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THE QUALITY OF ENTREPRENEURS*

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What determines the quality of entrepreneurs? The article proposes a model of the interaction between individual workers' decision to become entrepreneurs and employers' efforts to keep their best workers and ideas. The main prediction from the model is that larger firms produce entrepreneurs of higher quality than smaller firms. Using novel and unique Norwegian data, I find that previous employer size exerts a significant influence on entrepreneurial performance. For example, increasing previous employer size from the 25 percentile to the 75 percentile increases yearly profitability on assets by 6 percentage points.

Due to their role in fostering employment opportunities and growth, entrepreneurs are viewed as essential to long-run economic performance. For example, the US emphasis on the role of the entrepreneur has been viewed as a main reason for why the US outperformed Europe in the twentieth century. In spite of the economic importance attached to entrepreneurs, we have remarkably little systematic knowledge about them. In particular, we know almost nothing about who become successful entrepreneurs. This question is the focus of the article.

My starting point is broad empirical evidence suggesting that founders of new firms tend to be experienced workers who pursue opportunities closely related to their previous employment. Cooper (1985) finds that 70% of the founders of new firms in a broad cross-section of US industries were previously employed in the same industry, and Bhide (2000) reports that 71% of the entrepreneurs in his sample of fast-growing companies '[...] replicated or modified an idea encountered through previous employment'. Klepper and Thompson (2005) summarise studies from the automobile, laser, disc drive and semiconductor industries and find that about 20% of entrants in these industries have their basis in established firms from the same industry. This evidence suggests that entrepreneurs do not come from out of the blue but build their human intellectual capital through work experience in established firms.

Established firms can be expected to respond actively to the possibility of key workers leaving, by offering contingency wages or job security, by including no-compete clauses in the employment contract, or even by suing leaving workers. Still, there are limitations to these measures; the employer might lack good information about the productivity of individual employees, no-compete clauses must be of limited scope to be legally binding (Posner and Triantis, 2001; Stone, 2002), and even for established innovations, the effective protection of patents is variable (Cohen *et al*., 2000).

These observations suggest that a theory of the quality of entrepreneurs should address the interaction between workers' entrepreneurship decisions and firms' effort to protect their intellectual property. I suggest such a theory. In the model, a principal

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(owner) hires a worker (specialist) to engage in a project. The output of this project is an idea of uncertain quality *ex ante*, with imperfect property rights attached to it, meaning that the firm to a limited extent can use sticks to keep the worker from leaving to capture (a fraction of) the value of the idea for himself. Instead, the firm must use an attractive continuation wage as a carrot. I consider two different possible firm organisations, 'small' and 'large'. The main assumption made is that a large firm is from a technical perspective more efficient, in that it can exploit returns to scale due to, for example, worker specialisation, but also less informed about the progress and content of the projects the workers are engaged in than in a small firm.

It is a commonplace to state that the reason that a firm with superior technology does not grow infinitely large (or supply the entire market) is because of limited 'span of control' by the manager but it is rarely stated exactly how this limited span of control will decrease firm productivity as size grows large. Here the idea is that reduced monitoring ability will lead to the departure of the employees with the best projects, because these projects cannot be recognised.

The main insights from the model can be summarised as follows. Small firms can implement a wage policy that is fine-tuned to workers' outside option and workers leave a small firm to become entrepreneurs only to the extent that their private benefits, such as more flexible work hours or a sense of freedom and pride, from doing so are sufficiently high.[1] On the other hand, large firms have a more rigid wage policy and as a consequence lose the best workers and ideas. Entrepreneurs emerging from large firms will therefore have higher quality than entrepreneurs emerging from small firms. Second, recall that the downside from being large is that the principal obtains inferior information about the value of individual employees (or projects). When property rights protection is weak, the value of information is high, since the worker leaving with the idea is more of a threat, and being small becomes more beneficial. On the other hand, when property rights protection is strong, the value of information is low, since the worker leaving is not a serious threat, and the principal can focus on technical efficiency and commercialisation potential. Thus improved property rights make a larger firm more likely to be optimal and hence increases the quality of entrepreneurs.

In Section 6, I use novel and unique data from Norway to assess the empirical validity of the main hypothesis obtained from the theoretical part, that the quality of entrepreneurs increases in the size of the previous employer.[2] I obtain results that are consistent with previous employer size exerting a noticeable influence on entrepreneurial performance. For example, increasing previous employer size from the 25 percentile to the 75 percentile increases yearly profitability on assets by 6 percentage points.

[1] To let private benefits play a serious role in determining the entrepreneurship decision could sound overly *ad hoc*. Emphasising private benefits for entrepreneurs goes back at least to John Stuart Mill and Alfred Marshall: 'Concerning the entrepreneur [J. S. Mill] was explicit when he stated that small producers often value so highly the feeling of being their own masters that they consume their small capital in an unsuccessful struggle for independence; "they either sink into the condition of hired labourers, or become dependent upon others for support".' (Evans, 1949, p. 339). And Marshall wrote that '"Organizers of improved methods and appliances are stimulated by a noble emulation more than by any love of wealth for its own sake," and the entrepreneur "often holds his own great tenacity even under considerable disadvantages; for the freedom and dignity of his position are very attractive to him."' (Evans, 1949, p. 339).

[2] As discussed in the working paper version of the article, Hvide (2005), the available evidence supports the notion that firm size increases in property rights protection.

1. Related Literature

The main novelty of the article is to ask what determines the quality of entrepreneurs, a question I am not aware has been addressed head-on by established work.

On the background of entrepreneurs, in a typical economic theory of business start-ups, the defining feature of the entrepreneur – a business idea of some novelty – is simply assumed to exist (Kihlstrom and Laffont, 1979; Evans and Jovanovic, 1989; Rajan and Zingales, 1998, 2001; Landier, 2001). The process in which the entrepreneur obtains these ideas and his human capital is usually ignored.[3] Lazear (2005) models and finds empirical support for the idea that entrepreneurs are jacks-of-all-trades rather than specialists. Lazear (2005) does not focus on the transition to entrepreneurship (nor is explaining entrepreneurial quality his focus). Hellmann (2007) and Subramanian (2005) consider the multi-tasking problem that ensues if a worker can engage in 'private activities' on the job with the intention of creating a start-up later. Hellmann (2007) shows that entrepreneurship may come about through the firm committing not to reward such private activities (it could be *ex post* efficient to support them). Subramanian (2005) finds that the level of private activities inside the firm should be positively correlated with pay-for-performance contracts. In contrast to these papers, I assume that the principal can stop the worker from engaging in private activities but cannot stop the worker from leaving with ideas that are generated through his legitimate work.[4] Finally, Klepper and Thompson (2005) model a situation where an employee gets frustrated and leaves a firm if his opinion about the firm's best course of action disagrees too much with the prevailing opinion. Their model predicts a non-monotonic relation between the size of the employer and the quality of the start-up.

Since the article focuses on the interaction between entrepreneurship and the organisation of established firms, there is a related literature within Organisational Economics. Aghion and Tirole (1994) consider the management of innovations in a setting based on Grossman and Hart (1986). In their setting, there is no entrepreneurship in equilibrium due to ownership rights being fully contractible.[5] In the same tradition, but with imperfect property rights, Rajan and Zingales (2001) considers the optimal choice of organisation for a firm with an exogenously given 'critical resource' controlled by an owner. In my setting, the employee has informal control in that only he has the knowledge and human capital necessary for the innovation. Moreover, there

[3] Shane (2000) argues that this also holds for the Psychology and Management literatures on entrepreneurship.

[4] Hvide and Kristiansen (2006) builds on the current model's large firm case to analyse a moral hazard setting where the employer can litigate the worker if the latter leaves with an idea. That paper focuses on the interaction between the firm's suing decision and the potential entrepreneur's exertion of effort. Some other literature, Dunn and Holtz-Eakin (2000), among others, suggests that self-employed build their human capital through learning spillovers from their parents. Several papers, Evans and Jovanovic (1989), Evans and Leighton (1989) and Holtz-Eakin *et al.* (1994*a,b*) find evidence that financial constraints affect whether an individual becomes an entrepreneur. Gentry and Hubbard (2002) investigate the macro-level implications of the relation between savings and investments made by entrepreneurs. De Meza and Southey (1996), Amador and Landier (2003) and Landier and Thesmar (2009) study the role of entrepreneurial overconfidence, while Bates (1990) studies the link between education and entrepreneurship.

[5] Anton and Yao (1994) consider the effects of weak property rights in a market for ideas. Anton and Yao (1995) build on Anton and Yao (1994) to study whether an idea generated inside a firm leads to creation of one or two ventures. This question is eliminated in the current setting by assuming that the participation of the employee is essential to develop the idea.

is no start-up activity by workers in equilibrium in Rajan and Zingales (2001), due to information being complete. It is interesting to note, however, that both frameworks obtain the prediction that optimal firm size increases in the strength of property rights. Pakes and Nitzan (1983) were the first to consider the problems that arise where agents can appropriate part of their output. In their setting, there are no property rights and the principal is fully informed about the value of individual workers and therefore only efficient separations will occur, if any.

The idea that supervisors in larger firms have inferior information about projects than supervisors in small firms goes back to work by Simon (1973), who emphasised that as firm size grows, managerial attention becomes a scarce resource. A version of this idea was later used by Williamson (1981) and by Rosen (1982). These papers do not consider the implications of limited managerial resources for the design of compensation contracts, nor for turnover.

On the empirical side, previous work on entrepreneurial performance has focused on the effect of liquidity constraints and, in particular, whether more wealthy individuals do better as entrepreneurs. Evans and Jovanovic (1989) find that a doubling of founder wealth is associated with a 14% increase in self-employed earnings (Table 3, p. 820) but they do not control for investment level nor for the fact that wealthier founders tend to have higher effective human capital.[6] As shown by Hvide and Møen (2007), who use the same dataset as in the present article, lack of such controls can lead to seriously upward biased estimates of the effect of wealth on performance.

2. The Framework

A principal (owner) identifies a research area and hires a worker (specialist) at time 0 to generate ideas in that area. I shall assume that the firm has only this project and that the worker is hired from a homogeneous pool of risk neutral agents with reservation utility $\bar{U} = 0$. As explained later, the latter assumption means that I can safely assume that the worker waives any formal ownership rights for future output.

Upon signing the contract, the agent is paid a fixed wage F and supplies one unit of effort. Inelastic effort supply is meant to capture a situation where it is easier to monitor the input of the agent in terms of time spent and effort exerted than assessing his output. At time 1, he produces an idea with value x, where x is stochastic and non-negative (a bad idea can be viewed as no idea, i.e., $x = 0$). By the complex and often fuzzy nature of early stage innovations, x is assumed to be non-contractible (contracts are not enforceable by courts due to verifiability problems). The distribution of x follows $G(x)$ with density $g(x)$ and support on [0,1]. For convenience, it is assumed that $G(\cdot)$ is twice differentiable and with $g(1) = 0$. Although x is referred to as the quality of an idea produced by the agent, one can also think of x as the value of the worker's human capital if employed by the firm after time 1.

[6] Holtz-Eakin *et al.* (1994*a*) use data on the tax receipts of a sample of entrepreneurs that had received inheritances from large estates and find that a $150,000 inheritance increase will increase the survival probability by 1.3 percentage points and, if the enterprise survives, its receipts by almost 20%. That paper suffers from a similar problem to Evans and Jovanovic (1989) in that the positive relation between liquidity and receipts could just reflect that founders that receive a large inheritance are more likely to invest in the enterprise and thus be more highly capitalised.

I assume that x is known to the worker upon its realisation at time 1, while the principal receives a signal $s \in S$ about x. The precision of the signal is inversely related to the firm size in a particularly simple manner; in a small firm $s = x$ and in a large firm s is uninformative. This main assumption is discussed in more detail in Section 3.2. Conditional upon s, the firm makes a continuation wage offer B to the agent. Whether the firm can commit to a continuation wage schedule $B(s)$ at time 0 or not is immaterial to the analysis, as long as $\bar{U} = 0$, but I shall speak as if commitments were not possible.[7] Agents are protected by limited liability so that both F and B must be non-negative.

The agent decides whether to accept or reject the offer B (communication between the agent and the principal is discussed in Section 5). Accepting B means signing an extension of the employment contract and the final (time 2) payoffs become $x - B$ to the firm and B to the agent, respectively.[8] If the worker rejects the offer B, he quits the firm and develops a start-up based on x at time 1. An 'entrepreneur' is such an individual. The time 2 payoff from becoming an entrepreneur, $U(x,.)$, depends on the fixed costs (or benefits) from starting up a firm and the degree to which the idea generated is possible to carry away. I formalise this as the entrepreneurial payoff being equal to,

$$U(x) = \max(0, \eta x - c). \quad (1)$$

Since this is a key equation of the model setup, I discuss it in some detail. The parameter c is meant to capture the sum of financing costs and the private benefits the agent enjoys from being entrepreneur. For example, if a start-up requires a high investment cost (think of a pharmaceutical laboratory) or is located in region with a dearth of venture capitalists, then the financing costs are high.[9] For simplicity, it is assumed that the worker can finance this cost from own funds (the case with external financing is an interesting extension discussed informally in Section 5). Private benefits, on the other hand, are the monetary equivalent the entrepreneur is willing to sacrifice in order to start a venture (be his own boss, a sense of pride etc.). Since empirical evidence indicates that private benefits can be substantial (Hamilton, 2000), both the cases $c > 0$ and $c < 0$ are analysed. For simplicity it is assumed that c is known to both the worker and the employer at time zero, and is constant across all workers in the labour pool.[10]

The parameter η reflects the degree to which the idea generated by the agent has value to him if he leaves; the higher η the higher fraction of value the agent can carry

[7] If $\bar{U} > 0$ then under pre-commitment there will be an indeterminancy in the optimal contract, as in Pakes and Nitzan (1983), since F and B will be substitutable, but that will have no impact on the results. By the assumption $\bar{U} = 0$, then $F = 0$ in optimum and the optimal $B(s)$ schedule is uniquely determined.

[8] One might ask why the firm would not write a longer contract in the first place to avoid many problems. However, contracts of unbounded duration would not be acceptable according to labour laws in most countries and, for any contract with finite length, the problems the article discusses can occur.

[9] Evidence from Hellmann and Puri (2002) suggests that venture capitalists may boost the gross entrepreneurial payoff $U(x)$, in addition to providing funding. As long as the firm has the option of hiring the venture capitalist as a consultant, or a person with similar expertise, it seems unlikely that this possibility would change our results qualitatively.

[10] Since c does not interact with x, letting c be unknown to both parties prior to contracting (but learned at time 1) would give the same type of results. Letting c be privately known to the worker prior to signing the employment contract, would open for the firm screening for workers with a high c. When precommitment to $B(s)$ is not possible, such screening is not possible, since all worker types will prefer a high F. When precommitment to $B(s)$ is possible such screening contracts would give an advantage to small firms relative to large firms but apart from that make no qualitative difference to our results.

with him. My focus is on how the strength of property rights protection affects η (how technological complementarities can affect η is discussed in Section 5).

There are at least two ways in which η depends on the legal environment; through non-compete clauses and through patenting. Let us discuss these two mechanisms in turn. Non-compete clauses impose a direct restriction on the worker's legal ability to start up a business whose activities are close or similar to those engaged in at his previous employer. The ease to which non-compete clauses can be enforced varies between industries, one reason being that what is meant by a related business can be much harder to define in say the management consulting industry than in the electronics industry (Posner and Triantis, 2001; Stone, 2002). Varying η can also reflect differences in the strength of patent protection across industries, where the sources of variation are technological that can be taken as exogenous to the model.[11] This variable therefore is well-suited for comparative statics exercises.

I assume that the worker after accepting B can reveal x to the principal. This is a fairly innocuous assumption, as the agent would have no incentives to misrepresent x at this point and (non-verifiable) cheap talk will be credible. As a consequence, the quantity x can be interpreted as the value of the idea given its best use by the firm, either through development inside or through a spin off (creation of a new division organised as a separate firm). This interpretation will be explained further in Subsection 3.3. Since a spin-off can plausibly imitate a start-up along all technical dimensions (recall the assumption that the worker has committed to work for the firm) and there will be no efficiency loss associated with legal costs or other hassles, I shall assume throughout that $\eta \in (0,1)$.

The last thing to specify in the model is the payoff to the firm if the worker decides to leave. There are at least two, counteracting, effects. First, the employee leaving could involve some loss in profits for the firm due to increased product market competition. Second, the employee starting up a firm based on x could open up for the possibility of suing the agent, with some positive payoff if successful. To simplify the analysis, I assume that these effects are small, or cancel each other out, and that the employee leaving is, from the firm's perspective, equivalent to the employee leaving the workforce.

3. Quality of Entrepreneurs

This Section analyses the interplay between the entrepreneurship decision made by workers and the optimal wage offers made by firms, taking firm size as given. Section 4 considers the optimal firm size.

3.1. *Small Firm*

Recall that in a small firm, the owner knows x, i.e., $s = x$. If $c > 0$ then $U(x) < x$, it will be efficient that the worker stays and the firm will offer a bonus that is sufficient to retain the worker. If $c < 0$, however, then $U(x) > x$ for sufficiently low x. Without loss of

[11] For example, evidence from Cohen *et al.* (2000) indicates that innovations in the drugs (pharmaceutical), computers and chemicals industries are easier to patent than innovations in the food or steel industry.

generality, assume that the worker stays in the firm if $B_S = U(x)$. Since there is no reason to leave rents on the table, the optimal bonus offer by the firm will be,

$$B_S^* = \begin{cases} 0 & \text{if } U(x) < 0 \text{ or } U(x) > x \\ \eta x - c & \text{if } 0 < U(x) < x. \end{cases} \quad (2)$$

The leaving option implies that the bonus payment to the agent will be equivalent to a call option on (a fraction of) the value of the project. Incidentally, this payment scheme resembles pay structure in small technologically oriented firms, which commonly pay their workers with stocks or options.[12]

From the optimal bonus offer by the firm I get the following on the quality of entrepreneurs from a small firm.

Proposition 1. *There will be entrepreneurs emerging from small firms only when private benefits from a start-up outweigh the financing costs* ($c < 0$). *The entrepreneurs will be of low quality.*

Proof. For $c > 0$ then $U(x) < x$ and the firm will always pay a sufficient amount to keep the worker. When $c < 0$, the worker leaves in equilibrium if $\eta x - c > x$, or in other words if $x < P$, where $P \equiv -c/(1 - \eta) > 0$. Hence, from a small firm, workers with ideas on the interval $[0,P]$ will become entrepreneurs.

In a small firm there cannot be entrepreneurship unless there are private benefits associated with entrepreneurship. Moreover, entrepreneurs from small firms will tend to have low quality ideas, i.e., the value of their ideas are not a random sample from the distribution of x but a random sample below some threshold. Note that there will be a socially optimal level of separations in equilibrium, since the firm extracts all the surplus created when it sets the separation threshold through B_S^*.

Assuming that $c < 0$, the comparative statics properties on the quality and quantity of entrepreneurs emerging from a small firm are straightforward.

Remark 1. *The quality and quantity of entrepreneurs from a small firm decreases in c and increases in* η.

Proof. The remark follows from differentiating P with respect to c and η.

An increased financing cost or decreased private benefit, i.e., an increased c, makes entrepreneurship less efficient and only workers with ideas of very low quality will leave to start-up their own firm. Weaker property protection makes the quality of entrepreneurs go up.

3.2. *Large Firm*

I assume that in a large firm, the owner gets less precise information about x than the owner of a small firm. Since this is a key assumption, let me spend some time justifying it before moving on to the analysis.

[12] Oyer and Schaefer (2005) provide broader evidence that firms compensate employees in order to retain them, rather than to elicit effort.

The idea that smaller firms are better monitors has a long theoretical tradition, going back to at least Simon's (1973) work on managerial overload. Later, it was emphasised by, e.g., Rosen (1982) in his famous paper on authority and control: 'It is the supervisory activity that congests management scale economies and produces determinate firm sizes.' And 'As suggested by Williamson (1981) and others, fulfilment of plans requires monitoring of workers in adjacent ranks, because transaction costs raise possibilities for opportunistic behavior of subordinates and impose limitations on the information transfer within the firm.' (Rosen, 1982, p. 313).

On the empirical side, the assumption that smaller firms are better monitors is supported by evidence from Agell (2004), who interviewed the pay managers of 1,200 Swedish companies about the ease to which pay can be tied to performance for individual workers. Agell (2004) reports that pay managers at larger firms find it significantly more difficult to evaluate the performance of individual employees than pay managers at smaller firms. At a more anecdotal level (Shockley Semiconductors, Xerox Parc) large corporations are often criticised for being slow to adapt and to pose bureaucratic hurdles to employees with ideas and initiative. I suggest a reason why it might be so: large corporations are sluggish because they lack information about the right course of action.

Given the informational benefit from being small, there must be some benefit from being large for there to be an interesting choice of firm size. I formalise this by assuming that if the worker stays, being large has scale advantages that boost the value of the idea by a factor $\alpha > 1$: an idea of quality x is worth x to a small firm and αx to a large firm.[13]

The model's distinction between a small and a large firm can be seen as a reduced-form specification of several plausible mechanisms:

- Similar to Stein (2002), large can mean hiring a bureaucrat, or middle manager, in addition to a worker. The upside of hiring a bureaucrat is that he can boost the value of the project through, e.g., facilitating commercialisation. The downside of hiring a bureaucrat is that he acts as a veil between the agent and the owner, either because of lack of competence in assessing x or because he has a private agenda.[14]
- One can interpret a large firm as one with more workers than a small firm. The upside of employing more workers is to exploit scale advantages or complementarities between the worker's skills, and the downside with team production that it becomes harder to evaluate a particular worker's marginal contribution or value (Alchian and Demsetz, 1972).
- One can think of a large firm as having more projects than a small firm. On one hand, this can create synergies through, e.g., knowledge spillovers[15] but on the other hand more projects will tend to increase managerial overload by reducing the time available for the principal on each project (Simon, 1973).

[13] To have the 'boosting factor' α as a constant makes the analysis more convenient but is not necessary. It is sufficient for the same type of results to go through that $\alpha(x)x > x$ for all x.

[14] For example, as in Stein (2002), the bureaucrat cannot be trusted to make true announcements about x due to private benefits from keeping the project alive.

[15] There is empirical evidence supporting the idea of such synergies in Cockburn and Henderson (1996), who find that larger research efforts in the biotech industry are more productive, ascribed to knowledge spillovers.

Let us now move to the analysis. Recall that in a large firm, the principal knows $g(\cdot)$. The optimal offer by the firm is denoted by B_L^*, and the analysis is confined to the case $B_L^* > 0$, which occurs when $|c|$ is not too large (if $c << 0$ then all workers become entrepreneurs and when $c >> 0$, no workers become entrepreneurs even for $B_L = 0$, neither case very interesting). Given an offer $B_L > 0$, then a worker leaves iff $U(x) = \eta x - c > B_L$, or in other words if x exceeds a cutoff z, where

$$z = (B_L + c)/\eta. \tag{3}$$

Taking into account workers' best response, and viewing z as the choice variable for the firm, the profit of a large firm equals,

$$\Pi_L = \int_0^z (\alpha x - \eta z + c)g(x)\mathrm{d}x. \tag{4}$$

The firm's profit maximisation problem can be written as finding an optimal cutoff z^*, where

$$z^* = \arg\max_{z\in[0,1]}\left\{\int_0^z (\alpha x - \eta z + c)g(x)\mathrm{d}x\right\}. \tag{5}$$

The first order derivative of Π_L equals,

$$\Pi_L' = (\alpha z - \eta z + c)g(z) - \eta G(z). \tag{6}$$

This equation reflects the trade-off faced when deciding upon a cutoff z. Setting a higher z will decrease leaving at the margin but also increase the wage payment to all worker types that stay.[16] To see that z^* must be less than unity, observe that $\Pi_L'(1) = (\alpha - \eta + c)g(1) - \eta G(1) = -\eta < 0$. I then have the following result.

PROPOSITION 2. *There will always be entrepreneurs emerging from a large firm and the entrepreneurs will be of high quality.*

Entrepreneurs from large firms are from the top of the distribution of x simply because $U(x)$ slopes upwards in x and therefore workers with the best ideas reject the fixed bonus offer.

Assume for convenience that $\Pi_L' = 0$ has a unique solution; some conditions for uniqueness were considered in the working paper version, Hvide (2005). In that case, the first order condition (5) implicitly defines a differentiable function $z^*(\alpha,\eta,c)$ with the following comparative statics properties.

REMARK 2. *The quality (quantity) of entrepreneurs from a large firm,*

Increases (decreases) in α
Increases (decreases) in c
Decreases (increases) in η

[16] The second order condition for profit maximum is,

$$\Pi_L'' = (\alpha - 2\eta)g(z^*) + (\alpha z^* - \eta z^* + c_E)g'(z^*) < 0.$$

Proof. Implicitly differentiate the first order condition for profit maximum to obtain,

$$\begin{aligned}\frac{dz^*}{d\alpha} &= -z^* g(z^*)/\Pi''_L > 0\\ \frac{dz^*}{dc} &= -g(z^*)/\Pi''_L > 0\\ \frac{dz^*}{d\eta} &= z^* g(z^*) + G(z^*)/\Pi''_L < 0.\end{aligned} \quad (7)$$

These results are intuitive. Increased technical efficiency α makes the marginal employee more valuable to the firm, without affecting $U(\cdot)$, and the firm increases z (by increasing B_L). This reduces the probability of entrepreneurship but increases the average quality of entrepreneurs. An increased financing cost or decreased private benefit, i.e., an increased c, makes it cheaper for the firm to keep the marginal employee and z increases. Finally, weaker property rights protection makes it more expensive for the firm to keep the marginal employee and z decreases.

To sum up, a large firm is constrained by low quality on the information about the ideas generated and therefore has a rigid wage policy. The workers with the best ideas will tend to leave the firm to start their own venture. Therefore, entrepreneurs from large firms do not carry with them a random draw from the distribution of x but the distribution of x above some threshold.

3.3. *Some Interpretational Issues*

I have assumed that the firm has the formal ownership rights to the project. This is an innocuous assumption given that the reservation utility of a worker is zero ($\bar{U} = 0$), since the worker makes rents and therefore will be willing to waive any formal ownership rights at the time of employment. If $\bar{U} > 0$, however, then conceivably it would be optimal to sign a contract that gives some ownership rights of the project to the agent. To see why this would not be the case, suppose that contracts on formal ownership can be written to induce any η on the interval $[\eta_L,1]$. Then the agreed-upon η would equal the minimum point η_L. The reason is simple; if the agent's expected utility needs to be increased to ensure participation, it will be more efficient to increase it via increasing the fixed wage F rather than increasing η, since a higher η means a greater efficiency loss (due to an increased probability of entrepreneurship). Therefore, the only consequence of $\bar{U} > 0$ in the model would be to increase the fixed wage F paid by the firm. This is convenient because it means that the model can be encompassed in a general equilibrium type of framework (with endogenous $\bar{U}$) without any of the basic results being reversed.

Second, the spin-off option has been implicit in the firm's production function. Look more into this possible venue of developing ideas by considering the case of a small firm (the case of a large firm is practically speaking identical). A reasonable feature of spin-offs is that they have higher fixed costs than internal development. For spin-offs to occur at all, there must consequently be some technological advantage to it, such as negative synergies between the project and other existing projects of the firm (a spin-off occurs if the innovation does not fit existing business areas, or it might be easier to incentivise the agent in a separate unit). We can formalise this by assuming that developing an idea with 'intrinsic' quality y in-house gives it economic value equal to py, while developing it through a spin-off gives it value $\theta y - f$, where $f > 0$, and $\theta > p$. Conditional on the firm developing ideas optimally, it follows that $x = \max(py, \theta y - f)$. We then have that,

REMARK 3. *Only innovations of sufficiently high quality will be developed through a spin-off.*

This result is consistent with evidence of a positive stock market reaction to spin-off decisions, e.g., Desai and Jain (1999) for US evidence and Veld and Veld-Merkoulova (2004) for European evidence.[17]

Third, I have stressed the interpretation of η as reflecting the extent to which property rights are enforceable. The flexibility of the model allows for other interpretations. If we choose to interpret x as the human capital the agent acquires from working on the project, one interpretation of η is the extent to which this human capital is firm-specific; where a high degree of firm specificity implies that η is low. Although a firm may be able to affect the firm specificity of human capital acquisition when designing training projects, it seems reasonable to assume that firm specificity in the human capital acquired from working on a research project to a large extent is driven by technological factors outside the decision sphere of the firm. This justifies treating η as exogenous also under this interpretation of x.

Finally, while η is a constant in (1), the findings can easily be generalised to the case where η is a function of x,

$$U(x) = \max[0, \eta(x)x - c], \tag{8}$$

where the only restriction put on $\eta(x)$ is that $\mathrm{d}U/\mathrm{d}x = \eta'(x)x + \eta > 0$, i.e., the agent prefers a higher x to a lower x. This more flexible formalisation allows for complementarities that can vary upon the quality of the idea. Also it covers, for example, cases where it is easier for firms to enforce property rights when x becomes bigger.

4. Endogenous Firm Size

This Section studies how the property rights regime affects the trade-off between technical efficiency and quality of information, and determines the optimal firm size.

To solve for the optimal firm size, I need to calculate the difference in 'indirect' expected profits between organising as a large firm and organising as a small firm,

$$\begin{aligned}\Delta^*[\alpha, c, \eta, z^*(\alpha, c, \eta)] &= \Pi_L^* - \Pi_S^* = \alpha \int_0^{z^*} xg(x) - G(z^*)B_L^* - \Pi_S^* \\ &= (\alpha - 1)\mathrm{E}(x) - \alpha \int_{z^*}^1 xg(x) + \int_0^{I(c)P} xg(x) - [G(z^*)B_L^* - \mathrm{E}(B_S^*)]. \end{aligned} \tag{9}$$

[17] An interesting idea that will not be pursued further here is that a spin-off may make it easier to write a good compensation contract to the worker. At the extreme, we could think of the project organised in a spin-off to make x verifiable to courts. Even in that case the current analysis holds through as long as the fixed cost of setting up a spin-off, f, is not too low.

The first term gives the (hypothetical) productivity difference between a large and a small firm if there were no entrepreneurship, the second term gives the reduction in productivity for large firms due to workers leaving, and the third term gives the reduction in productivity in small firms due to workers leaving, where $I(c)$ is an indicator function which equals 1 if $c < 0$ and 0 otherwise. The final term gives the difference in expected wage bill for a large and a small firm. The Δ^*-function is continuous since both Π_L^* and Π_S^* are continuous.

We can note the following results,

Remark 4. *When*

(*i*) *α is sufficiently high or*

(*ii*) *η is sufficiently small, then a large firm is optimal.*

Proof. To prove (*i*) I show that for $\alpha \geq [\mathrm{E}(x) + \eta - c)]/\mathrm{E}(x)$ then a large firm dominates for all (c,η). The argument is simple. Suppose that the large firm pays a bonus equal to $\eta - c$ to all workers. It would then retain all and have profits equal to $\alpha\mathrm{E}(x) - \eta + c$. A small firm can never make a profit higher than $\mathrm{E}(x)$. Hence the difference in profits between a large firm and a small firm must be at least $(\alpha - 1)\mathrm{E}(x) - \eta + c$. This expression is greater than zero for $\alpha > [\mathrm{E}(x) + \eta - c)]/\mathrm{E}(x)$. To prove (*ii*), there are two cases to consider, $c < 0$ and $c > 0$. For $c < 0$, consider the limit case $\eta = 0$. In that case it is either optimal to pay all agents c (in which case all stay) or to pay them all zero (in which all leave). Assuming that $\mathrm{E}(x) - c > 0$, paying all agents c is optimal. The profits of a large firm then equals $\alpha\mathrm{E}(x) - c$ and the profits of a small firm equals $\mathrm{E}(x) - c$. Therefore $\Delta^* = (\alpha - 1)\mathrm{E}(x) > 0$ for $c < 0$ and $\eta = 0$. By continuity, an interval $[0,\bar{\eta}]$ must exist such that a large firm is optimal for any $\eta \in [0, \bar{\eta}]$. For $c > 0$, the worker stays even when $B_L = 0$ if $\eta \in [0,c]$. It follows directly that $\Delta^* > 0$ for $\eta \in [0,c]$.

I now have the following result.

Proposition 3. *For any c, then for α not too large there exists a cutoff η^* such that a large firm dominates for $\eta < \eta^*$ and a small firm dominates for $\eta > \eta^*$.*

Proof. See Appendix A.

Recall that the optimal firm size is a trade-off between improved technical efficiency (parameterised by $\dot{\alpha} > 1$) and inferior quality of information. When property rights are strong (η low) the leaving option is less of a threat, information about the quality of individual projects therefore of relatively small value, and a large firm is optimal. On the other hand, when property rights are weak (η high), the leaving option is more of a threat, the value of information high, and a small firm becomes optimal. Hence worsened property rights makes a small firm more likely to be optimal.[18]

[18] There is a qualification to this result. When the property rights are very weak (η close to 1), the surplus that can be extracted from the worker is low, and information can become of little value. Hence the relationship between weakened property rights protection and the value of information can be non-monotonic. Proposition 3 excludes this possibility to have an impact on the optimal firm size for α sufficiently close to 1. Restricting η to be bounded away from 1 will have the same effect.

Finally I derive some additional comparative statics results.

REMARK 5. *A large firm is more likely to be optimal the higher α. For the absolute value of c sufficiently small, a large firm is less likely to be optimal the higher c.*

Proof. See Appendix A.

While the first result is not surprising, the second result essentially says that increasing c will be more beneficial to the profits of small firms than to the profits of large firms. The intuition behind this result is that a higher c benefits a small firm for all (or approximately all) workers, while it benefits large firms only for workers with $x \in [0,z]$.

5. Discussion

The purpose of the analysis has been to clarify our understanding of the relationship between an entrepreneur's background and his likelihood of obtaining success as an entrepreneur. Here I discuss three aspects of the model; financing of entrepreneurs, the absence of contingent offers from a large firm and a possible interaction between property rights protection and observability.

I have assumed that workers can self-finance if they decide to become entrepreneurs. Suppose instead that a start-up requires external funding, and eventual repayment according to a debt contract. If financiers are risk averse or there is some cost of bankruptcy, entrepreneurs from small firms will then get worse financing conditions than entrepreneurs from large firms (i.e., have a higher c). The reason is simple: entrepreneurs from small firms carry (more) credit risk and financiers will only be willing to tolerate this if they are compensated through a higher effective interest rate.[19] Interestingly, this argument suggests a reason why venture capitalists may be able to better capture value from ideas than established firms: the fact that a worker has left (and whether he has left a small or a large firm) will provide the venture capitalist with a better-informed position than (a large) employer had.

I have assumed that profit sharing schemes or contingent pay to the agent in a large firm are not feasible, since x is non-contractible. Given that x is not directly contractible, there are two versions of profit sharing that can be taken into account. First, the large firm might offer the worker shares in the company if he stays on. This could possibly solve the efficiency loss problems due to turnover since the agent's payoff would depend on the quality of the idea also if he stays on in the firm (a higher stock price of the firm if the idea is valuable). However, even if profit sharing through stocks, stock options or group rewards might give the agent stronger incentives to stay on in the firm, they would typically only marginally do so, since the increased value due to a good project would have to be shared with the other shareholders or project members (Merges, 1999; Kim and Marschke, 2005).[20] A better solution than awarding the worker

[19] This will have the qualitative effect of shifting the Δ^* function to the left.

[20] If the firm is small, the worker might get a substantial share of the firm if he stays. This is consistent with anecdotal evidence of key workers in Silicon Valley firms having significant ownership stakes in their companies.

stocks might therefore be for the firm to allow the worker to set up his own company and get a share of the profits of the new company. Although such worker-initiated spin-offs are quite common (for example spin-offs from the MIT Engineering School) there are limitations to this solution. It is for example not clear what would stop the worker from neglecting the spin-off and to develop the idea inside a different company (Anton and Yao, 1995). In line with this argument, Anand and Khanna (2000) find in their sample of UK firms that there are few licensing contracts in markets were it is 'difficult to clearly specify the content and boundaries of knowledge and other intangible assets' (p. 126). Arora and Ceccagnoli (2006) reports a similar finding with the use of US data. If it is difficult to use profit sharing or other incentive contracts, we are back in a similar situation to the one focused on in the model.

Instead of profit sharing, an alternative way to let the agent's payoff depend upon the quality of the idea would be to let the informed worker demand a continuation wage rather than having the (uninformed) firm offer a wage. Obviously, such communication would have no effect on the small firm solution. Potentially, however, communication could enable the agent in a large firm to reveal the value of the idea to the principal, and only efficient separations would occur. Some versions of this argument seem sound, others not. First, suppose that the worker has a cheap means of credibly communicating the content (and value of) the idea. Such revelation would be unlikely, however, since it may drastically reduce the value of the worker's position (Anton and Yao, 1995), by making it easier for the firm to claim its property right. Second, if the agent can only make non-verifiable statements about the value of the idea, talk would be utterly cheap since the worker would have incentives to inflate x and thereby get a higher B. Third, and more interestingly, we could turn the bargaining table around and let the worker make a wage demand instead of the firm making a wage offer. Such a version of the incomplete information bargaining, which is analysed in Appendix B, opens up the interesting possibility that the worker can credibly reveal information about x through his demand (in fact, I construct a separating equilibrium where the demand fully reveals x). Apart from this, there must be workers leaving in equilibrium, and the probability of leaving increases in x, so that the main results on entrepreneurship are unchanged.[21]

I assumed that the information advantage of a small firm relative to a large firm is independent of the strength of property rights protection η. It is however, worth thinking more about what causes property rights to be weak. Presumably, this occurs due to problems with unverifiability, so that one could expect a positive correlation between the strength of property rights and the extent to which small firms would have an information advantage. This argument is complementary to the model, in that there would be even greater reasons to choose a large firm if both ownership rights are strong and information is good, and, vice versa, there would be even greater reason for organising as a small firm if both ownership protection is weak and the informational

[21] Of course, there is a wide range of other formalisations of the incomplete bargaining game between the worker and the firm. I am not aware of any such formulation, however, without the property that bargaining is more likely to break down (i.e., entrepreneurship to occur) the higher x, which is the essential feature needed.

advantage versus large firms becomes greater.[22] Finally, I have assumed that the principal can monitor the input (effort, time) of agents in a perfect manner. What if (a portion of) effort had to be induced via incentives? Since a small firm can condition its pay on a less noisy measure of x than a large firm can, it can link pay and performance in a more direct fashion, and therefore elicit effort more easily than a large firm. Modelling such a consideration would tend to shift the Δ^*-function to the left in the model.

6. Empirical Analysis

The theoretical analysis predicts that entrepreneurs originating from larger firms start up companies of higher quality than entrepreneurs originating from smaller firms. This section confronts this hypothesis with data from Norway.

6.1. *Data*

The dataset consists of incorporated companies founded between 1994 and 2002 in Norway.[23] The dataset is compiled from three different sources. First, accounting information from Dun and Bradstreet's database of accounting figures based on the annual tax reports. These data include variables such as organisation identification number, industry codes, sales, assets, profits and so on for the years 1994–2005. Second, data on individuals are prepared by Statistics Norway. These records include individual identification number and yearly sociodemographic variables such as age, education, wealth, and earnings split into labour income and capital income, for 1986–2004. The Statistics Norway data is used to construct measures of founder background. Third, founding documents submitted by new firms to the government agency *Brønnysundregisteret*. These data include the organisation identification number for the start-up, personal identification number of the founders, total capitalisation of the company and each founder's respective ownership share. Using these data, I define an 'entrepreneur' as an individual with a majority stake, i.e., more than 50% of the total shares, in a newly established incorporated company.[24]

Many start-ups in Norway, particularly in real estate, are tax-shelters or have minimal activity. The sampling procedure dealt with this in two ways.[25] First, by oversampling

[22] Related, we have assumed that the principal knows x in a small firm and knows nothing about x in a large firm (except its distribution). Allowing for an informative signal received by the principal in a large firm will open up for the possibility that the set of entrepreneurs in a large firm will be a non-connected set. This can mean a lower quality of entrepreneurs from a large firm than presently but it will still be true that the average quality of entrepreneurs will be higher from a large firm than from a small firm.

[23] The main advantage of focusing on incorporated companies rather than on the self-employed is that incorporated companies trace out much more detailed data on the business unit, such as investment levels and industry code classification. Moreover, since setting up an incorporated company carries tax benefits relative to being self-employed (e.g., more beneficial write-offs for expenses such as home office, company car and computer equipment) incorporation status will be more tax efficient than self-employed status except for the smallest projects. Also, incorporated companies are required to have an external auditor certifying the accounting statements in the annual reports, which makes the reliability of the data higher than for self-employed.

[24] Restricting the sample to majority owners avoids the problem of defining founder background characteristics when dealing with multiple founders. Other advantages include avoiding double counting of companies and nominal founders such as 'sleeping spouses'.

[25] Avoiding sampling empty companies was an important concern since the incorporation documents had to be hand-collected by research assistants at a considerable cost.

start-ups in manufacturing and IT, since tax shelters are less likely to occur in these industries. As an added benefit, these industries exhibit high variation in perceived capital-intensity. Second, to avoid sampling empty shells, start-ups sampled were required to have at least NOK 500,000 in sales and at least two persons employed during one of the first two years of operation.[26]

For each start-up identified in Dun and Bradstreet's database, a list of founders was compiled based on the founding documents. Next, the founders' associated socio-demographic information from the public registers supplied by Statistics Norway was matched in. This procedure gave a sample of about 1000 entrepreneurs and 5000 entrepreneur-years.

We can note several unique features of the dataset. Most importantly, it contains detailed information about the employment and wage history of the entrepreneurs. This enables me to control for human capital and the entrepreneur's opportunity cost, and to construct measures of the size of the previous employer. Second, the dataset includes the industry codes of the start-ups (in contrast to datsets on self-employed I am aware of), enabling industry-specific effects related to employer size or profitability to be controlled for. Third, the detailed data allow me to construct several different performance measures for the start-ups which captures different aspects of start-up success.

6.2. *Empirical Strategy*

I use operating returns on assets (OROA) as the benchmark performance measure. OROA is the standard performance measure in a large accounting and financial economics literature; see e.g. Bennedsen *et al.* (2007) and the references therein. OROA is defined as the ratio of earnings before interest and taxes (EBIT) to the total asset base used to generate them. Unlike returns on equity or returns to capital employed, OROA compares firm profitability relative to total assets.[27] In contrast to net income-based measures such as return on assets, OROA is not affected by capital structure or dividend policy differences across firms. Following Frank and Goyal (2003), I use three-year average OROA, weighted by the level of assets. This measure weighs profitability in years where the start-up is larger more heavily than profitability in years where the start-up is smaller.

OROA does not necessarily capture the success of companies whose asset base grows fast relative to profitability. To capture such growth companies, I therefore use asset growth as an alternative performance measure to OROA. As a second alternative performance measure I use start-up survival.[28] Focusing on survival is useful, for example, to accommodate the possibility that growth-oriented companies might also have a higher probability of failure. To have a reasonable sample size, I focus on four-year survival.

[26] The final sample consisted of about 35% start-ups within manufacturing (NACE 23–35), 50% within IT (NACE 72) and 15% drawn randomly from other non-financial sectors.

[27] The asset base I use to compute yearly OROA is the average of assets at the beginning and the end of the calendar year. This is in line with the accounting literature.

[28] The data do not contain information on whether a start-up ceases to exist due to a liquidiation or due to a buy-out. This reduces the reliability of the survival measure I construct. Buy-outs occur rarely for very young firms so this lack of detail is unlikely to cause much bias.

As outlined in Section 3.2, the measure of firm size best aligned with the theoretical model is the number of employees. Employee supervision typically occurs at the plant level. Therefore, the number of employees at plant level captures the difficulty to which principals can assess individual productivity, and I therefore measure employer size by number of employees at plant level.[29] Since the data gives access to yearly plant identification number for all workers is Norway, I was able to construct exact yearly measures of plant size for the majority of the future entrepreneurs. I use the average plant size over three years before the venture's first year of operations.[30] Reasonably, the informational effects of larger employer size should be declining at the margin. To accommodate this concavity, I use log number of employees as the benchmark employer size measure.

A positive correlation between previous employer size and performance need not be due to the informational reasons outlined in the model. It is well known from the labour economics literature that larger firms tend to recruit workers with stronger formal credentials such as education level, so that omitting controls for such credentials could create a spurious relation between employer size and entrepreneur quality. I therefore include controls for age and years of education, and these variables squared. It is also well known from labour economics (Fox, 2004) that large firms pay higher wages than small firms even after controlling for education level and experience. Although there is no consensus on what creates these pay differences, they may well be due to differences in ability at the hiring stage (or through subsequent training). To accommodate ability differences not captured by education or experience, I include a control for the wage earned by the entrepreneur while still being an employee. As a benchmark measure of previous wage, I use the average wage over three years before the venture's first year of operations.

More wealthy founders tend to start up companies that are larger (see e.g., Holtz-Eakin *et al.* (1994*b*), or, using the same data as here, Hvide and Møen, 2007), so that if entrepreneurs from larger firms are wealthier then they may perform better for liquidity or size reasons not related to wage. To accommodate possible liquidity and size effects, I include founder taxable gross wealth and company size at start-up date as measured by the total equity infusion as controls. Finally, I include dummy variables for start-up year and 2-digit industry codes to capture business cycle and industry effects.

6.3. *Descriptive Statistics*

Table 1 presents summary statistics of the founders and firms in the sample. As expected, founders tend to be experienced workers and the start-ups are generally small. There is substantial variation in the size of previous employer and a majority of firms survive the first four years.

[29] Plants are defined through having an independent business address.

[30] Because of the tax benefits of incorporation status, the start-ups could be continuations of existing sole proprietorships. We avoided this problem by defining plant size as an average only over years where the founder was not self-employed (the same applies to the previous wage measure defined below).

Table 1

Summary Statistics ($n = 988$)

Variable	Description	Median	Mean (St.Dev)
Age	Founder age at start-up date	39	40.1 (8.6)
Education	Founder education in years, at start-up date	12	13.1 (2.6)
Wealth	Founder taxable wealth, 3-year average before start-up date	454.2	1200.0 (5012.1)
Wage before	Founder wage income, 3-year average before start-up date	428.5	477.6 (297.0)
Prevsize	Employer size in number of employees, 3-year average before start-up date	28.8	232.0 (1097.0)
Start-up year	First reporting year	1999	1998.5 (2.8)
Equity	Start-up equity at start-up date	100	185.2 (1124.5)
Sales	Start-up sales, first year	957.1	2636.7 (7740.1)
Assets	Assets, end of first year	707.0	2184.0 (7480.0)
OROA	Start-up return on assets, asset–weighted 3-year average	0.123	0.155 (0.288)
Growth	Yearly asset growth	0.057	0.228 (0.696)
Survival	4-year survival	1	0.74 (0.441)

Note. Krone values are expressed in (1000) 2002 kroner. 1000 kroner is equivalent to about 140 Euro. The formal capital requirement for registering an incorporated company was NOK 50,000 in equity until 1998 and NOK 100,000 thereafter. The asset base used to compute yearly OROA is the average of assets at the beginning and at the end of the calendar year. OROA is based on yearly 5% winsorised values.

6.4. *Previous Employer Size and Performance*

I now turn to the main question: do start-ups where the entrepreneur was previously employed at a larger firm perform better? As discussed above, I use three complementary performance measures; OROA, asset growth and 4-year survival. I start out looking at the effect of employer previous size on OROA (Table 2).

Regressing OROA on employer size without controlling for previous wage, start-up size or industry codes, I find a statistically significant relationship, as depicted in column (I). A one log increase in previous size (which approximately equals a doubling of previous size) gives a 2.4 percentage points increase in OROA. Introducing a set of controls for human capital in column (II) we see that the size of the estimated effect is weakened but only slightly. The economic magnitude of a change in previous size seems quite considerable. For example, by moving from the 25 percentile to the 75 percentile in previous employer size (from 8 to 119 employees) gives a 6 percentage points increase in OROA. In comparison, an increase from the 25 percentile to the 75 percentile in previous wages (315K to 570K) gives 3 percentage points increase in OROA. Hence the relation between previous employer size and OROA seems quite strong both in absolute terms and relative to the strength of the relationship between founder's previous wage and OROA.

Table 2

Entrepreneurial Performance

	I	II	III	IV	V	VI	VII	VIII
	OROA	OROA	Growth	Growth	Survival	Survival	Wages	Wages
Ln(previous size)	0.024***	0.021***	0.019***	0.018***	−0.031	−0.014	0.027***	0.012
	(0.005)	(0.005)	(0.005)	(0.006)	(0.028)	(−0.030)	(0.008)	(0.009)
Ln(previous wage)		0.054**		0.035		0.075		0.355***
		(0.023)		(0.023)		(0.121)		(0.068)
Age, education	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Equity, wealth	No	Yes	No	Yes	No	Yes	No	Yes
Industry dummies	No	Yes	No	Yes	No	Yes	No	Yes
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	988	924	4,786	4,166	730	638	987	919
R^2	0.084	0.141	0.072	0.090	0.019	0.052	0.126	0.311

***, **, * significant coefficients at 1%, 5% and 10% levels. Standard errors in parenthesis.
The dependent variable in columns (I) and (II) is the OROA of the start-up, calculated as a weighted average over the three first years excluding the first year. The dependant variable in columns (III) and (IV) is yearly asset growth. The dependent variable in the probit regression of columns (V) and (VI) is a dummy which equals 1 if the firm is in operation after four years and zero otherwise. This regression has a lower number of observations because some firms in the sample were founded after 2001. The dependent variable in columns (VII) and (VIII) is the log of 4-year average wage after the start-up year. In (VII) and (VIII), I add a control on whether the founder works for the start-up for at least one year or not, and in regressions (III) and (IV), I include dummies for start-up age in years. In the OROA, wage and survival regressions I report robust standard errors. In the growth regression I report Huber-White robust standard errors allowing for clustering of errors by individuals. (***) denotes significant at the 1% level, (**) significant at the 5% level, and (*) significant at the 10% level. Standard errors in parenthesis.

Moving on to relationship between previous employer size and asset growth in column (III) and (IV), the results are somewhat similar. A one log increase in previous size gives about 2 percentage points higher yearly asset growth. An increase from the 25 percentile to the 75 percentile in previous size gives 5 percentage points higher asset growth, while an increasing previous wage from the 25 percentile to the 75 percentile gives 2 percentage points higher asset growth. In columns (V) and (VI), I investigate 4-year survival. Here, somewhat surprisingly, neither human capital as measured by previous wage nor previous employer size are statistically significant.[31]

As a robustness check,[32] I undertook the same regression as in column (II) and (IV) but defining employer size with the log of number of employees at the company level rather than at the plant level. The results were almost identical. The positive relation between OROA and previous employer size could be offset by a negative relation between entrepreneurial wage and previous employer size. Analysis of the relation between previous employer size and performance as measured by entrepreneurial wages in columns (VII) and (VIII), however, suggested a weak positive relation between previous employer size and entrepreneur wage.

[31] Start-up size as measured by log total equity and founder wealth turn out statistically signficant. As shown by Hvide and Møen (2007), although total equity and founder wealth is statistically significant in explaining survival, the economic magnitude is small. One reason for these somewhat puzzling results is that I am unable to separate liquiditations from buy-outs when defining survival.

[32] In addition to the checks reported below, I also ran median and robust regressions. These gave results close to those reported in Table 2.

To accommodate non-linear effects from previous size other than those dictated by the log formulation, I used two alternative specifications: a dummy specification where the previous size variable was replaced with 10 dummy variables defined by previous size deciles, and a fourth-order polynomial specification. Both these formulations suggested that the positive effect of previous size is not confined to a particular interval of the previous size variable (consistent with the log formulation in Table 2, the effect of previous size in these alternative formulations was monotonically positive and declining). The levels of statistical and economic significance of previous size in these regressions were very similar to those in (II).

The empirical results reported in Table 2 are consistent with the theoretical prediction of the model. Since I do not have access to natural experiments or instruments that could establish causality, it is impossible to exclude the possibility that other mechanisms than outlined in the theoretical model drives the empirical results. Let me discuss some of them.

First, in a small firm the entrepreneur may be more likely to be one of the founders, and this may increase his incentives to stay irrespective of the firm's ability to monitor. This mechanism, which would tend to stop promising ideas from leaving small firms, would seem more plausible for the very smallest previous employers. Since I find a monotonic relationship between previous employer size and start-up performance, however, this mechanism seem unlikely to explain the empirical results.

Second, a common strategy for entrepreneurs is to consult or subcontract for former employers. Such a strategy could be more lucrative for larger or more productive former employers, even controlling for the wage earned by the entrepreneur while being an employee. Since I do not know the identity of the main customers of the start-up, it is hard to test this hypothesis directly. As an indirect test, one can investigate the IT industry, where such subcontracting through consulting services seems perhaps more likely than in manufacturing. To this end, I ran the same regressions as in Table 2 but splitting the sample into IT and non-IT companies. The results conveyed minimal differences in the effect of previous size for IT and non-IT companies. Moreover, I included the profitability and sales volume of the previous employer as additional controls. Including these variables gave a stronger effect of previous firm size on OROA, so the results do not seem to be explained by larger former employers being more profitable.

Third, if large firms tend to defer wages more than small firms (as suggested by Lazear and Moore, 1984) then for a given wage young workers in large firms will tend to be more productive than young workers in small firms. Given that the entrepreneurs in the sample are quite mature, with an average age of above 40 years, this alternative explanation seems unlikely.[33]

Finally, if workers anticipate the likelihood that they will have an idea, this could affects their initial choice of firm size. More creative employees should self-select into small firms if their creativity is more observable in such settings (which might explain why many top engineering graduates prefer to work for small firms rather than for large established firms). Self-selection based on creativity then arguably suggests that

[33] I experimented with other measures of previous wage, such as including yearly wages three years before the start-up date, to capture differences in wage evolution. These specifications gave unchanged results with respect to the effect of firm size.

entrepreneurs from small firms are of higher quality than entrepreneurs from large firms, which stands in contrast to the empirical findings.

7. Conclusion

Understanding the determinants of entrepreneurship is a key question to policy makers, economists and students of business. Still progress in the area has been limited; for example, microeconomics textbooks' notion of an entrepreneur is synonymous to an exogenously given production possibility frontier; courses on entrepreneurship are largely case-based and normatively (or perhaps rather romantically) tilted, and commonly taught by practitioners rather than academics. This state of affairs justifies an aggressive research effort by economists towards a better understanding of entrepreneurship.

The starting point of the article is the stylised fact that entrepreneurs are experienced workers who follow start-up opportunities closely related to their previous work experience. From this, I suggested an imperfect property rights framework that attempts to capture the interaction between the worker's leaving decision and an established firm's innovation strategy. The reduced-form nature of the model makes it consistent with several underlying mechanisms and forces a focus on results that are robust across these mechanisms.

The main insights were twofold. First, due to large firms having less precise information about the value of individual employees, large firms will pay less flexible wages and produce entrepreneurs of higher quality than small firms. Second, by affecting the trade-off between information quality and returns to scale, a large firm is more likely to be optimal the stronger property rights protection. Evidence on the quality of entrepreneurs from Norway gave encouraging support to the first hypothesis.

The main advantage of the current framework is that it is simple, and can be extended in various directions. One example would be to capture aspects the established firm's choice of R&D strategy (such as project choice and the extent to which workers are delegated decisions at project level) and labour market competition for workers.

Appendix

A. Proofs on $\Delta(\cdot)$.

I start out by proving Proposition 4 in several steps. For brevity I skip the * notation, and throughout the Appendix I assume interior solutions to the large firm's profit maximisation, i.e., $z \in (0.1)$. To be able to prove the proposition for both $c < 0$ and $c > 0$ it is convenient to define the function,

$$\Omega(c, \eta) = \begin{cases} P & \text{if } c < 0 \\ A & \text{if } c \geq 0, \end{cases} \tag{10}$$

where $P \equiv -c/(1 - \eta)$ and $A \equiv c/\eta$, as before. Clearly the function $\Omega(c,\eta)$ slopes downward in c for $c < 0$ and upwards in c for $c > 0$. $\Omega(\cdot)$ decreases in η since $\mathrm{d}P/\mathrm{d}\eta = -c/(1 - \eta)^2 < 0$ and $\mathrm{d}A/\mathrm{d}\eta = -c/\eta^2 < 0$. $\Omega(\cdot)$ is continuous in c since $\lim_{c\to 0^+} A = 0 = \lim_{c \to 0^-} P$.

Recall that,

$$\Delta[\alpha, c, \eta, z(\alpha, c, \eta)] = \Pi_L - \Pi_S = \alpha \int_0^z xg(x) - G(z)B_L - \Pi_S. \quad (11)$$

We start out with the following useful application of the envelope theorem.

Lemma 1.

$$\frac{d\Delta}{d\eta} = \frac{\partial \Delta}{\partial \eta} = \int_{\Omega}^{1} xg(x) - G(z)z. \quad (12)$$

Proof. Recall that $\Delta = \alpha \int_0^z xg(x) - G(z)B_L - \Pi_S$, where $B_L = \eta z - c$. Therefore,

$$\frac{d\Delta}{d\eta} = \frac{\partial \Delta}{\partial \eta} + \frac{\partial \Delta}{\partial z}\frac{\partial z}{\partial \eta}. \quad (13)$$

But by the construction of Δ, we have that $\partial\Delta/\partial z = 0$. Recall that $B_L = \eta z - c$ and $\partial B_L/\partial \eta = z$. Therefore,

$$\frac{d\Delta}{d\eta} = \frac{\partial \Delta}{\partial \eta} = -G(z)\frac{\partial B_L}{\partial \eta} + \frac{\partial \Pi_S}{\partial \eta} = \int_{\Omega}^{1} xg(x) - G(z)z.$$

The next Lemma is also on a property of Δ.

Lemma 2. *Δ is convex in η.*

Proof. Write for brevity $d\Omega/d\eta = \Omega'$ and recall that $\Omega' < 0$. Using the envelope theorem again,

$$\begin{aligned} \frac{d^2\Delta}{d\eta^2} &= \frac{\partial^2 \Delta}{\partial \eta^2} + \frac{\partial^2 \Delta}{\partial z \partial \eta}\frac{\partial z}{\partial \eta} \\ &= -\Omega'\Omega g(\Omega) - [g(z)z + G(z)]\frac{\partial z}{\partial \eta} > 0. \end{aligned} \quad (14)$$

Since $\partial z/\partial \eta < 0$.

Now define,

$$\Delta^1(\cdot) = \Delta(\eta = 1, .). \quad (15)$$

Since Δ is convex in η from the previous Lemma, the following obvious but very useful observation follows directly.

Lemma 3. $\Delta^1(\cdot) < 0$ implies both existence and uniqueness of η^*.

Recall that,

$$\Delta^1(\cdot) = \alpha \int_0^z xg(x) - G(z)B_L - \Pi_S. \quad (16)$$

Now define $\bar{\alpha}$ as a value of α which makes $\Delta^1(\cdot) = 0$. Since $d\Delta^1(\cdot)/d\alpha > 0$ there is at most one $\bar{\alpha}$ for each c, and hence there exists a function f such that $\bar{\alpha} = f(c)$, whose graph demarcates the values of (c,α) where $\Delta^1(\cdot) < 0$ from values of (c,α) where $\Delta^1(\cdot) > 0$. The area north of the graph would have $\Delta^1(\cdot) > 0$ and the area south of the graph would have $\Delta^1(\cdot) < 0$ since $d\Delta^1(\cdot)/d\alpha > 0 > 0$. So one way of completing the proof is to show that $f(c) > 1$ for all c. It turns out, however, that there is a simpler way to complete the proof. Specifically, set $\Delta^1(\cdot) = 0$ and rearrange to form a fixed-point definition of $\bar{\alpha}$,

$$\bar{\alpha} = h[\bar{\alpha}, c, z(\bar{\alpha}, c)] = \frac{G(z)B_L + \Pi_S}{\int_0^z xg(x)}.$$

It is sufficient to prove the Proposition to show that any solution to this equation must have $\bar{\alpha} > 1$ for any c. Note first that $h(\cdot)$ converges to $(1 - c) + \Pi_S$ when $\bar{\alpha}$ goes to infinity, since z converges to 1 and B_L converges to $1 - c$. The reason is simple; when α becomes large, the large firm maximises profits by keeping all workers and must pay them $1 - c$. It is therefore sufficient for existence and uniqueness of a fixed point above 1 that $h[1,c,z(1,c)] > 1$. But this is trivial to see. Recall that $\Pi_L = \int_0^z xg(x) - G(z)B_L$.

I therefore have that,

$$h(\bar{\alpha} = 1) = \frac{\int_0^z xg(x) + \Pi_S - \Pi_L}{\int_0^z xg(x)}. \tag{17}$$

But the right hand side of this expression exceeds 1, since a small firm must make weakly higher profits than a large firm for any c when $\alpha = 1$.[34] Therefore $h[1,c,z(1,c)] > 1$, and the proposition is proved. One may note that this result does not depend on the firm getting nothing if the worker leaves, since if $\eta = 1$ then the firm gets nothing anyway, given that Δ is convex.

Proof of Remark 5. Let me first prove the second statement. We have that,

$$\frac{d\Delta}{dc} = \frac{\partial \Delta}{\partial c} + \frac{\partial \Delta}{\partial z}\frac{\partial z}{\partial c}. \tag{18}$$

But by the construction of Δ, the envelope theorem gives $\partial\Delta/\partial z = 0$. Therefore

$$\frac{d\Delta}{dc} = \frac{\partial \Delta}{\partial c} = -G(z)\frac{\partial B_L}{\partial c} - \frac{\partial \Pi_S}{\partial c} = G(z) - \int_\Omega^1 xg(x)dx = G(z) + \int_0^\Omega xg(x)dx - 1. \tag{19}$$

Using the envelope theorem and the implicit function rule,

$$\frac{d\eta^*}{dc} = -\frac{\Delta_c^*}{\Delta_\eta^*} = \frac{1 - G(\Omega) - G(z)}{\Delta_\eta^*}. \tag{20}$$

Note that by uniqueness of η^* then $\Delta_\eta^* < 0$. For c close to zero, then $G(\Omega)$ is close to zero, and therefore $d\eta^*/dc < 0$. To find $d\eta^*/d\alpha$, I use the same method to obtain,

$$\frac{d\eta^*}{d\alpha} = \frac{\partial \eta}{\partial \alpha} = -\frac{\Delta_\alpha^*}{\Delta_\eta^*} = -\frac{\int_0^z G(x)}{\Delta_\eta^*}. \tag{21}$$

B. Alternative Bargaining Formulation

In the main analysis, the firm makes a take-it or leave-it offer to the agent at time 1. Now consider the opposite formulation, i.e., when the worker can give a take-it or leave-it wage demand to the principal and leaves the firm if these conditions are not met. Since the principal in practice may not know at which point in time the agent learns about x, this formulation may be more realistic and opens up for the interesting possibility that the agent through the wage demand can reveal information about x (if employed in a large firm).

Let us begin by considering a small firm (symmetric information). First suppose that $c > 0$. In that case, it is always efficient that the agent stays in the firm, and the optimal take-it or leave-it

[34] Recall that the large firm pays the same wage to all agents that stay in the firm. The small firm can replicate whatever wage policy the large follows but pay less to the agents with a low x (it can do even better but that is beside the point). Therefore $\Pi_S - \Pi_B > 0$ when $\alpha = 1$, $\eta = 1$, and $c < 1$. When $c = 1$, the profits of both types of firm equals $E(x)$, in which case the only solution to the fixed point equation is for $\bar{\alpha} = 1$. Therefore the curve defined by the function $f(c)$ can hit the c axis only in the point $c = 1$.

demand, denoted by w, clearly equals x. That leaves the firm's profit at zero. In the case with $c < 0$, the worker will take x if $x > c$ but leave the firm if $x < c$. Hence I can express the optimal take-it or leave-it demand as,

$$w = \begin{cases} 0 & \text{if } x < c \\ x & \text{if } x \geq c. \end{cases} \tag{22}$$

Note that separations are efficient also in this case, since the worker takes the social benefits and costs of a separation fully into account. *A large firm.* To illustrate how the agent can convey information through his demand, and how this may affect who becomes entrepreneurs, I focus on the equilibrium which conveys the maximal amount of information about the true x. This turns out to be a separating equilibrium where the agent fully reveals x through his demand.[35]

Let the agent's strategy be described by a (possibly random) function $w(x)$, which describes the wage he demands as a function of x, and let the firm's strategy be represented by an accept function $Q(w)$. The interpretation of the second function is that for any demand w, the firm accepts the demand with probability $Q(w)$ and rejects the demand (in which case the worker becomes an entrepreneur) with probability $1 - Q(w)$.

Suppose that a separating equilibrium exists where the agent fully reveals x through his demand w. By standard reasons, there cannot exist such an equilibrium where the firm's strategy is deterministic (i.e., only takes the values 0 or 1).[36] I therefore confine attention to the firm playing a mixed strategy.[37] For a firm playing a mixed strategy, it must be indifferent between accepting the worker's demand or not, and consequently $w(x) = x$, i.e., the worker takes all the rents. For a given x and $Q(\cdot)$, the agent's utility from demanding w equals,

$$U(w, x) = Q(w)w + [1 - Q(w)](\eta x - c). \tag{23}$$

The first term reflects that the agent gets the continuation wage w if the firm accepts the demand. The second term reflects that the worker gets the entrepreneurial payoff $U(x)$ if the demand is rejected. Without loss of generality I can assume that $Q(\cdot)$ is continuous and differentiable. Writing $Q(w)$ as Q, and $\mathrm{d}Q/\mathrm{d}w$ as Q', I then have that,

$$\frac{\mathrm{d}U}{\mathrm{d}w} = Q'(w - \eta x + c) + Q. \tag{24}$$

For a separating equilibrium to exist, $w = x$ must be the optimal wage demand for all x,

$$Q'(x - \eta x + c) + Q = 0. \tag{25}$$

This is a linear partial differential equation in x, with the solution,

$$Q(x) = K[(1 - \eta)x + c]^{-\frac{1}{1-\eta}}. \tag{26}$$

where K is an integration constant. Since it is strictly optimal for the firm to accept a zero demand, I can impose the corner condition $Q(0) = 1$ to arrive at,

$$Q(x) = c^{\frac{1}{1-\eta}}[(1 - \eta)x + c]^{-\frac{1}{1-\eta}}. \tag{27}$$

As can easily be verified, this function is decreasing and convex in x.[38] I therefore have that,

[35] This Section has formal resemblence to the financier-entrepreneur costly state verification repayment game modelled in Hvide and Leite (2004). As discussed there, the separating equilibrium has some attractive equilibrium selection properties. Issues of renegotiation are also discussed in that paper.

[36] Suppose that the firm plays a pure strategy, and let $\tilde{w}$ be the highest offer that the firm would accept with probability 1. Then all worker types would strictly prefer to offer $\tilde{w}$, which would contradict the assumption that there exists a fully separating equilibrium.

[37] One interpretation of such a mixed strategy is that there are many possible firm types, and that each of these play a pure strategy. In aggregate, however, they must play a mixed strategy described by $Q(.)$.

[38] That $Q(\cdot)$ is convex intuitively means that the principal is particularly sensitive to the agent lying when making small offers w, which is economically plausible.

PROPOSITION 4. *When the agent makes the take-it or leave-it demand, the firm makes zero profits, and the probability of the worker becoming an entrepreneur increases in x.*

Proof. This follows directly from $Q(x)$ decreasing in x.

As can be shown, this equilibrium has the same qualitative comparative statics properties to that in the main case (Remark 4).

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