make different choices of action after receiving different financial endowments.

- **Age or experience in the job.** A major implication of career concerns models (Holmström, 1982, 1999) is that the implicit incentives emerging from the labor market discipline managers as long as the assessment about their talents is highly uncertain ($\sigma_0^2$ is large), that is, at the beginning of their careers. Thus, it is not surprising to observe that experienced managers or those about to retire have a higher proportion of explicit incentives in their compensation packages than younger or less experienced managers. Here, the standard effect is also at work: The less established the reputation of the scientist, the larger the extent to which effort impacts the market’s view about his talent, and so the more powerful are implicit incentives (see (9)). However, there exists an offsetting effect that only impacts the probability of earning a higher revenue. For a given additional unit of the scientist’s talent, the higher $\sigma_0^2$, the lower the increase in the probability of firm creation, and thus, the lesser the incentives to exert effort. More generally, suppose it is possible to empirically separate managers facing discontinuities in their revenue functions from managers facing standard career concerns. Then, one should observe that the former have less explicit incentives than the latter in their compensation packages.

- **Partially asymmetric information about talent.** Until now, we have not distinguished between the different ways in which the scientist can start a business venture. Assume that part of the scientist’s talent is observable only to the current employer and not to the market as a whole. For instance, either collaborating with the scientist grants the employer free access to privileged information, or this access is costly and the employer must design an appropriate monitoring
policy. If information is asymmetric, the scientist will face more severe credit constraints when accessing outside financiers than when obtaining funds internally, such as by taking part in an internal corporate venture capital program within which the scientist is responsible for the business venture. However, the scientist then must share the gains derived from an internal innovation with the current employer. This trade-off should influence the scientist’s willingness to start the business venture with or without any link to the current employer: The more asymmetric the information is, the more likely the business venture will be funded internally.

- **Endogenous attractiveness of the business opportunity.** Imagine that the choice of action we consider in this paper is reduced to a choice of risk regarding the strategy of the R&D policy of the firm, and that the scientist can utilize his employment period to improve the initial idea or find another valuable one. Then, the scientist has a call option on the outcome of the R&D policy, with the fraction of the results that the scientist can appropriate depending on the laws protecting intellectual property or on the severity of non-competition contractual clauses. If the scientist discovers some invention or a new way to discover some invention, he benefits from the opportunity to utilize these findings by creating a new firm, and thus benefits from the upside potential of the R&D policy. If the R&D policy is a failure, the scientist stays with the firm and continues to run the existing technology. The value of this option increases with the volatility of the R&D policy. Reinterpreting our results against the backdrop of this option framework should not alter them qualitatively, but would bias the scientist’s choice towards the riskier action.

### IV. Concluding Remarks

In this paper, we analyze the role of professional reputation in the transition from employee activity to entrepreneurial activity when credit is rationed. Establishing a new firm allows our would-be
entrepreneur to capture the profits related to an innovation. Without moral hazard, the would-be entrepreneur would start the business venture in the first period, whatever the level of reputation. When there are moral hazard problems, the prospective entrepreneur can start a business venture immediately provided that his reputation is high enough. If it is impossible, the would-be entrepreneur can work as an employee during a first period, then undertake an action or a project that will be more or less informative regarding talent, and unobservable and costly effort is exerted. When considering these two choice variables, all would-be entrepreneurs share the common objective of maximizing their reputation and their cash. However, these two goals can conflict. Opting for the less informative project has four related consequences. First, it prevents the market from updating reputation efficiently. Second, it lowers the productivity of the scientist. Third, it decreases the wage. Fourth, it diminishes the cash that will be available to invest in the future business venture. When their reputation is high, would-be entrepreneurs are induced to maintain this reputation rather than increasing their resources. Since they cannot commit to work hard (they undertake the less informative project), they receive a low wage. Conversely, would-be entrepreneurs with a lower reputation benefit from choosing the more informative project, since it encourages the market to change its beliefs regarding their talents, and induces them to work hard, allowing them to accumulate the financial resources that later facilitate their access to credit. Finally, we show that starting a business venture early can be easier than waiting to accumulate financial capital.
Let $\Delta > \overline{\Delta}$, where $\overline{\Delta} = \max\{I + e^{FB} - \psi(e^{FB}); \Delta(O^T < E(\theta) < T^O); \Delta(W_O^T < E(\theta) < T^O); \Delta(E(\theta) \leq T^O)\}$. These last three terms are specified below in the proof of Lemma 2.

### I. Proof of Lemma 1

Suppose that the market anticipates $e_1^*$. The scientist chooses $e_1$ so as to maximize

$$
\mathbb{E}[\mathbb{E}(\theta \mid \pi_1, a_1, e_1^*)] + \Pr(\mathbb{E}(\theta \mid \pi_1, a_1, e_1^*) \geq \overline{\theta}) \times (\Delta - I) - \psi(e_1),
$$

where the first expectation is with respect to $\pi_1$, and the second expectation is with respect to $\theta$.

Assuming an interior solution, the first-order condition for an equilibrium is

$$
\frac{\partial}{\partial e} \left[ \int \int \theta \frac{f(\theta, \pi_1 \mid a_1, e_1^*)}{f(\pi_1 \mid a_1, e_1^*)} d\theta d\pi_1 \right] dF(\pi_1 \mid a_1, e_1) + \Pr(\mathbb{E}(\theta \mid \pi_1, a_1, e_1^*) \geq \overline{\theta}) \times (\Delta - I) = \psi'(e_1^*),
$$

or

$$
\int \int \theta \frac{\hat{f}(\pi_1 \mid a_1, e_1^*)}{f(\pi_1 \mid a_1, e_1^*)} f(\theta, \pi_1 \mid a_1, e_1^*) d\Pi d\theta + \frac{\partial \Pr(\mathbb{E}(\theta \mid \pi_1, a_1, e_1^*) \geq \overline{\theta})}{\partial e} \times (\Delta - I) = \psi'(e_1^*),
$$

where $\hat{f}(\pi_1 \mid \theta) = \int f(\pi_1, \theta \mid \pi_1, e_1^*) d\Pi$ and $f(\pi_1, \theta \mid \pi_1, e_1^*)$ denote respectively the marginal density of the observables, and the joint density of the talent and of the observables, given $e_1^*$ and $a_1$. $\hat{f}_e$ denotes the derivative of the marginal distribution with respect to effort.

Consider the first term on the left-hand side of (13). Since the likelihood ratio has zero mean, i.e.

$$
\mathbb{E}\left(\frac{\hat{f}_e}{f}\right) = 0,
$$

$$
\int \int \theta \frac{\hat{f}_e(\pi_1 \mid a_1, e_1^*)}{f(\pi_1 \mid a_1, e_1^*)} f(\theta, \pi_1 \mid a_1, e_1^*) d\Pi d\theta = \text{cov}\left(\theta, \frac{\hat{f}_e}{f}\right).
$$

The marginal density $\hat{f}(\pi_1 \mid a_1, e_1^*)$ is proportional to $\exp\left(-\frac{1}{2} \frac{(\pi_1 - (\mathbb{E}(\theta) + e_1))^2}{\sigma_\theta^2 + \sigma_a^2}\right)$, and $\frac{\hat{f}_e}{f}(\cdot) = (\theta - \mathbb{E}(\theta)) + r_{\alpha_1} \sigma_\alpha^2 / \sigma^{2}$. Thus,

$$
\text{cov}\left(\theta, \frac{\hat{f}_e}{f}\right) = \frac{\sigma_\theta^2}{\sigma_\theta^2 + \sigma_a^2}.
$$
Now consider the second part on the left-hand side of (13). Applying statistic rules for computing a conditional expectation in the case of normal laws gives
\[
E(j_{1};a_{1};e_{1}) = E(j) + (e_{1} - e_{1})
\]
which leads to
\[
Pr(E(j_{1};a_{1};e_{1}) \geq \theta) = 1 - \Phi \left( \frac{\theta - E(j)}{\sigma_{\theta}^{2} + \sigma_{a}^{2}} \right).
\] (16)
Thus,
\[
\frac{\partial Pr(E(j_{1};a_{1};e_{1}) \geq \theta)}{\partial e_{1}} = \frac{1}{\sigma_{\theta}^{2} + \sigma_{a}^{2}} \frac{1}{\sqrt{2\pi}} \exp \left[ -\frac{1}{2} \left( \frac{(\theta - E(j))^{2}}{\sigma_{\theta}^{2} + \sigma_{a}^{2}} \right) \right].
\] (17)
Combining (15) and (17), and rearranging shows that \(e_{1}^{*}\) verifies
\[
\frac{\sigma_{\theta}^{2} + \Delta - I}{\sigma_{\theta}^{2} + \sigma_{a}^{2}} \frac{1}{\sqrt{2\pi}} \exp \left[ -\frac{1}{2} \left( \frac{(\theta - E(j))^{2}}{\sigma_{\theta}^{2} + \sigma_{a}^{2}} \right) \right] = \psi'(e_{1}^{*}).
\] (18)
Using (18), we obtain \(\frac{\partial e_{1}^{*}}{\partial \sigma_{a}} < 0\) since \(\psi'(e_{1}^{*}) > 0\) as \(\psi'' > 0\). Hence, \(e_{1}^{*}(T) > e_{1}^{*}(O)\).

II Proof of Proposition 3

A scientist can start a business venture based on a new idea in the second period if
\[
E(\theta | \pi_{1}, a_{1}, e_{1}^{*}) + W_{1} \geq I - \Delta + \frac{B}{1 - q}.
\] (19)
We have \(W_{1} = E(\theta) + e_{1}^{*}\), where \(e_{1}^{*}\) is given by (18). Then, (19) can be rewritten as
\[
E(\theta | \pi_{1}, a_{1}, e_{1}^{*}) \geq I + \frac{B}{1 - q} - \Delta - \Delta E(\theta) - \psi' - 1 \left( \frac{\sigma_{\theta}^{2}}{\sigma_{\theta}^{2} + \sigma_{a}^{2}} + \frac{\Delta - I}{(\sigma_{\theta}^{2} + \sigma_{a}^{2})^{2}} \frac{1}{\sqrt{2\pi}} \exp \left[ -\frac{1}{2} \left( \frac{(\theta - E(j))^{2}}{\sigma_{\theta}^{2} + \sigma_{a}^{2}} \right) \right] \right).
\]
Let us define
\[
h(x, \sigma_{a}^{2}) \overset{d}{=} \left[ I + \frac{B}{1 - q} - \Delta - \Delta E(\theta) - \psi' - 1 \left( \frac{\sigma_{\theta}^{2}}{\sigma_{\theta}^{2} + \sigma_{a}^{2}} + \frac{\Delta - I}{(\sigma_{\theta}^{2} + \sigma_{a}^{2})^{2}} \frac{1}{\sqrt{2\pi}} \exp \left[ -\frac{1}{2} \left( \frac{(x - E(j))^{2}}{\sigma_{\theta}^{2} + \sigma_{a}^{2}} \right) \right] \right) \right],
\]
and \(g(x) \overset{d}{=} x\).
We have
\[
\frac{\partial h(x, \sigma_a^2)}{\partial x} = \frac{(x - \mathbb{E}(\theta)) (\sigma_\theta^2 + \sigma_a^2)^{1/2}}{\sigma_a^4} \Delta - I \exp \left[ -\frac{1}{2} \frac{(x - \mathbb{E}(\theta))^2 (\sigma_\theta^2 + \sigma_a^2)}{\sigma_\theta^4} \right] (\psi^{-1})'(x).
\]
Thus, \(h(x, \sigma_a^2)\) is strictly decreasing when \(x < \mathbb{E}(\theta)\) and strictly increasing when \(x > \mathbb{E}(\theta)\).

Besides,
\[
\lim_{x \to -\infty} h(x, \sigma_a^2) = I + \frac{B}{1 - q} - \Delta - \mathbb{E}(\theta) - \psi^{-1} \left( \frac{\sigma_\theta^2}{\sigma_\theta^2 + \sigma_a^2} \right) = \lim_{x \to +\infty} h(x, \sigma_a^2).
\]
Therefore, a scientist can create a firm in the next period if \(\mathbb{E}(\theta | \pi_1, a_1, e_1^\ast) \geq \tilde{\theta}\), where \(\tilde{\theta}\) is the smallest value of \(x\) which satisfies \(g(x) = h(x, \sigma_a^2)\).

We have
\[
\frac{\partial h(x, \sigma_a^2)}{\partial \sigma_a^2} = \left[ \frac{\sigma_\theta^2}{\sigma_\theta^2 + \sigma_a^2} + \frac{1}{2} \left( \frac{1}{(\sigma_\theta^2 + \sigma_a^2)^{1/2}} + \frac{(x - \mathbb{E}(\theta))^2}{\sigma_\theta^2(\sigma_\theta^2 + \sigma_a^2)^{1/2}} \right) \frac{\Delta - I}{\sqrt{2\pi}} \exp \left[ -\frac{1}{2} \frac{(x - \mathbb{E}(\theta))^2 (\sigma_\theta^2 + \sigma_a^2)}{\sigma_\theta^4} \right] \right] (\psi^{-1})'(x) > 0,
\]
which implies that for a given scientist,
\[
h(x, \sigma_a^2) > h(x, \sigma_T^2).
\]
Thus, \(h(\tilde{\theta}_T, \sigma_0^2) > h(\tilde{\theta}_T, \sigma_T^2) = \tilde{\theta}_T\). Moreover, using (20) and the fact that \(g\) is increasing in \(x\), we obtain \(\tilde{\theta}_0 > \tilde{\theta}_T\), where \(\tilde{\theta}_0\) denotes the threshold above which the scientist can start a business venture when opting for action \(a_1\).

Since \(h(x, \sigma_a^2)\) is strictly decreasing in \(x\) when \(x < \mathbb{E}(\theta)\) and strictly increasing in \(x\) when \(x > \mathbb{E}(\theta)\) and verifies (20), we have
\[
\begin{align*}
\left. h(x, \sigma_a^2) \right|_{x = \mathbb{E}(\theta)} &\leq \mathbb{E}(\theta) \iff \mathbb{E}(\theta) \geq \frac{1}{2} \left( I + \frac{B}{1 - q} - \Delta - \psi^{-1} \left( \frac{\sigma_\theta^2}{\sigma_\theta^2 + \sigma_a^2} + \frac{\Delta - I}{\sqrt{2\pi}} \frac{1}{\sigma_\theta^4} \right) \right),
\end{align*}
\]
then \(\tilde{\theta} \leq E(\theta)\). On the contrary,
\[
\begin{align*}
\left. h(x, \sigma_a^2) \right|_{x = \mathbb{E}(\theta)} &> \mathbb{E}(\theta) \iff \mathbb{E}(\theta) < \frac{1}{2} \left( I + \frac{B}{1 - q} - \Delta - \psi^{-1} \left( \frac{\sigma_\theta^2}{\sigma_\theta^2 + \sigma_a^2} + \frac{\Delta - I}{\sqrt{2\pi}} \frac{1}{\sigma_\theta^4} \right) \right),
\end{align*}
\]

implies that \( \overline{\theta} > E(\theta) \).

### III Proof of Lemma 2

The scientist chooses \( a_1 \) so as to maximize \( \mathbb{E} [E(\theta | \pi_1, a_1, e^*_1)] + \text{Pr} (E(\theta | \pi_1, a_1, e^*_1) \geq \overline{\theta}) \times (\Delta - I) - \psi(e^*_1) \). Since the market perfectly anticipates \( e^*_1 \) and ex post observes \( a_1 \), so that \( \mathbb{E} [E(\theta | \pi_1, a_1, e^*_1)] = \mathbb{E} [\mathbb{E}(\theta | \pi_1(e^*_1), a_1, e^*_1)] = \mathbb{E}(\theta) \), the scientist makes a choice of action by considering (i) the cost of effort implied by the action and (ii) the probability of starting a business venture. Observe that when making a choice of action, the scientist knows the threshold above which it is possible to start a business venture since \( W_1 \) is already fixed.

1. Let \( E(\theta) \geq \overline{\theta}_O \). First, (18) shows that minimizing \( \psi(e_1) \) implies to maximize \( \sigma^2_a \), hence to opt for \( O \). Next, examine the probability. Using statistic rules for computing conditional expectations in the case of normal laws leads to \( \mathbb{E}(\theta | \pi_1, a_1, e^*_1) \sim N \left( \mathbb{E}(\theta); \frac{\sigma^2_\theta}{\sigma^2_\theta + \sigma^2_a} \right) \). Thus, raising \( \sigma^2_a \), which implies to select \( O \), decreases the variance of \( \mathbb{E}(\theta | \pi_1, a_1, e^*_1) \), and in turn maximizes the probability to be above \( \overline{\theta}_T \) and \( \overline{\theta}_O \) as \( \mathbb{E}(\theta) \geq \overline{\theta}_O \). To summarize, the scientist’s dominant strategy is to choose \( O \). Accordingly, the wage is \( W_O \) and the relevant threshold is \( \overline{\theta}_O \).

2. Let \( \overline{\theta}_T < E(\theta) < \overline{\theta}_O \). Suppose first that employers anticipate that the scientist will choose \( T \), and will pay \( W_T \) so that \( \overline{\theta} = \overline{\theta}_T \). Then, maximizing the probability to start a business venture as well as minimizing \( \psi(e_1) \) drives the scientist to opt for \( O \) since \( \mathbb{E}(\theta) > \overline{\theta}_T \). However, this cannot be an equilibrium since paying \( W_T = \mathbb{E}(\theta) + e^*_1(T) > \mathbb{E}(\theta) + e^*_1(O) \) would imply a loss for the employer. Suppose now that (i) employers anticipate that the scientist will opt for \( O \), and (ii) the scientist is paid \( W_O \) so that the relevant threshold is \( \overline{\theta}_O \). Minimizing \( \psi(e_1) \) leads the scientist to choose \( O \). However, this decreases the probability of starting a business venture since \( \mathbb{E}(\theta) < \overline{\theta}_O \). Hence there exists a trade-off. Choosing \( O \) is optimal when

\[
\begin{bmatrix}
-\psi(e^*_1(T, \overline{\theta}_O)) \\
\text{Pr}(E(\theta | \pi_1, T, e^*_1) \geq \overline{\theta}_O) \times (\Delta - I)
\end{bmatrix} < \begin{bmatrix}
-\psi(e^*_1(O, \overline{\theta}_O)) \\
\text{Pr}(E(\theta | \pi_1, O, e^*_1) \geq \overline{\theta}_O) \times (\Delta - I)
\end{bmatrix}.
\]

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This requires that $\Delta < \Delta_{\sigma^2_{\theta}}$, with

$$
\Delta_{\sigma^2_{\theta}} = I + \frac{\psi(e^*_1(T, \bar{\theta})) - \psi(e^*_1(\mathcal{O}, \bar{\theta}))}{\Phi \left[ (\bar{\theta} - \mathbb{E}(\theta)) \left( \frac{\sigma^2_{\theta} + \sigma^2_{\Omega}}{\sigma^2_{\theta}} \right)^{1/2} \right] - \Phi \left[ (\bar{\theta} - \mathbb{E}(\theta)) \right]},
$$

(21)

which is not verified here since $\Delta > \Delta$. Hence, $(\mathcal{O}, W_{\mathcal{O}})$ is not an equilibrium. As observed above, paying the scientist $W_T$ cannot be an equilibrium since the employer would then incur a loss.

Paying the scientist $W_{\mathcal{O}} < E(\theta) + e^*_1(T)$ is not an equilibrium either since firms are competitive. Thus, the scientist receives $W_T^* < E(\theta) < \bar{\theta}$, where $W_T^* < E(\theta) < \bar{\theta}$ is the highest possible wage such that (i) $\bar{\theta}$ is higher than $E(\theta)$, where $\bar{\theta}$ is the smallest value of $E(\theta \mid \pi_1, T, e^*_1)$ such that (19) is verified with $W_T^* < E(\theta) < \bar{\theta}$, and that (ii) the scientist actually chooses $T$, which reduces to

$$
\Delta \geq \Delta(W_T^* < E(\theta) < \bar{\theta}),
$$

where

$$
\Delta(W_T^* < E(\theta) < \bar{\theta}) = I + \frac{\psi(e^*_1(T, \bar{\theta}(W_T^* < E(\theta) < \bar{\theta}))) - \psi(e^*_1(\mathcal{O}, \bar{\theta}(W_T^* < E(\theta) < \bar{\theta}))))}{\Phi \left[ (\bar{\theta} - \mathbb{E}(\theta)) \left( \frac{\sigma^2_{\theta} + \sigma^2_{\Omega}}{\sigma^2_{\theta}} \right)^{1/2} \right] - \Phi \left[ (\bar{\theta} - \mathbb{E}(\theta)) \right]},
$$

Then, $(T, W_T^* < E(\theta) < \bar{\theta})$ is an equilibrium.

3. Let $E(\theta) \leq \bar{\theta}_T \leq \bar{\theta}_O$. It is straightforward that whatever $\bar{\theta}$, the scientist maximizes the probability of starting a business venture by minimizing $\sigma^2_{\theta}$, i.e. by choosing $T$. However, choosing $T$ implies a higher cost of effort. Hence, the trade-off the scientist faces. Two cases are possible:

a. Employers anticipate that the scientist will select $T$ and will pay $W_T$ so that $\bar{\theta} = \bar{\theta}_T$. This is an equilibrium if the scientist actually chooses $T$, which occurs when

$$
\left[ -\psi(e^*_1(T, \bar{\theta}_T)) + \Pr(\mathbb{E}(\theta \mid \pi_1, T, e^*_1) \geq \bar{\theta}_T) \times (\Delta - I) \right] \geq \left[ -\psi(e^*_1(\mathcal{O}, \bar{\theta}_T)) + \Pr(\mathbb{E}(\theta \mid \pi_1, \mathcal{O}, e^*_1) \geq \bar{\theta}_T) \times (\Delta - I) \right].
$$
It is equivalent to $\Delta \geq \Delta_{T}^{E(\theta) \leq \bar{\theta}_{T}}$, where

$$\Delta_{T}^{E(\theta) \leq \bar{\theta}_{T}} = I + \frac{\psi (e_{1}^{*} (T, \bar{\theta}_{T})) - \psi (e_{1}^{*} (O, \bar{\theta}_{T}))}{\Phi \left[ (\bar{\theta}_{T} - \mathbb{E}(\theta)) \left( \frac{\sigma_{\theta}^{2} + \sigma_{O}^{2}}{\sigma_{\theta}^{2}} \right)^{\frac{1}{2}} \right] - \Phi \left[ \frac{(\bar{\theta}_{T} - \mathbb{E}(\theta))}{\sigma_{\theta}} \right]}.$$

b. Employers anticipate that the scientist will select $O$ and will pay $W_{O}$ so that $\bar{\theta} = \bar{\theta}_{O}$. This cannot be an equilibrium since the scientist chooses $O$ when

$$\left[ -\psi (e_{1}^{*} (T, \bar{\theta}_{O})) + \Pr (\mathbb{E}(\theta \mid \pi_{1}, T, e_{1}^{*}) \geq \bar{\theta}_{O}) \times (\Delta - I) \right] < \left[ -\psi (e_{1}^{*} (O, \bar{\theta}_{O})) + \Pr (\mathbb{E}(\theta \mid \pi_{1}, O, e_{1}^{*}) \geq \bar{\theta}_{O}) \times (\Delta - I) \right].$$

It is equivalent to $\Delta < \Delta_{O}^{E(\theta) \leq \bar{\theta}_{T}}$, where

$$\Delta_{O}^{E(\theta) \leq \bar{\theta}_{T}} = I + \frac{\psi (e_{1}^{*} (T, \bar{\theta}_{O})) - \psi (e_{1}^{*} (O, \bar{\theta}_{O}))}{\Phi \left[ (\bar{\theta}_{O} - \mathbb{E}(\theta)) \left( \frac{\sigma_{\theta}^{2} + \sigma_{O}^{2}}{\sigma_{\theta}^{2}} \right)^{\frac{1}{2}} \right] - \Phi \left[ \frac{(\bar{\theta}_{O} - \mathbb{E}(\theta))}{\sigma_{\theta}} \right]},$$

which is not the case since $\Delta > \Delta$. 
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