IS BILL GATES THE EXCEPTION OR THE NORM – ROLE OF HUMAN CAPITAL IN OCCUPATION CHOICE IN IT INDUSTRIES

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IS BILL GATES THE EXCEPTION OR THE NORM – ROLE OF HUMAN CAPITAL IN OCCUPATION CHOICE IN IT INDUSTRIES

Complete Paper

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Abstract

While innovation is the hallmark of the information technology (IT) industry, very little research has studied individuals’ motivation to innovate either as scientists in research and development (R&D) departments of established firms, or as entrepreneurs starting their own ventures. In this research, we develop a game theoretic model based on theories of human capital and information asymmetry to explore how individuals’ skill levels impact their decision on whether to work for established companies or become entrepreneurs. Our results suggest that if information about individuals’ skills is private information, then highly skilled individuals choose to become entrepreneurs. In the presence of imperfect signaling, employees with very high skills or very low skills tend to work in established companies, and those with intermediate skills become entrepreneurs. We also find that entrepreneurs, on average, have higher skill levels than scientists, and increased technology risks raise the mass of scientists in the market.

Keywords: Game Theory, Occupation Choice, IT workforce, Information Economics
Introduction

Who is the quintessential IT entrepreneur - Gordon Moore or Bill Gates? The two men could not be more different in their educational backgrounds. Moore had a PhD in Chemistry and Physics, whereas Bill Gates dropped out of undergraduate college. Yet both men proved themselves as innovators par excellence by establishing two highly successful companies (Intel and Microsoft respectively). Their story raises a very interesting question: what is the role of signals of individual ability such as education in creating successful IT innovators?

Innovation is the cornerstone of the information technology (IT) industry. The rapid change in technology provides opportunities for the creation of new product and obsolescence of existing products. Two main types of individuals are at the forefront of innovation in IT – one, researchers working in established companies (henceforth labeled ‘scientists’ in this paper), and entrepreneurs (henceforth labeled ‘entrepreneurs’) who create new products in newly-formed establishments which is symbolic of the garage startup culture of Silicon Valley. Ceteris paribus, one would expect that highly skilled individuals would choose to become entrepreneurs since the monetary rewards of entrepreneurship are generally greater than those of working in an established company. However, the industry is also rife with instances of pioneers with very little formal education such as Bill Gates, Larry Ellison, and Michael Dell who founded very successful IT companies. Studies have shown mixed results on the link between human capital indicators such as education and entrepreneurship. For example, Wadhwa et al (2008) show that 31% of technology entrepreneurs have a masters degree and that they come from a wide assortment of schools (both ivy league, first and second tier schools). In short, there is ambiguity in the role of human capital on individuals’ choice to become entrepreneurs vis-à-vis conducting research in established firms in the IT industry.

Several studies have written about the role of human capital in Information Technology (IT) firms (Ang et al, 2002; Mithas and Krishnan, 2007). These studies have mainly explored the value that IT firms perceive for employees’ human capital indicators such as education and experience. Banker et al (2009) suggest that employees with higher levels of education have a significant impact on R&D productivity of IT firms. While these issues are clearly important, they are mainly relevant to employees who choose to work in established firms. Few studies have analyzed the role of skill in the motivation of IT professionals to indulge in entrepreneurial ventures. This is surprising considering that IT industries are well known for a culture of entrepreneurship, where individuals choose to forgo the benefits and security of working in established firms for the uncertainty of joining a start-up or setting up a start-up of their own. With this motivation, we propose our main research question as follows: what is the role of skills in individuals’ decision to become entrepreneurs vis-à-vis scientists in established firms? How does the ability of individuals to signal human capital through objective measures such as education or standardized test scores impact the equilibrium?

We propose this study in the context of IT producing industries1. This includes IT hardware and software firms whose main objective is to develop new products for the market. Examples include established companies such as Microsoft, Cisco, and Intel, as well as startup companies such as Xintronix (www.xintronix.co.uk), and Tabula (www.tabula.com). While product designers (entrepreneurs and scientists) are responsible for creating new products, yet another set of professionals complete the innovation cycle in IT industries – ‘production engineers’ working for IT manufacturing organizations such as Flextronics which bring the new products designs to fruition in form of manufactured integrated circuits (IC). For simplification, we assume that the entire eco-system of IT producers comprises of three types of professionals – scientists, entrepreneurs, and production engineers.

We set up an occupational choice model where agents have the above three occupational choices - they choose a research career either with as scientists running a corporate-sponsored research venture at a large firm, or as entrepreneurs starting an independent research venture. Alternately, the agents may choose a non-research career as a ‘production engineers’. It is generally accepted that research based activities such as product design and innovation require more creativity, whereas production is more of a routine job with well defined descriptions. We assume that agents are risk-averse, and are endowed with a skill factor that determines one’s average productivity at performing research. In the process of innovating, agents are subject to an uninsurable idiosyncratic shock. Employers observe the aggregate output of their operations, but not the individual skills of a researcher.

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1 While other IT firms (such as IT services, software services providers) are an essential part of the IT industry, we exclude these from our discussion for simplicity
Our main results are as follows: we show that if skill is private information, low-skilled agents become production engineers, those of intermediate ability become scientists, and high-skilled agents become entrepreneurs. On the other hand, if skill is public information, high-skilled agents become scientists and low-skilled agents become production engineers; no individual chooses to become an entrepreneur. We also consider the case where employers observe a noisy signal of ability, such as education or experience, and compensate employees based on the observable signal of ability. We show that in equilibrium, high-skilled agents sort as follows: those with fairly accurate signals become scientists; those that are underrated by the signal become entrepreneurs; and those with low signal become production engineers. Our results suggest that the presence of a noisy signal is essential for entrepreneurs to exist in the market - if the signal is not sufficiently noisy, all high skills agents choose to become scientists. The paper contributes to literature on human capital and IT by examining the role of individual skills in employees’ decision to self select into different job types within the IT industry.

Literature Review

Recent research in MIS literature has focused on the role of human capital in IT firms. Ang et al (2002) show that employers in the software industry in Singapore reward education and work experience of employees with high compensation. Levina and Xin (2007) extend these results to the context of IT employers based in the US. Slaughter, Ang and Boh (2007) suggest that the relation between human capital and compensation is moderated by the firm-specificity of the human capital. Banker et al (2008) suggest that educated employees are associated with higher R&D productivity in IT firms. Recent research has also examined the role of training in IT firms (Ramasubbu et al., 2008).

Research in labor economics and strategic management has examined individual’s motivation to engage in entrepreneurial activities, and the results are mixed. Lazaer (2005) summarizes the different facets of the argument as follows: on one hand, we would expect creative and skilled individuals to pursue entrepreneurship. On the other hand, it is also likely that entrepreneurs are workers who cannot find regular job (or have no other alternatives), and could come from the lower half of the ability distribution. Blanchflower and Meyer (1991) pointed out that research concerning entry into an entrepreneurial (or managerial) occupation has focused on the following assumptions [Kanbur (1982), Kihlstrom and Laffont (1979), Grossman (1984)]. First, profitable business opportunities are feasible for all individuals, yet most simply choose not to exploit them. Second, entrepreneurs receive the same expected utility as they would as workers. Third, the entrepreneur is likely to be someone with unusually low risk-aversion (as in Kihlstrom and Laffont, 1979). On the other hand, classical literature on the topic such as Kirzner (1973), Knight (1921), and Schumpeter (1939) argue that attitude to risk is not the central characteristic that determines who becomes an entrepreneur.

Recent literature on entrepreneurship has highlighted the importance of individual ability and other factors such as propensity for risk, gender, social background, education and intelligence as significant predictors of entrepreneurial talent (van Praag and Cramer, 2001). Fraser and Greene (2006) suggest that experience also plays a role in individual’s choice to become an entrepreneur.

Our work differs from past literature in the following ways: one, while prior studies consider the tradeoff between entrepreneurial returns and fixed wages, we consider an additional option – that of a scientist where a firm provides insurance by pooling risk across several individuals and compensating them based on the group output (which is different from fixed wages). Two, we consider different types of information – full information case, no information case, and incomplete information case - and model how individuals’ propensity to choose an occupation depends on the type of information revelation.

Prior literature also points out the difference in pay structure between startups and established companies. Stafford (1980, p. 334) pointed out that “a larger establishment can provide insurance functions ... if the different jobs (occupations) or individuals within the plant are subject to earnings uncertainty.” Medoff and Abraham (1980) find only a weak link between pay and performance in large firms. In accordance with these observations, the large research firm provides full insurance to its employees in the form of a fixed wage, as in Holmstrom (1983). Gompers (1999), Bullock (1983), and Kozmetsky et al (1985) showed that research-intensive start-ups are typically funded by venture capitalists; moreover, they usually hold an equity stake instead of using debt.

Model
In every period, a continuum of mass one of risk-averse agents is born, whereby an agent is indexed by a skill level \( s \) that is drawn from a distribution \( F \) with support \([0, \infty)\). Skill is private information, though we shall also consider the full information case. Agents live for one period and become an entrepreneur, scientist, or production engineer. Entrepreneurs create and run independent ventures financed by risk-neutral venture capitalists. Venture capitalists are endowed with the know-how and investment technology to start-up a small firm, so entrepreneurs cannot initiate an independent venture on their own.\(^{2}\) Scientists run corporate-sponsored ventures at a large research firm. A production engineer earns the exogenous wage \( w \). For simplification, we make the following assumption: the large research firm offers fixed wage contracts, whereas the venture capital firm offers equity based contract. This assumption is not critical, and if we relax this assumption and allow firms to offer different types of contracts, we find that in equilibrium, only the fixed-wage contract of the large firm is accepted, while only the equity-based contracts of venture capitalists are accepted. No agent accepts an equity-based contract from the large firm due to the lemons problem.

Independent ventures and corporate-sponsored ventures develop schematics for new goods, each of which generates the payoff \( P_A \). The firm employing the inventor of a schematic obtains an infinitely lived patent, the rights to which are then sold to a monopolist that produces the good at constant marginal cost. It is assumed the firm employing the inventor is the full residual claimant to the rent generated by the innovation. The actual inventor receives either a wage (as a scientist) or a share of the returns (as an entrepreneur).

Each agent is endowed with an innovation technology. When \( x \) units of capital are invested in an agent of skill \( s \), she invents \( \varepsilon(s) x^{1-\delta} \) new goods, where \( \varepsilon(s) \) is an uninsurable idiosyncratic shock ("productivity") whose distribution depends on \( s \). The timing is such that the idiosyncratic shock is realized after the investment has been made. The productivity of an agent with skill \( s \) has the support \([0, \infty)\) and expectation \( \bar{\varepsilon}(s) \). Let

\[
\bar{\varepsilon}(S) \equiv \int_S \bar{\varepsilon}(s) dF(s) \left[ \int_S dF(s) \right]^{-1}
\]

denote the average productivity of agents in the set \( S \subset [0, \infty) \).

An individual with skill level \( s \) that chooses a research-based occupation (i.e. by becoming a scientist or entrepreneur) incurs the disutility \( u(d(s)) \). For convenience, the disutility has the same functional form \( u \) as that over consumption, and it enters preferences in an additive fashion; that is, the utility of a scientist or entrepreneur with skill \( s \) consuming \( c \) is equal to \( u(c) - u(d(s)) \). The disutility of performing research is decreasing in skill, such that \( d'(s) < 0 \).

Preferences, technology, and the skill distribution satisfy the following throughout the paper:

(A1) The utility function of an agent is \( u(c) = \frac{c^{1-\sigma}}{1-\sigma} \), where \( c \) is consumption and \( \sigma > 0 \).

(A2) The average productivity of an agent \( \bar{\varepsilon}(s) \) is strictly increasing in skill \( s \), and \( \bar{\varepsilon}(0) \equiv 0 \).

(A3) The cumulative distribution function of skill \( F \) is strictly increasing.

(A4) \( \frac{E[\varepsilon(s)^{1-\sigma}]}{1-\sigma} \) is strictly increasing in skill \( s \).

Assumption (A2) states that, holding the level of investment and state of technology constant, a highly skilled individual invents a greater number of schematics for new goods on average. Moreover, note that (A4) follows directly from (A2), since the expected value of a monotone transform of a variable is a monotone transform of the expected value.

The Corporate-Sponsored Venture

\(^{2}\) In a dynamic context, in which an independent venture operates over multiple periods, this is akin to imposing that only venture capitalists have access to the capital markets, thus being able to borrow sufficient funds to launch a firm.
The large research firm operates a collection of ventures, each of which is run independently by a scientist. Let $\Gamma$ denote the set of skills of the agents who choose to become scientists. Being unable to observe skill, the large firm has no control over the characteristics of its employees, so it takes $\Gamma$ as given. To construct the equilibrium, it is assumed the firm is endowed with rational expectations (perfect foresight); that is, it accurately predicts the set $\Gamma$ in equilibrium. Because the firm cannot distinguish its employees, it invests the same amount $x$ in each corporate-sponsored venture. Let $v$ denote the wage paid scientists, which is taken as given by the firm in a competitive equilibrium. Being risk neutral, the firm maximizes its expected profits:

$$\int \int \int \int \Gamma \Gamma v(s) dF(s) - (x + v) \int dF(s).$$

The first-order condition (FOC) with respect to $x$ leads to

$$x(\Gamma) = [(1 - \delta) P_A \overline{e}(\Gamma)]^{-1}. \quad (1)$$

There is free entry into the research sector, so the large firm makes zero expected profits in equilibrium yielding an expression for the wage $v$ as a function of the average skill of scientists:

$$v(\Gamma) = \delta (1 - \delta)^{(1-\delta)/\delta} [P_A \overline{e}(\Gamma)]^{-\delta}. \quad (2)$$

**The Independent Venture**

Consider a venture capitalist that is paired with an entrepreneur of skill $s$ to form an equity contract. Let $\Omega$ denote the set of entrepreneurs, which is taken as given by venture capitalists. As was assumed for the large research firm, venture capitalists are endowed with rational expectations; that is, they accurately predict the set $\Omega$ in equilibrium. A venture capitalist makes an investment $k$ in exchange for a share $\alpha$ of the revenues. There are many venture capitalists bidding for each equity contract, so the entrepreneur decides the values of $\alpha$ and $k$. Letting $u$ denote an agent’s utility function, an entrepreneur of skill $s$ solves

$$\max_{\alpha \in [0,1], k \geq 0} \{ u[(1 - \alpha) P_A e(s) k^{1-\delta}] - u(d(s)) \},$$

subject to the condition that the venture capitalist is willing to enter into the equity contract. Since the venture capitalist must make this decision prior to the realization of the shock without knowing the skill of the entrepreneur, and she is risk neutral, the participation constraint (PC) is $\alpha P_A \overline{e}(\Omega) k^{1-\delta} - k \geq 0$. The following lemma describes the solution to this problem.

**LEMMA 1:** Suppose the utility function is strictly increasing. Then the share of revenues that accrues to the venture capitalist is $\alpha = 1 - \delta$. Moreover, for any given set $S \subset [0, \infty)$, an independent venture utilizes the same investment policy as a large firm, $k(S) = x(S)$.

The lemma states that the entrepreneur chooses a share of revenues that accrue to the venture capitalist equal to $\alpha = 1 - \delta$. Recall that if the venture capitalist invests $x$ in the venture, then the entrepreneur invents $\varepsilon(s)x^{1-\delta}$ new goods. Hence, the coefficient $1 - \delta$ represents the (percentage) contribution towards the innovative process made by the investment. As $\delta$ converges to zero, the venture capitalist must become the full residual claimant of the investment to ensure his participation.

**The Occupational Choice Decision**

First, we consider the case where skills is private information, and the firm can only infer the distribution of skills available in the market.

**PROPOSITION 1 (The Separating Equilibrium):** Assume skill is private information. Define $\hat{\delta}_{UN}$ and $\overline{\delta}_{UN}$ according to

$$[\delta(1 - \delta)^{(1-\delta)/\delta} [P_A \overline{e}([\hat{\delta}_{UN}, \overline{\delta}_{UN}])]^{-\delta}]^{1-\sigma} - d(\hat{\delta}_{UN})^{1-\sigma} \equiv w^{1-\sigma}; \quad (3)$$

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In equilibrium, agents choose the following occupations: those in the skill range \([0, \hat{s}_{UN})\) become production engineers; those in \([\hat{s}_{UN}, \bar{s}_{UN})\) become scientists; and those in \([\bar{s}_{UN}, \infty)\) become entrepreneurs.

In equilibrium, a positive mass of agents sorts into each occupation in the following fashion. High-skilled agents become entrepreneurs, those of intermediate ability become scientists, and the lowest skilled segment of the population chooses the occupation of production engineers. The intuition of this outcome is straightforward. Because ability is private information, scientists are paid on the basis of their average product. Therefore, agents with sufficiently high skill levels are drawn away from the large research firm since they are not compensated an amount commensurate with their productivity. Only such agents can earn a high expected income as entrepreneurs, so they are willing to bear a fraction of the risk associated with running an independent venture. Because the large research firm provides its employees with full insurance, there is a positive mass of agents who choose to become scientists since agents are risk averse, which leads us to the next point.

The presence of the idiosyncratic shock is crucial to the existence of the separating equilibrium. If the innovation technology is deterministic, then no agents become scientists because of the “lemons” problem. The large firm would no longer provide insurance functions, so there is no incentive for a researcher to remain with the large firm when skill is unobservable and there is no idiosyncratic risk. This observation is also interesting considering that IT innovations are characterized by high levels of risk and uncertainty – which explains why R&D operations of companies such as Intel and Cisco find a steady supply of scientists to hire.

**The Full Information Case**

Next, we consider the case where skill is observable to employers, in which case agents are paid their marginal product at the large research firm while receiving the benefits of full insurance.

**PROPOSITION 2 (The Pooling Equilibrium):** Assume skill is public information, and agents are risk averse. Define \(\hat{s}\) according to

\[
(5) \quad [\delta(1-\delta)]^{1-\sigma} \left[ P_A(e(\hat{s})) \right]^{1-\sigma} - d(\hat{s})^{1-\sigma} \equiv w^{1-\sigma}.
\]

In equilibrium, agents choose the following occupations: those in the skill range \([0, \hat{s})\) become production engineers, and those in \([\hat{s}, \infty)\) become scientists. There are no entrepreneurs.

It follows that, due to risk aversion, no agent has an incentive to become an entrepreneur. Because the marginal product of a researcher is strictly increasing in skill by definition, and scientists incur a disutility of performing research that is strictly decreasing in skill, the equilibrium consists of a unique cutoff skill level below (above) which agents become production engineers (scientists, respectively).

Combining this result with Proposition 1, we infer information asymmetries between innovators and their investors are required to generate a positive mass of entrepreneurs. We previously found that, in the absence of idiosyncratic risk, no agents become scientists when skill is private information. Hence, in the presence of both unobservable skill and uninsurable idiosyncratic risk, scientists and entrepreneurs can coexist.

The following corollary establishes that \(\hat{s}_{UN} < \hat{s} < \bar{s}_{UN}\), implying fewer agents become employed by the research sector when skill is observable.

**COROLLARY OF PROPOSITION 2:** The separating equilibrium relates to the pooling equilibrium as follows: \(\hat{s}_{UN} < \hat{s} < \bar{s}_{UN}\).

\(^3\) In fact, if agents are risk neutral, they are precisely indifferent between becoming an entrepreneur versus scientist.

\(^4\) If there is no risk and skill is observable, then individuals are indifferent between becoming scientists versus entrepreneurs.
Some basic comparative statics may be performed to deduce how the mass of agents in each occupation depends on the fundamental parameters of the model. The cutoff \( \hat{S} \) is strictly increasing in the interest rate. If \( r \) rises, the payoff per innovation falls, lowering the wage of scientists. Being a scientist thus becomes less attractive, implying more agents become production engineers instead.

So far, we have analyzed the bipolar cases in which skill is either public or private information. In the former case, no individuals choose to become entrepreneurs since they are paid their marginal product at a large firm. In the latter case, highly skilled individuals are paired with venture capitalists offering equity contracts, while individuals of intermediate ability become scientists, earning a fixed wage which proxies for full insurance. In both cases, low-skilled agents become production engineers since choosing a research-based occupation entails a loss of utility that is decreasing in skill. Next, we consider the intermediate case of imperfect information, wherein individuals know their true skill level, but employers observe a noisy signal of skill. For example, education, work experience, and standardized examinations are typically observable, but these are not a perfect indicator of ability. In markets with incomplete information, signals such as education are commonly used as an indicator of one’s ability (Spence, 1973).

**Model with Imperfect Information**

Suppose employers observe a test score \( t \) instead of the actual skill \( s \) of an agent. All agents are required to take the test prior to employment, and they know their own skill level. Employers (corporate and venture capitalists) consider an agent’s test score as a measure of her expected skill level. That is, if \( x \) is invested in an agent with test score \( t \), she is expected to invent \( \bar{\varepsilon}(t)x^{1-\delta} \) new goods. The test score takes on the functional form \( s = \eta \cdot t \), where \( \eta \) is a random variable with support \([0, \infty)\) and a distribution \( T \) that does not depend on skill and is i.i.d. across agents.

**Corporate Sponsored Research**

Consider a corporate-sponsored venture run by a scientist who obtained the test score \( t \). Let \( v(t) \) denote the wage schedule of scientists mapped according to their test score, which is taken as given by the large research firm in the competitive equilibrium. The firm maximizes its expected profits: \( \max_{\{x \geq 0\}} P_A \bar{\varepsilon}(t)x^{1-\delta} - v(t) - x \). The FOC with respect to \( x \) leads to the investment policy

\[
(6) \quad x(t) = [(1-\delta)P_A \bar{\varepsilon}(t)]^{1-\delta}. 
\]

The wage schedule must be such that no scientist can earn a higher salary at another large firm, yielding the relation \( v(t) = \max_{\{x \geq 0\}} P_A \bar{\varepsilon}(t)x^{1-\delta} - x \). Due to constant returns, this condition is equivalent to requiring that the typical large firm make zero expected profits in equilibrium. Hence, we equate the marginal cost of hiring a scientist who obtained the test score \( t \) with his expected marginal product: \( v'(t) = P_A \bar{\varepsilon}'(t)x(t)^{1-\delta} \). Applying the investment policy function, we obtain the expression \( v'(t) = P_A \delta \bar{\varepsilon}'(t)[(1-\delta)\bar{\varepsilon}(t)]^{(1-\delta)\delta^{-1}} \). Integrating this from zero to \( t \), and using the fact that \( v(0) = 0 \) since \( \bar{\varepsilon}(0) \equiv 0 \), the competitive wage schedule equals

\[
(7) \quad v(t) = \delta(1-\delta)^{(1-\delta)\delta^{-1}} [P_A \bar{\varepsilon}(t)]^{\delta^{-1}}. 
\]

Consider an agent with test score \( t \) and skill \( s \) who becomes an entrepreneur by entering into an equity contract with a venture capitalist. Because an agent knows his own skill level, the objective remains the same, except for having removed the disutility of performing research: \( \max_{\{\alpha \in [0,1], k \geq 0\}} E[u[(1-\alpha)P_A \bar{\varepsilon}(s)k^{1-\delta}]] \). The participation constraint (PC) of the venture capitalist must reflect the fact that she only observes the test score of the entrepreneur. Hence, the PC is given by \( \alpha P_A \bar{\varepsilon}(t)k^{1-\delta} - k \geq 0 \). The first-order conditions are identical to those derived in Lemma 1, whereby \( \bar{\varepsilon}(\Omega) \) is replaced by \( \bar{\varepsilon}(t) \), yielding \( \alpha = 1-\delta \) and \( k(t) = x(t) \).
The Occupational Choice Decision

The following proposition states the equilibrium. Subsequent corollaries describe the sorting of agents according to their skill level and test score.

**PROPOSITION 3 (The Signaling Equilibrium):** Assume employers observe a test score \( t = \eta \cdot s \), the idiosyncratic innovation shock is \( \varepsilon(s) = \varepsilon \cdot s^\delta \), with \( \bar{\varepsilon} \equiv \mathbb{E}\{\varepsilon\} \) and \( \varepsilon \in [0, \infty) \), and the distribution \( T \) of \( \eta \) is strictly increasing with support \([0, \infty)\). Define the cutoff \( \overline{\eta} \) according to

\[
(8) \quad \overline{\eta} \equiv \left[ \frac{\mathbb{E}(s^\delta)}{\bar{\varepsilon}^{1-\sigma}} \right] ^{(1-\sigma)\delta}.
\]

Furthermore, given (8), define \( \hat{\eta} \) according to

\[
(9) \quad \bar{\varepsilon}(\hat{\eta}) \equiv \frac{w^\delta}{\delta^\delta (1-\delta)^{1-\delta} P_A}.
\]

In equilibrium, agents choose the following occupations: those in the set \( \{(\eta, s) : \eta s \leq \hat{\eta} \min\{(\eta \overline{\eta})^{-\delta}, 1\}\} \) become production engineers; those in \( \{(\eta, s) : \eta s > \max\{\overline{\eta}s, \hat{\eta}\}\} \) become scientists; and those in \( \{(\eta, s) : \hat{\eta}(\eta \overline{\eta})^{-\delta} < \eta s \leq \overline{\eta}s\} \) become entrepreneurs.

**FIGURE 1: The Signaling Equilibrium**
Figure 1 is a graphical depiction of the equilibrium in \((\eta, s)\) space. Employee skill \(s\) is plotted on the X-axis, and \(\eta\) is plotted on the Y-axis. R1 – R6 represents different regions of equilibriums based on these parameters. The line \(\eta = \eta^*\) describes the point of indifference between an entrepreneur and scientist.\(^5\) The function \(\eta_1(s)\) describes the point of indifference between a production engineer and scientist. Finally, the function \(\eta_2(s)\) describes the point of indifference between a production engineer and entrepreneur. Figure 1 is read as follows: all agents to the left and below both curves \(\eta_1(s)\) and \(\eta_2(s)\) become production engineers; all agents above the line \(\eta = \eta^*\) and to the right of \(\eta_1(s)\) become scientists; and all agents below the line \(\eta = \eta^*\) and to the right of \(\eta_2(s)\) become entrepreneurs. Define a high-skilled agent as one with a skill level above \(\hat{\eta}\). Agents with \(\eta \leq \hat{\eta}\) are referred to as underrated because \(\hat{\eta} < 1\) by Jensen’s inequality; that is, employers undervalue their true worth. Thus regions R1 and R2 represent scientists, R3 and R4 represent production engineers, and R5 and R6 represent entrepreneurs.

The proposition demonstrates that, depending on their realized value of \(\eta\), high-skilled agents may choose any of the three occupations, while low-skilled agents become production engineers or scientists. A low-skilled agent that did not test well, having obtained a test score below \(\hat{t}\), becomes a production engineer, while a low-skilled agent with a test score above \(\hat{t}\) becomes a scientist. A high-skilled agent with \(\eta > \eta^*\) becomes a scientist, while an underrated high-skilled agent becomes a production engineer or entrepreneur. An extremely underrated high-skilled agent, having obtained \(s\eta^{1-\delta} \leq \hat{t}\eta^{-\delta}\), becomes a production engineer. An underrated high-skilled agent that did not perform so poorly, having obtained \(s\eta^{1-\delta} > \hat{t}\eta^{-\delta}\), becomes an entrepreneur. We may think of \(\eta^*\) as an allowable margin of error in the signal to not choose the occupation of entrepreneur. If the distribution \(T\) is truncated such that no realizations of \(\eta\) are below \(\eta^*\), then no agents become entrepreneurs, so the signal must be sufficiently noisy to have a positive mass of entrepreneurs.

IT firms compensate their employees on the basis of verifiable qualifications, which corresponds with the test score in our model (Ang et al., 2002). The higher an individual’s test score, the more productive she is expected to be, so the wage schedule of a scientist is increasing in his test score, according to (7). If a high-skilled agent performed well on the test, then the market, and in particular the large research firm, values highly her (expected) innovative contribution. Hence, if his test score is sufficiently close to his skill level, or exceeds it, then she strictly prefers to become a scientist instead of an entrepreneur since agents are risk averse. A high-skilled agent that performed terribly on the test will get a low wage offer from the large research firm, so she rules out the occupation of scientist. Indeed, if she was unlucky, the wage offer is so low that she is better off as a production engineer in that range become entrepreneurs.

**COROLLARY 1 OF PROPOSITION 3:** Suppose the assumptions stated in Proposition 3 hold. Consider an agent with skill level \(s > \hat{t}\eta^{-1}\). The higher his skill level, the more likely she is to become an entrepreneur and less likely she is to become a production engineer, while the probability that she becomes a scientist remains unchanged and positive (since \(\eta s\) and \(\eta^* s\) both grow). Consider an agent with skill level \(s \leq \hat{t}\eta^{-1}\). The higher his skill level, the more (less) likely she is to become a scientist (production scientist, respectively), while no agents in that range become entrepreneurs.

A direct implication of the corollary is that the average skill of entrepreneurs (averaged over the noise in the signal) exceeds that of scientists, which in turn exceeds that of production engineers, as occurred in the separating equilibrium. Corollary 2 of Proposition 3 describes the sorting process in terms of the test score.

\(^5\) The cutoff \(\hat{\eta}\) should not be confused with the mean of \(\eta\), which we have not explicitly defined.
**COROLLARY 2 OF PROPOSITION 3:** Suppose the assumptions stated in Proposition 3 hold. Consider an agent with test score \( t > \hat{t} \). The higher his test score, the more (less) likely she is to become a scientist (entrepreneur, respectively), while no agents in that range become production engineers. Consider an agent with test score \( t \leq \hat{t} \). The higher his test score, the more (less) likely she is to become an entrepreneur (production engineer, respectively), while no agents in that range become scientists.

This suggests that overall, agents with high skill levels are more likely to become entrepreneurs, while those with high test scores are more likely to become scientists. The cutoff \( \hat{t} \) has numerous interpretations. For example, suppose attaining the test score \( \hat{t} \) is equivalent to having a PhD or other advanced degree, such that individuals with test scores below \( \hat{t} \) do not have an advanced degree. Suppose, the higher an individual’s test score in excess of \( \hat{t} \), the more famous (or reputable) is the graduate program she attended. According to Figure 1, no production engineer has an advanced degree. Some individuals without an advanced degree become entrepreneurs, but they must be highly skilled (specifically having a skill level in excess of \( 1 - \eta \)). Among individuals with an advanced degree, the more reputable is the granting institution, the more likely they are to be hired by a large firm [Corollary 2 of Proposition 3]. However, a select group of highly skilled individuals with advanced degrees become entrepreneurs. They tend to be individuals that attended slightly less reputable institutions, or those that went to top graduate programs, but have exceptionally high skill levels.

**Comparative Statics**

The following corollary predicts the impact changes in \( \eta \) have on the signaling equilibrium when \( \epsilon \) is distributed uniformly. The cutoff \( \eta \) in Proposition 3 solely depends on the fundamental parameters of the model, including the idiosyncratic shock distribution and the coefficient of relative risk aversion.

**COROLLARY 3 OF PROPOSITION 3:** Suppose the assumptions stated in Proposition 3 hold. An increase in \( \eta \) raises the mass of entrepreneurs, while lowering that of scientists and production engineers. If the idiosyncratic shock \( \epsilon \) is distributed uniformly over \([\epsilon_0, 2 - \epsilon_0]\), where \( 0 \leq \epsilon_0 < 1 \), then \( \eta \) rises in response to either of the following: a decrease in the variance of the idiosyncratic shock (i.e. a rise in \( \epsilon_0 \)), or a decrease in the coefficient of relative risk aversion \( \sigma \).

The above corollary establishes that a decrease in the variance of the idiosyncratic shock, such that performing research is less risky, leads to a rise (fall) in the mass of entrepreneurs (scientists, respectively), as does a decrease in risk aversion. When agents are not very risk averse, or the idiosyncratic shock is not highly volatile, the entrepreneurial occupation is not as risky as that of a scientist, so it becomes relatively more attractive if one has a sufficiently high skill level.

It is not possible to predict how the mass of entrepreneurs versus scientists varies with the signal to noise ratio. When the signal becomes less noisy, the large research firm pays its employees an amount that is more highly correlated with their true skill level, which we call the “income effect.” As such, the occupation of scientist becomes more attractive, implying more agents should choose that occupation instead of pursuing a more risky, entrepreneurial venture. Venture capitalists are also endowed with imperfect information, investing in entrepreneurs on the basis of their test score. Hence, as the signal becomes less noisy, venture capitalists invest an amount that is more aligned with an entrepreneur’s true marginal product, which we call the “investment effect.” Whether the investment effect supersedes the income effect depends on the parameters of the model.

**Conclusions**

In this research, we explore the motivation of professionals to self select into different occupational choices in the IT industry. In the context of an occupational choice framework, our approach emphasized the role of two features: researchers face uninsurable idiosyncratic risk, and their ability is private information. In equilibrium with private information, the most able researchers sort into an entrepreneurial, risky occupation, while those of intermediate ability prefer the benefits of full insurance at a large firm. When employers observe a noisy signal of ability, such as test scores, large firms employ individuals with a greater educational attainment, while highly skilled individuals...
who are not able to obtain high test scores choose to become entrepreneurs. We also show that entrepreneurs, on average, have higher skills than scientists. Our results suggest that individuals from reputable institutions are more likely to be hired as scientists; hence entrepreneurs may come from a crop of extremely talented individuals from lower ranked schools. Entrepreneurs can come from top schools as well, but these tend to be the exceptionally bright students. Finally, we show that increased uncertainty and risk in innovation leads to more individuals choosing to become scientists.

Our model examines the phenomenon that industrial leadership positions are often held by people with less prestigious academic achievement and shed light on its possible causes. An implication of our model is that if the innovation technology is deterministic and skills are unobservable, no agents become scientists. Any scientist with a skill level above the average at the large firm would prefer starting up his own venture since, without idiosyncratic risk, insurance is not needed. Therefore, idiosyncratic risk is necessary for a vibrant corporate sponsored research sector to exist. Understanding the motivations of individuals to become entrepreneurs or scientists can benefit managers and policy makers alike. For example, by understanding that test scores and other signals may not represent skills perfectly, employers can complement these with additional measures of employee skills such as pre-employment testing. Moreover, firms should offer some pay-for-performance incentives to attract skilled people who would otherwise become entrepreneurs; however, offering only performance based compensation to scientists is not optimal since this creates the classical 'market for lemons'.

The results of this research need to be understood in view of some limitations. Our model examines occupation choice under different signal types considering heterogeneity in individual ability, ignoring other personality traits that shape an individual’s desire to be an entrepreneur. Moreover, the three tiered employment structure – entrepreneurs, scientists, and production engineers simplifies the actual industry structure where many different kinds on people play different roles. But overall, the paper captures the interaction among the underlying variables such as skills, research productivity, and efficiency of test scores in such a way that the parsimoniousness of the model does not compromise much in terms of the insights gained. Future research can extend our model to consider a multidimensional scenario where individuals differ on more than one dimension such as environment and risk aversion. Future research can also shed additional light on issues raised in the paper. For example, survey based research can uncover whether there are systematic differences between IT professionals whose test scores reflect their true skills, as compared to those whose test score are a noisy indicator of skills.

Appendix

Proof of Lemma 1:

Define \( y(s) \equiv (1 - \alpha)P_A\varepsilon(s)k^{1-\delta} \) as the income of an entrepreneur with skill \( s \), and let \( \lambda \) denote the multiplier associated with the PC. The first-order condition (FOC) with respect to \( \alpha \) is \( E\{\varepsilon(s)u'[y(s)]\} = \lambda\bar{\varepsilon}(\Omega) \), and that with respect to \( k \) is given by

\[
(1 - \alpha)(1 - \delta)P_A\left(\frac{1}{k}\right)^{\delta}E\{\varepsilon(s)u'[y(s)]\} = \lambda\left[1 - (1 - \delta)\alpha P_A\bar{\varepsilon}(\Omega)\left(\frac{1}{k}\right)^{\delta}\right].
\]

Since \( \bar{\varepsilon}(\Omega) \geq 0 \), if the utility function is strictly increasing, we have that \( \varepsilon(s)u' > 0 \), implying the multiplier \( \lambda \) must be positive, such that the PC binds, leading to \( k^{-\delta} = [\alpha P_A\bar{\varepsilon}(\Omega)]^{-1} \). Plugging this into the FOC with respect to \( k \), we obtain

\[
\left(\frac{1 - \alpha}{\alpha}\right)\left(\frac{1 - \delta}{\delta}\right) = \frac{\lambda\bar{\varepsilon}(\Omega)}{E\{\varepsilon(s)u'[y(s)]\}}.
\]

From the FOC with respect to \( \alpha \), the right-hand side of this expression equals unity, implying \( \alpha = 1 - \delta \). Plugging this into the PC, we find

\[
k(\Omega) = [(1 - \delta)P_A\bar{\varepsilon}(\Omega)]^{\delta^{-1}},
\]

yielding the second statement of the lemma.

Proof of Proposition 1:
The utility of a scientist is given by
\[ u[\nu(\Gamma)] - u(d(s)) = u[\delta (1 - \delta)^{\frac{1-\delta}{\delta}} [P_A \bar{\varepsilon}(\Gamma)]^{\delta^{-1}}] - u(d(s)). \]

Using the results \( \alpha = 1 - \delta \) and \( k(S) = x(S) \) for all \( S \subset [0, \infty) \), the expected utility of an entrepreneur with skill \( s \) is given by

\[ E[u(\delta (1 - \delta)^{\frac{1-\delta}{\delta}} [P_A \bar{\varepsilon}(\Omega)]^{\delta^{-1}} \frac{\epsilon(s)}{\bar{\varepsilon}(\Omega)})] - u(d(s)). \]

Suppose agents choose their occupations as hypothesized, such that \( \Gamma = [\hat{s}_{UN}, \bar{s}_{UN}] \) and \( \Omega = [\bar{s}_{UN}, \infty) \).

Applying our chosen functional form \( u(c) = \frac{c^{1-\sigma}}{1-\sigma} \), we find that an agent with skill \( s \) strictly prefers to become an entrepreneur instead of a scientist if and only if

\[ (1 - \sigma)^{-1} E[\epsilon(s)^{1-\sigma}] > (1 - \sigma)^{-1} \frac{\epsilon([\hat{s}_{UN}, \bar{s}_{UN}])^{1-\sigma}}{\bar{\varepsilon}([\hat{s}_{UN}, \bar{s}_{UN}])} \]

By assumption, \( \frac{E[\epsilon(s)^{1-\sigma}]}{1-\sigma} \) is strictly increasing in \( s \), such that the expected utility of an entrepreneur is strictly increasing in skill. Hence, by virtue of (4), all agents with skill levels above the cutoff \( \bar{s}_{UN} \) so-defined strictly prefer to become entrepreneurs instead of scientists.

An agent with skill level \( s \) strictly prefers becoming a scientist instead of a production engineer if and only if

\[ u(\delta (1 - \delta)^{\frac{1-\delta}{\delta}} [P_A \bar{\varepsilon}([\hat{s}_{UN}, \bar{s}_{UN}])]^{\delta^{-1}}] - u(d(s)) \]

By construction, an individual with skill \( \hat{s}_{UN} \) should be indifferent between the occupations of scientist versus production engineer. Applying the functional form \( u(c) = \frac{c^{1-\sigma}}{1-\sigma} \), and setting the utility of a scientist equal to that of a production engineer, we thus obtain (3).

Individuals with skill levels above \( \hat{s}_{UN} \) strictly prefer becoming scientists versus production engineers since the disutility of doing research is decreasing in skill.

**Proof of Proposition 2:**

Let \( \nu(s) \) denote the wage schedule of scientists mapped according to their skill. The firm maximizes the expected profits of each corporate-sponsored venture (CSV), \( \max_{s \geq 0} P_A \bar{\varepsilon}(s) x^{1-\delta} - \nu(s) - x \), leading to

\[ x(s) = [(1 - \delta) P_A \bar{\varepsilon}(s)]^{\delta^{-1}} \]

The wage schedule must be such that no scientist can earn a higher salary at another large firm, yielding \( \nu(s) = \max_{s \geq 0} P_A \bar{\varepsilon}(s) x^{1-\delta} - x \). Equating the marginal cost of hiring a scientist of skill \( s \) with his marginal product, we obtain \( \nu'(s) = P_A \bar{\varepsilon}(s) x(s)^{1-\delta} \). Applying the investment policy, we obtain

\[ \nu'(s) = P_A^{\delta^{-1}} \bar{\varepsilon}'(s) [(1 - \delta) \bar{\varepsilon}'(s)]^{\delta^{-1}}. \]

Integrating this expression from zero to \( s \), and using the fact that \( \nu(0) = 0 \) since \( \bar{\varepsilon}(0) \equiv 0 \), the competitive wage schedule equals \( \nu(s) = \delta (1 - \delta)^{\frac{1-\delta}{\delta}} [P_A \bar{\varepsilon}(s)]^{\delta^{-1}} \).

The objective of an entrepreneur remains unchanged:
\[
\max_{\alpha \in [0,1], k \geq 0} E[u((1-\alpha) P_A \varepsilon(s) k^{1-\delta})] - u(d(s)).
\]

However, the participation constraint (PC) of the venture capitalist must now reflect the fact that she can observe the entrepreneur’s skill, so it becomes \( aP_A \overline{\varepsilon}(s) k^{1-\delta} - k \geq 0 \). The first-order conditions are identical to the previous ones, whereby \( \overline{\varepsilon}(\Omega) \) is replaced by \( \overline{\varepsilon}(s) \). As long as the utility function of an agent is strictly increasing, it follows that the PC still binds, leading to \( \alpha = 1 - \delta \) and \( k(s) = [(1-\delta)P_A \overline{\varepsilon}(s)]^{\delta^{-1}} \), so the large firm and venture capitalists use the same investment policy.

We begin by showing that no agents become entrepreneurs because they strictly prefer the occupation of scientist. An agent with skill \( s \) strictly prefers to become a scientist instead of an entrepreneur if

\[
E[u((1-\alpha) P_A \varepsilon(s) k^{1-\delta})] - u(d(s)) \geq 1 - \delta \quad \text{exceeds}
\]

\[
E[u((1-\alpha) P_A \varepsilon(s) k^{1-\delta})] = u(d(s)).
\]

Using the results \( \alpha = 1 - \delta \) and \( k(s) = [(1-\delta)P_A \overline{\varepsilon}(s)]^{\delta^{-1}} \), the expected utility of an entrepreneur is given by \( E[u((1-\delta) \delta [P_A \overline{\varepsilon}(s)]^{\delta^{-1}} \overline{\varepsilon}(s))] - u(d(s)) \). Because agents are risk averse by hypothesis, we may assume their utility function is strictly concave. By Jensen’s inequality, \( u(E(c)) > E(u(c)) \) for any random variable \( c \), and hence, for all \( s \), we obtain

\[
u((1-\delta) \delta [P_A \overline{\varepsilon}(s)]^{\delta^{-1}} \overline{\varepsilon}(s))] - u(d(s)) > E[u((1-\delta) \delta [P_A \overline{\varepsilon}(s)]^{\delta^{-1}} \overline{\varepsilon}(s))] - E(u(d(s))).
\]

That is, at all skill levels, an agent strictly prefers being a scientist instead of an entrepreneur. This occurs because venture capitalists give entrepreneurs their marginal product (on average) so that risk aversion pushes them to become scientists in large firms.

Now we show that all agents above \( \hat{s} \) become scientists, and all those below become production engineers. An individual with skill \( s \) becomes a scientist instead of a production engineer if

\[
u((1-\delta) \delta [P_A \overline{\varepsilon}(s)]^{\delta^{-1}} \overline{\varepsilon}(s))] - u(d(s)) \geq 1 - \delta \quad \text{exceeds}
\]

\[
u((1-\delta) \delta [P_A \overline{\varepsilon}(s)]^{\delta^{-1}} \overline{\varepsilon}(s))] - u(d(s)) = u(w).
\]

The skill level \( \hat{s} \) at which an individual is indifferent between the two occupations satisfies

\[
u((1-\delta) \delta [P_A \overline{\varepsilon}(\hat{s})]^{\delta^{-1}} \overline{\varepsilon}(\hat{s})]) - u(d(\hat{s})) = u(w).
\]

Under (A2) and (A3), \( \overline{\varepsilon}(s) \) is strictly increasing. Moreover, the function \( d(s) \) is strictly decreasing in skill. Hence, the left-hand side of this expression is strictly increasing in skill, implying \( \hat{s} \) is uniquely determined, and all agents with skill levels above \( \hat{s} \) become scientists.

**Proof of the Corollary of Proposition 2:**

Equating (3) and (5), we have

\[
[\delta(1-\delta)^{(1-\delta)^{-1}} [P_A \overline{\varepsilon}(\hat{s}_{UN}, \overline{\varepsilon}_{UN})]]^{1-\sigma} - d(\hat{s}_{UN})^{1-\sigma} = [\delta(1-\delta)^{(1-\delta)^{-1}} [P_A \overline{\varepsilon}(\hat{s})]]^{1-\sigma} - d(\hat{s})^{1-\sigma}
\]

We begin by proving that \( \hat{s} > \hat{s}_{UN} \). Suppose not, such that \( \hat{s} < \hat{s}_{UN} \), implying \( F(\hat{s}) < F(\hat{s}_{UN}) \) under (A3) and \( d(\hat{s}) > d(\hat{s}_{UN}) \). According to the above expression, we thus must have that \( \overline{\varepsilon}(\hat{s}_{UN}, \overline{\varepsilon}_{UN}) < \overline{\varepsilon}(\hat{s}) \). Because \( \hat{s} < \hat{s}_{UN} \) and the expected idiosyncratic shock is strictly increasing in skill under (A2), this is a contradiction. We
now prove that $\overline{s}_{UN} > \hat{s}$. Suppose not. Since we established that $\hat{s} > \hat{s}_{UN}$, we have $F(\hat{s}) > F(\hat{s}_{UN})$ and $d(\hat{s}) < d(\hat{s}_{UN})$, leading to $\overline{E}(\{\hat{s}_{UN}, \overline{s}_{UN}\}) > \overline{E}(\hat{s})$. By hypothesis $\overline{s}_{UN} < \hat{s}$, which is a contradiction.

**Proof of Proposition 3:**

Since the specified utility function is strictly increasing, an agent with test score $t$ strictly prefers becoming a scientist instead of a production engineer if and only if $v(t) = \delta(1-\delta) \frac{1-\delta}{\delta} [P_A \overline{E}(t)]^{\delta-1}$ exceeds $w$. Given the definition (9), it follows that all agents with test scores above $\hat{t}$ strictly prefer becoming a scientist instead of a production engineer.

Consider an agent with test score $t$ and skill $s$ who is considering becoming an entrepreneur instead of a scientist. The utility of a scientist with test score $t$ is given by $u[v(t)] = u[\delta(1-\delta) \frac{1-\delta}{\delta} [P_A \overline{E}(t)]^{\delta-1}]$. Using the results $\alpha = 1-\delta$ and $k(t) = x(t) = [(1-\delta)P_A \overline{E}(t)]^{\delta-1}$, the expected utility of an entrepreneur with test score $t$ and skill $s$ is given by $E[u[\tilde{\delta}(1-\delta) \frac{1-\delta}{\delta} [P_A \tilde{E}(t)]^{\delta-1} \frac{E(s)}{\tilde{E}(t)}]]$. Setting $u(c) = \frac{c^{1-\sigma}}{1-\sigma}$, the expected utility of an entrepreneur exceeds the utility of a scientist when $(1-\sigma)^{-1} E[\varepsilon(s)^{1-\sigma}] > (1-\sigma)^{-1} \tilde{E}(t)^{1-\sigma}$. Using the fact that $\varepsilon(s) = \varepsilon^\delta$ and $t = \eta s$, the inequality becomes $(1-\sigma)^{-1} E[\varepsilon^{1-\sigma}] > (1-\sigma)^{-1} \tilde{E}^{1-\sigma} \eta^{\delta(1-\sigma)}$. It follows that all agents with test scores below $\tilde{\eta}s$, where $\tilde{\eta}$ is defined by (8), strictly prefer becoming an entrepreneur instead of a scientist.

Now consider an agent with test score $t$ and skill $s$ who is considering becoming an entrepreneur instead of a production engineer. The utility of a production engineer is simply $u(w)$. According to the definition of $\hat{t}$, this is equal to $u[v(\hat{t})] = u[\delta(1-\delta) \frac{1-\delta}{\delta} [P_A \overline{E}(\hat{t})]^{\delta-1}]$. Comparing the expected utility of an entrepreneur with the utility of a production engineer, we find that the former exceeds the latter if and only if $(1-\sigma)^{-1} \tilde{E}(t)^{(1-\sigma)(1-\delta)-1} E[\varepsilon(s)^{1-\sigma}] > (1-\sigma)^{-1} \tilde{E}(\hat{t})^{(1-\sigma)\delta-1}$, after having applied $u(c) = \frac{c^{1-\sigma}}{1-\sigma}$. Using $\varepsilon(s) = \varepsilon^\delta$ and $t = \eta s$, the inequality becomes $s \eta^{1-\delta} > \hat{t} \tilde{\eta}^{-\delta}$. This inequality must hold irrespective of whether $\sigma < 1$ or $\sigma > 1$.

Define $\eta_1(s) = \hat{t}^s$ and $\eta_2(s) = \left[\frac{\hat{t}}{s \tilde{\eta}}\right]^{(1-\delta)-1}$. From Jensen’s inequality, according to (8), we have that $\tilde{\eta} < 1$; moreover, by assumption, $0 < \delta < 1$. Hence, $\eta_2(s) > \eta_1(s)$ for all $s < \hat{t} \tilde{\eta}^{-1}$; similarly, $\eta_2(s) < \eta_1(s)$ for all $s > \hat{t} \tilde{\eta}^{-1}$, and the two functions are equal at $\hat{t} \tilde{\eta}^{-1}$. An agent’s occupation in $(\eta, s)$ space is thus as shown graphically in Figure 1.

**Proof of Corollary 1 of Proposition 3:**

Let $PW$ denote the occupation of production engineer, $S$ that of scientist, and $E$ that of entrepreneur. Define $P_s(j)$ as the probability that an agent with skill $s$ chooses occupation $j$, for $j = PW, S, E$. Define the functions $\eta_1(s) = \hat{t}^s$ and $\eta_2(s) = \left[\frac{\hat{t}}{s \tilde{\eta}}\right]^{(1-\delta)-1}$, and note that they are both strictly decreasing in skill $s$. Then
Proposition 4 implies the following: for \( s > \hat{t}\bar{\eta}^{-1} \), we have \( P_s(PW) = T(\eta_2(s)) \), \( P_s(S) = 1 - T(\bar{\eta}) \), and \( P_s(E) = T(\bar{\eta}) - T(\eta_2(s)) \); otherwise, we have \( P_s(PW) = T(\eta_1(s)) \), \( P_s(S) = 1 - T(\eta_1(s)) \), and \( P_s(E) = 0 \). Since \( T \) is strictly increasing, it follows that \( P_s(PW) \) is strictly decreasing in \( s \) over the entire skill range \([0, \infty)\); \( P_s(E) \) is strictly increasing for \( s > \hat{t}\bar{\eta}^{-1} \); and \( P_s(S) \) is constant with respect to \( s \) for \( s > \hat{t}\bar{\eta}^{-1} \), and strictly increasing otherwise.

**Proof of Corollary 2 of Proposition 3:**

Define the function \( \eta(s) = ts^{-1} \), which graphically is identical to the curve \( \eta_1(s) = \hat{t}s^{-1} \) depicted in Figure 1. Consider the set of agents that obtained the test score \( t \). The occupation they choose depends on where they lie along the curve \( \eta(s) = ts^{-1} \). Suppose we increase the test score \( t \). This causes the curve \( \eta(s) = ts^{-1} \) to shift to the right and upward. No agents with test scores below \( \hat{t} \) become scientists, and no agents with test scores above \( \hat{t} \) become production engineers.

**Proof of Corollary 3 of Proposition 3:**

Consider the first statement. Inspecting Figure 1, we find that a rise in \( \bar{\eta} \) has two effects: it raises the line \( \eta = \bar{\eta} \) and shifts the curve \( \eta_2(s) = \left[ \frac{\hat{t}}{s\bar{\eta}} \right]^{(1-\sigma)^{-1}} \) to the left. The first effect (in isolation) causes the mass of entrepreneurs to rise and that of scientists to fall, while holding constant the mass of production engineers. The second effect (in isolation) causes the mass of entrepreneurs to rise and that of production engineers to fall, while holding constant the mass of scientists. Consider the second statement. If \( \varepsilon \) is distributed uniformly over \([\varepsilon_0, 2-\varepsilon_0]\), we have \( \bar{\eta} = \left[ \frac{(2-\varepsilon_0)^2-\varepsilon^2-\sigma}{2(1-\varepsilon_0)(2-\sigma)} \right]^{[\delta(1-\sigma)]^{-1}} \). Holding \( 0 \leq \varepsilon_0 < 1 \) constant, \( \bar{\eta} \) is strictly decreasing in \( \sigma \) over \([0,2]\) (ignoring the limiting case \( \sigma = 1 \)). Beyond that range, the solution is imaginary. Holding \( 0 \leq \sigma < 2 \) constant, \( \bar{\eta} \) is strictly increasing in \( \varepsilon_0 \) over the entire open unit interval. Hence, as the variance of the idiosyncratic shock falls (\( \varepsilon_0 \) rises), or an agent becomes less risk averse (\( \sigma \) falls), the cutoff \( \bar{\eta} \) rises, as claimed.

**References**


