The Benefit of the Start-Up Handicap†

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Abstract: Why do prestigious companies choose to fund new product development by venture capital instead of doing so in their own Research & Development Laboratories? In this note, we consider the launching of a start-up to be associated with "waste". The inventor has to deal with much of the bureaucratic proceedings himself to get the start-up off the ground, and such dealing with bureaucracy and paperwork is wasteful (a "handicap"). One reason might be asymmetric information of the quality of the inventor. Only the most productive of the inventors are able to lead start-up ventures, and overcome the problems associated with getting a new venture off the ground. We characterize the conditions for a unique separating contract (among the different contracts that a financing company could offer), such that the high type inventor launches a start-up company and the low type scientist remains in in-house development.

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1. Introduction

In 2003, in the United States, corporate venture capital invested \$1.2 billion dollars, or 6% of total venture capital funds. The issue that we want to tackle in our paper is: Why do prestigious companies choose to fund new product development by venture capital instead of doing so in their own Research & Development Laboratories? The question seems relevant, because prestigious firms in the United States have or have had venerable R&D labs that throughout their history have developed widely successful products. Researchers in such corporations receive most of their compensation as a base salary, while inventors developing a new venture are mostly compensated with profit and ownership sharing.

One reason for corporations to fund start-ups might be that only the most productive of the inventors are able to lead start-up ventures, and overcome the problems associated with getting a new venture off the ground. In our model an inventor has a project in mind, but is financially constrained. He approaches a company for possible project funding. The inventor can be one of two possible types: one that yields a high expected return (who is the high type), or a lower expected return (which we call the low type). He knows his own type, but the financing company does not. [As explained in the next section, the financing company cannot offer a contract depending on the realization of the project.] The company has a choice of hiring the inventor in its own lab, or it can finance a start-up company for the inventor. In the first case, the inventor has all the resources available to him that the company provides (infrastructure, legal support, etc.), and is paid a fixed wage. In the start-up case, the inventor gets a share in the enterprise. The inventor has to deal with the bureaucratic proceedings himself to get the start-up off the ground. Such dealing with bureaucracy and paperwork is wasteful, and we model this as a parameter that reduces the expected value of the project for each type.

We characterize the condition for a unique separating contract (among the different contracts that the company could offer), such that the high type inventor launches a start-up company and the low type scientist remains in in-house development.

Our title is inspired in Zahavi's (1975) work on mate selection. He argued that a handicap on a certain sex (for instance, very big antlers of a deer or excessive tail plumage of a peacock) serves as advertising of its quality as a mate. In our case, the handicap is bureaucratic waste that a start-up has to face, which only a high type inventor is able to overcome.[1]

There is, of course, a sizeable literature on related work, in particular on the decision to "make or buy", franchising and spin-offs. An early seminal paper is the signaling model by Leland and Pyle (1977). More recently, Ambec and Poitevin (2001) also examine the case of a firm that considers financing a project internally or externally. However, they do not consider the waste associated with getting a start-up off the ground (which is the handicap in our case). For papers that deal with financing of projects under perfect and symmetric information, see Aghion and Tirole (1994) and Hellmann (1998).

The next section introduces the model. Section 3 presents the results. The appendix contains several of the proofs.

2. The Model

Consider the case of a risk-neutral inventor, who has a project in mind, but is financially constrained. The inventor approaches a (risk-neutral) company for project funding. The cost of funding the project is a fixed amount K. The inventor

[1] We are aware that Zahavi (1975) is a signaling model; surveying the vast signalling and screening literature is beyond the scope of this paper.

can be one of two types: one that yields an expected return $E(H)$ (which we will call type H), and the other that has an expected return of $E(L) < E(H)$, (which we will call type L); these types have probability μ and $1 - \mu$, respectively. The firm does not know the type of the inventor; however, the inventor knows his own type.

The firm cannot offer a contract depending on the realization of the project. For example, the low type inventor may have a high return in his possible states of nature (with lower probability, though). In the event of a realization of such a high return, the low type may ask for the compensation equal to the high type (a state of nature that is realized with high probability if the type is high); the firm would like to avoid such a situation, given that it takes the risk of failure and lose K (in other words, the firm cannot recover the amount K from the inventor).

The firm has two possibilities: it can hire the inventor as a scientist in its own lab or it can finance a start-up. In the first case, the inventor has all the resources available to him that the firm provides: a laboratory, physical and administrative infrastructure, legal support, etc. The scientist is paid a wage w, which is independent of the project profit.[2]

On the other hand, the financier may provide financing for a start-up company led by the inventor. The inventor gets a share $1 - \beta$ of the enterprise and the firm obtains the rest β. In this case, the inventor does not have access to the infrastructure provided by the firm, and has to deal with much of the bureaucratic proceedings himself. Running a company in the Research & Development stage reduces the productivity of the R&D. We model this waste as a parameter $\alpha \in (0, 1)$ that reduces the expected value of the project for each type.

Before we proceed, we will make two (relatively innocuous) assumptions:

[2] In reality, of course, we see employees of a company getting stocks and stock options as part of their compensation. However, for simplicity, we will ignore it.

Assumption A1. The labor market is competitive. Thus, the inventor gets his expected productivity (either as expected salary or as expected profit) that the firm assigns to him.

Assumption A2. The expected return for the low type is higher than the cost of the project, i.e., $E(L) > K$. In other words, there is always a market for the project, even for the low type.

Consider the following four possible arrangements:

i) the firm offers a wage w and share $1-\beta$ in project profits such that the high type launches a start-up and the low type remains in-house.

ii) the firm offers a wage w and share $1-\beta$ in project profits such that the high type remains at in-house development and the low type in a start-up.

iii) the firm offers the inventor a pooling contract for in-house development.

iv) the firm proposes a pooling contract to finance a start-up.

3. Results

Separating contract I: The firm offers a separating contract such that the high type inventor launches the start-up (and keeps[3] $1-\beta_s^H$ of the profits) and the low type scientist remains in-house at a salary w_s^L. As a consequence of assumption A1, this means that:

$$E(L) - K - w_s^L = 0 \tag{1}$$

$$\beta_s^H \alpha E(H) - K = 0 \tag{2}$$

Such an arrangement is an equilibruim if neither type is willing to deviate. That is:

$$w_s^L \geq (1-\beta_s^H)\alpha E(L) \tag{3}$$

[3] We will adopt the following notation convention for the share β and the salary w : the superscripts $\{H, L\}$ will denote the type and the subscripts $\{p, s\}$ denote the contract (pooling, separating).

$$(1-\beta_s^H)\alpha E(H) \geq w_s^L \tag{4}$$

Condition (3) is the incentive compatibility constraint (ICC) for the low type; that is, the low type inventor should get a salary at least as high as the profit he would get from the start-up pretending to be a high type. Condition (4) is the ICC for the high type; the profit that the high type gets from the venture is at least as high as the salary of the low type inventor.

With this, we can establish the following lemma:

Lemma 1. If $\frac{E(L)}{E(H)} < \alpha < 1 - K\left[\frac{E(H)-E(L)}{E(L)E(H)}\right]$, there is a separating equilibrium I.

Proof: See appendix.

Separating contract II: The firm offers a contract such that the low type inventor launches a start-up (and gets a share $1-\beta_s^L$) and the high type scientist remains in-house at a salary w_s^H. By A1, this means that the firm has zero profits.

$$E(H) - K - w_s^H = 0 \tag{5}$$

$$\beta_s^L \alpha E(L) - K = 0 \tag{6}$$

Such a settlement is an equilibrium if the ICCs are:

$$w_s^H \geq (1-\beta_s^L)\alpha E(H) \tag{7}$$

$$(1-\beta_s^L)\alpha E(L) \geq w_s^H \tag{8}$$

Inequality (7) means that the high type inventor should get a salary at least as high as the profit he would get from the start-up pretending to be a low type. Condition (8) the profit that the low type gets from the venture is at least as high as the salary of the high type inventor.

Lemma 2. A separating equilibrium II cannot exist.

Proof: Immediate from (7), (8) and $E(H) > E(L)$. QED

The low type inventor will not sacrifice from his productivity the fraction $1-\alpha$ to prove that he is low type. Only the high type does this (see Lemma 1).

Pooling contract I - In-house development: The firm employs the inventor at one wage, no matter his type. By assumption A1:

$$\mu E(H) + (1-\mu)E(L) - K = w_p \tag{9}$$

To break this pooling equilibrium one needs to show that there exists a share β_p^H such that:

$$\beta_p^H \alpha E(H) - K > 0 \tag{10}$$

$$(1-\beta_p^H)\alpha E(H) > w_p \tag{11}$$

Condition (10) is the profit from the start-up venture that the firm keeps, after paying cost K. Such profit has to be greater than zero. Condition (11) is that the share of the profit that goes to the (high type) inventor has to be greater than the wage he gets in the pooling contract (note that the wage w_p does not have a superscript because it is a pooling wage).

Lemma 3. If $\frac{\mu E(H)+(1-\mu)E(L)}{E(H)} < \alpha$, an in-house pooling equilibrium cannot exist.

Proof: See appendix.

Pooling contract II - Financing a start-up: The financing company could offer a share β_p such that by A1:

$$\beta_p \left[\mu\alpha E(H) + (1-\mu)\alpha E(L)\right] - K = 0 \tag{12}$$

To break this possible pooling contract there should exist w_p^L such that:

$$E(L) - K - w_p^L > 0 \tag{13}$$

$$w_p^L > (1 - \beta_p)\alpha E(L) \tag{14}$$

Inequality (13) says that the financing company makes a positive profit from hiring the (low type) inventor to develop the project internally. Condition (14) asserts the fact that working in-house and getting paid a salary[4] w_p^L is higher than sharing in the profit of the (pooling contract) start-up company.

Lemma 4. If $\alpha < 1 - K \left[\frac{1}{E(L)} - \frac{1}{\mu E(H) + (1-\mu)E(L)} \right]$, then a start-up pooling equilibrium cannot exist.

Proof: See appendix.

After this lemmata, we can present our main result.

Proposition 1. If $\frac{\mu E(H) + (1-\mu)E(L)}{E(L)} < \alpha < 1 - K \left[\frac{E(H) - E(L)}{E(H) \cdot E(L)} \right]$, then the separating equilibrium I is the unique outcome of this game.

Proof:

In Lemma 1 we showed that a separating equilibrium exits. From all of the lemmas, we have three possible outcomes on the parameter α :

i) $\frac{E(L)}{E(H)} < \alpha < 1 - K \left[\frac{E(H) - E(L)}{E(L) \cdot E(H)} \right]$,
ii) $\frac{\xi}{E(H)} < \alpha$, where $\xi = \mu E(H) + (1-\mu)E(L)$,
iii) $\alpha < 1 - K \left[\frac{\xi - E(L)}{\xi \cdot E(L)} \right]$.

Since $E(L) < \xi$, we know that a lower bound for α is $\frac{\xi}{E(H)}$. Furthermore, it is easy to check that $1 - K \left[\frac{\xi - E(L)}{\xi \cdot E(L)} \right] > 1 - K \left[\frac{E(H) - E(L)}{E(L) \cdot E(H)} \right]$. Thus, if α is such that:

$$\frac{\xi}{E(H)} < \alpha < 1 - K \left(\frac{1}{E(L)} - \frac{1}{E(H)} \right), \tag{15}$$

[4] In this case it is the low type L who deviates.

the separating equilibrium I is unique (as (15) is the condition of the proposition).

QED

Consider the left-hand side inequality in expression (15). If the probability of the high type μ is small, and the return $E(H)$ is high compared to $E(L)$, then $\frac{\mu E(H)+(1-\mu)E(L)}{E(H)}$ is small. In consequence, the lower limit becomes small. The right-hand side inequality in (15) is in fact a more restrictive constraint. By A2, $E(L) > K$. However, if $E(L)$ is fairly close to K, by equation (1), the salary of the low type inventor is very small. Granting, at the same time, that $E(H)$ is very high, by equation (2), β_s^H has to be small, which means that the inventor is able to reap most of the profits of the project. By equation (3), α has to be small. But this makes the right-most expression in (15) very small, which, in turn, reduces the range for α. However, if $E(L)$ is significantly bigger than K, then the right hand side of (15) is not so restrictive.

A situation where the range for α is relatively big could be likely be true in the high-tech industry; for example, in software development. The percentage of gifted software programmers is low, and the expected returns of such programmers very high. On the other hand, the low type programmers get a decent salary in software companies. Thus, we see many more start-up companies in the software industry, even though setting up a company (at least in its R&D initial stages) entails bureaucratic and paperwork costs.

References

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Appendix

Proof of Lemma 1:

By (2) we obtain $\beta_s^H = \frac{K}{\alpha E(H)}$. By (1), $E(L) - K = w_s^L$; replacing this into (3), and some algebra:

$$\alpha \leq 1 - K \left(\frac{E(H) - E(L)}{E(L)E(H)} \right).$$

From inequality (4) of separation, we have that:

$$\left(1 - \frac{K}{\alpha E(H)} \right) \alpha E(H) \geq E(L) - K \quad \Rightarrow \alpha \geq \frac{E(L)}{E(H)}.$$

In this last inequality we know that the right hand side is strictly less than one. Thus, we have a separating equilibrium if:

$$\frac{E(L)}{E(H)} < \alpha < 1 - K \left(\frac{E(H) - E(L)}{E(L)E(H)} \right).$$

The set of possible αs is not empty if:

$$\frac{E(L)}{E(H)} < 1 - K \left(\frac{E(H) - E(L)}{E(L)E(H)} \right).$$

Algebra shows that the inequality hold iff $E(L) > K$, which is A2. QED

Proof of Lemma 3:

Recall inequality (11). To break the in-house pooling equilibrium, we must have that:

$$\left(1-\beta_p^H\right)\alpha E(H) > w_p \quad \Rightarrow \quad 1-\frac{w_p}{\alpha E(H)} > \beta_p^H.$$

The second condition (inequality (10)) to break the pooling is that:

$$\beta_p^H \alpha E(H) - K > 0 \quad \Rightarrow \quad \beta_p^H > \frac{K}{\alpha E(H)}.$$

In other words, the share β_p^H has be in the following interval:

$$\frac{K}{\alpha E(H)} < \beta_p^H < 1-\frac{w_p}{\alpha E(H)}.$$

When is $\frac{K}{\alpha E(H)} < 1-\frac{w_p}{\alpha E(H)}$? Using (9), we obtain that the condition for breaking the in-house pooling contract is that (recall that $\xi = \mu E(H) + (1-\mu)E(L)$) :

$$\alpha > \frac{\xi}{E(H)}.$$

QED

Proof of Lemma 4:

Putting together conditions (13) and (14), we know that:

$$(1-\beta_p)\,\alpha E(L) < w_p^L < E(L) - K$$

Recall that the pooling contract establishes that:

$$\mu\beta_p\alpha E(H) + (1-\mu)\beta_p\alpha E(L) - K = 0$$

Solving for $1-\beta_p$ we obtain:

$$1-\beta_p = \frac{\alpha\xi - K}{\alpha\xi}.$$

Using this expression above:

$$[\alpha\xi - K]\,\frac{E(L)}{\xi} < w_p^L < E(L) - K.$$

Thus, what remains to be shown is, that it is in fact possible that

$$[\alpha\xi - K]\,\frac{E(L)}{\xi} < E(L) - K \quad \Rightarrow \alpha < 1 - K\left(\frac{\xi - E(L)}{\xi \cdot E(L)}\right).$$

QED