Task Discretion, Labor Market Frictions and Entrepreneurship*

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Abstract

An agent can perform a job in several ways, which we call *tasks*. The decision rights over which task to choose change with the agent's occupation: it is the prerogative of management within firms, and of the agent himself if he is an entrepreneur. While an agent's comparative advantage at different tasks is unknown, it can be learned by observing his performance. However, tasks that generate more information may also lead to lower short-term expected profits. Hence in the presence of contracting frictions firms will allocate workers to more informative tasks only if workers cannot easily move to other firms. In this case, agents may prefer to become entrepreneurs and acquire task discretion, even if their short-term payoff is lower than in firms. The model generates novel predictions with respect to, for example, the payoff and wage dynamics of agents who switch between entrepreneurship and employment.

JEL classification: D83, J24, J62, J63, L26, M13.

Keywords Task discretion, organizational choice, entrepreneurship, labor-market frictions, entrepreneurial failures, learning.

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1 Introduction

The property right literature has long argued that contracting frictions may prevent the efficient allocation of inputs within production units (Grossman and Hart, 1986). An overlooked implication is that, to the extent that the allocation of residual decision rights differs across occupations, contractual frictions may lead to misallocation of inputs also across occupations. Motivated by this observation, we study how contractual frictions affect both agents' sorting across occupation and then, within each production unit, between different ways to do a job, which we call *tasks*. We do so by building a two-period model in which agents first sort between employment in a firm and entrepreneurship, and then between one of two tasks. An agent's productivity at different tasks, i.e., his talent, is unknown but can be learned by observing his performance at a task, with some tasks being more informative than others. However, task allocation is not contractible. As in the property right literature, task allocation is chosen by owners or management within firms, and by the agent himself if he is an entrepreneur.

Examples of non contractible tasks informative about talent are plentiful. A contract with a scientist defines the objective of the research (e.g., find a cure for Alzheimer) but not the exact experimental design, even if the experimental design may reveal the scientist's comparative talent at following well established or unusual research paths. A contract with a new manager does not specify the exact organizational chart of the firm (people under his authority or people who have authority on him), and, as a consequence, does not specify the extent to which he can delegate or centralize decisions. Delegating or centralizing decisions may, however, reveal his comparative advantage at different styles of management.

An initial result is a novel motive for entrepreneurship: we show that an agent may become entrepreneur to gain task discretion and learn his talent. This motive resembles the well-documented "be one's own boss" motive (see for example the survey by Stephan et al., 2015). Importantly, however, we do not assume that individuals have an intrinsic benefit from task discretion, from being their own boss. Becoming an entrepreneur to acquire task discretion is beneficial if and only if learning does not occur within firms while it would be efficient. This, in turns, depends on the level of labor market frictions which, in the model, are measured by the probability that an agent receives an external wage offer. As this probability decreases, firms are more likely to allocate their employees to informative tasks because they capture part of the benefit of learning their workers' comparative advantage. It follows that agents are less likely to become entrepreneur to gain task discretion when labor market frictions are high. Hence, the novelty here is to connect labor market frictions, with firms' internal organization, with agent's career choice.[1]

A second contribution is to link the level of labor market fictions to the productivity of former entrepreneurs relative to former workers, hence to their respective wage dynamics. When labor market fictions are low, some agents will become entrepreneurs to learn their talents, which cannot happen within firms. As a consequence, in the following period, if these agents decide to switch occupation, they will earn a higher wage than former workers—there is a *positive wage premium for former entrepreneur*. On the other hand, if labor market frictions are high, learning will occur within firms. Agents may choose entrepreneurship if they have a very valuable business idea or if they fail to find a job. These agents are less likely then workers to choose an informative task allocation, leading to a *negative wage premium for former entrepreneurs*.

The model therefore sheds new light on the relationship between labor market frictions, the motives for entrepreneurship and the internal organization of firms (in terms of task discretion). Doing so generates a number of interesting results. In particular, in the model there is a non-monotonic relationship between the degree of labor market frictions and the likelihood of entrepreneurship. When labor market frictions are large, the main effect of a decrease in labor market frictions is to decrease the number of individuals who do not receive wage offers and are forced into entrepreneurship. Therefore

[1] That is, the connection between labor market frictions and organizational choice was noted before. For example, in Acemoglu and Pischke (1999), as labor market frictions increase firms become more likely to invest in generic human capital. Here we point out that these changes in organizational structure have implication for career choice.

the total number of entrepreneurs decreases when labor market frictions decrease. However, as labor market frictions decrease further, firms' organization will change, making learning within firms impossible, making entrepreneurship more appealing. Hence, it is possible that, as labor market frictions decrease, *fewer* agents are hired by firms and *more* of them will become entrepreneurs.

These comparative static results are consistent with a rough comparison between the US and the EU. By most estimates, labor-market frictions in continental Europe are significantly higher than in the USA.[2] Consistent with our theoretical mechanism, the US has a higher rate of entrepreneurship than the EU (see, for example, the Global Entrepreneurship Monitor 2015/16 Global Report[3]). Also, US firms tend to give less task discretion to their workers than EU firms: according to OECD (2013) the US ranks 14th out of 22 in terms of task discretion within firms, below most European countries.[4]

Relative to the existing literature (which we discuss in details below), our main methodological innovation is to assume that agents sort across occupations, each bundled with different decision rights. This is in sharp contrast with existing papers that study how learning determines wage dynamics and career paths *within* an occupation but across heterogeneous firms (see, for example, Papageorgiou, 2013 or Pastorino, 2019, both discussed in more detail below). Instead, we assume that firms are identical and focus on occupational choice and wage dynamics *across* occupations, e.g., how previous entrepreneurs fare with respect to past workers when they go back to employment.

The rest of this paper proceeds as follows. The next section discusses the relevant literature. In Section 3 we introduce the model. In Section 4 we derive conditions under which the choice of task presents a trade off between learning

[2] Close to our measure of labor frictions, Ridder and Berg (2003) estimate the rate of arrival of job offers to employed workers for the US, France, UK, Germany and Holland; they show that, with the exception of the UK, European countries have a rate of job arrival that is significantly lower than in the US; Layard, Nickell, and Jackman (2005) find a similar ranking among countries when looking at the arrival rate of job offers to unemployed workers.

[3] Available at http://www.gemconsortium.org/report/49480.

[4] In this study, the variable *task discretion* is defined, as in our model, as "Choosing or changing the sequence of job tasks, the speed of work, working hours; choosing how to do the job." The study is available at `https://read.oecd-ilibrary.org/education/oecd-skills-outlook-2013_9789264204256-en`, see in particular Figure 4.2.

and short-run profit maximization. We assume that this trade off is present, and derive the equilibrium of the model in Section 5. In Section 6, we present additional results relative to wages of entrepreneurs and workers along their career path and the value of entrepreneurial failures. We conclude in Section 7. Unless otherwise noted, all mathematical derivations are in Appendix A. In Appendixes B and C we relax some of our assumptions.

2 Relevant Literature

We contribute to the literature on occupational choice, learning in the labor market, entrepreneurial failures and incentives for experimentation.

Co-determination of organizations and occupational choices. Other models in which organization and occupational choice are simultaneously determined are Hellmann (2007) and De Bettignies and Chemla (2008), who focus on intellectual protection as a determinant of *innovation development* within or outside firms. When an employee owns his inventions, his incentive to innovate increases, and with it the incentive to develop this innovation as an entrepreneur, outside the firm. The firm's optimal response may be to allow the worker to develop the innovation internally as an "intrapreneur." De Bettignies and Chemla (2008) also find that as the return to entrepreneurship increases, firms become more likely to engage in corporate venturing. We instead focus on labor-market frictions as determinant of both entrepreneurial activity and firms organizational structure.[5]

Occupational choices and learning comparative advantages. We introduce learning agents' comparative advantages at different tasks as a driver of organizational and occupational choice. We therefore complement the literature on occupational choice started by Banerjee and Newman (1993) and

[5] Note also that there are various ways in which firms' organizational choice affects talent discovery. Here we focus on task allocation. In the seminal work of Meyer (1994) the choice is how to form teams.

Galor and Zeira (1993) that has considered financial frictions as a key determinant of career choices. Closer to our focus on learning, a literature initiated by Vereshchagina and Hopenhayn (2009) studies the choice between wage work and entrepreneurship under the assumption that the return on entrepreneurship is uncertain but can be learned. Within this literature, Manso (2016) and Dillon and Stanton (2017) show that the instantaneous payoff of entrepreneurs may be lower than that of comparable workers. This happens because entrepreneurs can always go back to wage work after having discovered that their entrepreneurial returns are low, and hence some agents are willing to "try out" entrepreneurship even if their returns are expected to be low. In our model, instead, agents learn their comparative advantage at different tasks, and by doing so increase their productivity at all possible occupations. Hence, by becoming entrepreneurs, agents do not learn their entrepreneurial ability, but rather they learn their ability *tout court*. This has novel empirical implications relative to, for example, the wage paid by firms to former entrepreneurs, which could be above or below that of former workers depending on the severity of labor-market frictions (see Section 6.1).

In this respect, we are related to Hincapié (2020), who consider a model similar to Dillon and Stanton (2017) in which agents are risk averse and performance as a worker is informative with respect to entrepreneurial ability (and vice versa). The model is then estimated using US data, leading a number of interesting results. For example, an agent may want to work for a few years before becoming an entrepreneur, which rationalizes the observations that most entrepreneurs start when they are in their mid-thirties (and not at the start of their career). For our purposes, Hincapié (2020) finds a positive wage premium for entrepreneurs returning to wage work (provided that the entrepreneurial spell was long enough and the entrepreneur returns to white collar work). This is in line with our model for the case of low labor market frictions. We show, however, that the entrepreneurial wage premium may be negative when labor market fictions are large (again, see Section 6.1).

Talent discovery in the labor market. Starting from Jovanovic (1979), a large body of literature has studied the implication of learning for career paths and wage dynamics. In pioneering papers, MacDonald (1982a,b) analyzes a task-assignment problem with symmetric uncertainty about talent, a frictionless labor market and employment as the unique occupation. Gibbons and Waldman (1999) and Gibbons and Waldman (2004) develop within-firm task assignment models in which there is learning about an agent's talent via task allocation, and also task-specific human capital accumulation. Terviö (2009) argues that cash constraints or the absence of long-term contracting prevent optimal talent discovery, in the sense that jobs will not reveal productivity of the worker. Antonovics and Golan (2012) address experimentation, defined as choosing a job where the expected probability of success is low, but where the agent's type correlates with outcome. Pastorino (2019) estimates a labor market model in which firms generate information about their workers via task assignment, and measures the importance of learning relative to human capital accumulation in explaining cumulative wage growth and wage dispersion. In Canidio and Gall (2019) the rate of on-the-job talent discovery depends on the task allocation chosen within firms, which may be inefficient.

here we may want to cite Guvenen et al. (2020).but in their model in every period, a worker chooses the occupation that better fits its current belief wrt its productivity. Hence, learning does not motivate the choice of career. Of course, in an occupation, a worker may learn something, revise its expected productivity and then change occupation. But people do not choose a job because of learning. I don't think we should cite them. On the other hand, Antonovics and Golan (2012) is more closely related because people choose jobs precisely because they lead to learning

Within this literature, Papageorgiou (2013) is the most closely related because it considers labor-market frictions, and studies how they affects talent discovery. His model assumes that firms use only one task and cannot choose their internal organization. In his framework, agents must move *between* firms to discover their comparative advantage. Hence, as labor-market frictions increase, mobility decreases and the rate of talent discovery must decrease. This is not always true in our model because agents can learn *within* firms, and more severe labor-market frictions enhance learning in firms. Also related is Bruenner, Friebel, Holden, and Prasad (2019), who study how the incentive to learn one's talent is affected by the structure of the labor market (i.e., whether the labor market is competitive or monopsonistic). They consider a two period model in which agents first learn (in a stage that is interpreted as education) and then work. They show that a competitive market creates more incentives to learn because a larger fraction of the benefit of learning is earned by the agent. Here instead we are interested in learning on-the-job: how performing a job in different ways (which we interpret as tasks) may generate information relative to the agent's talent.

All the above papers consider a single occupation, and hence study how learning affects wage dynamics within an occupation. Our novelty with respect to this literature is that, in our model, agents can switch occupation and become entrepreneurs. Our focus is on how learning affects occupational choices and wage dynamics *across occupations*.[6]

Value of failures. It is a common assumption in the economic literature that failures provide bad news about the expected productivity of an agent. Prominent examples in the literature on entrepreneurship are Gromb and Scharfstein (2002) and Landier (2005), who build equilibrium models in which entrepreneurial failures always produce a stigma, which may be more or less pronounced depending on some features of the economy. In Gromb and Scharfstein (2002), failed entrepreneurs are hired by firms. Because of exogenous noise, failing in a start-up is not as bad a signal as being fired as a manager, and firms will replace failed managers with failed entrepreneurs. Landier (2005) shows that when failures are widespread, they reveal little information regarding the entrepreneur's type and hence there is a high level of entrepreneurship. When failures are rare, they carry a larger stigma and deters

[6] An important observation is that our paper (as well as all those discussed above) assume symmetric uncertainty. Bar-Isaac et al. (2020) instead assume asymmetric information. In that model, the selection of workers into different sectors is driven by adverse (or sometimes advantageous) selection.

entrepreneurship.[7]

Many business leaders and scholars share Henry Ford's view that a failure "is only the opportunity to begin again more intelligently." For example, the *Harvard Business Review* dedicated an entire issues to failures and how they led to business success ("Failure Chronicles," April 2011). A recent book by the journalist Tim Harford, *Adapt: Why Success Always Starts with Failure* well summarizes this positive attitude in the business world toward entrepreneurial failures.

Our model shows how the value of entrepreneurial failures reflects the *nature of talent*. Talent can be *horizontal*–different agents have an absolute advantage at different tasks—or vertical *vertical*– same agents have an absolute advantage at all tasks. We show that talent can be good news or bad news depending on the level of labor market frictions only if talent is horizontal. If instead talent is vertical, failures are always bad news. As we will see, current evidence provides support to the horizontal view.

Experimentation and incentives. The literature on experimentation and incentives (Jeitschko and Mirman, 2002; Manso, 2011; Drugov and Macchiavello, 2014; Gomes, Gottlieb, and Maestri, 2016) focuses on how to design a contract that motivates *an agent* to experiment. By contrast, in our model the contracting frictions is that firms cannot commit to allocate a worker on a given task. Hence, our focus is on how to design a contract that motivates a firms to experiment.

Finally, at the core of our model there is a tradeoff between short-run profit maximization and learning. This tradeoff has been extensively studied by the literature on multi-arms bandit problems, and is therefore neither new nor specific to our model. However, this literature typically assumes that the arms are independent: success and failures at an arm is not informative with respect to the other arm. Hence, failures always reduce the probability of future success. This case is therefore equivalent to the vertical talent case.

[7] See also Schumacher, Gerling, and Kowalik (2015).

3 The model

The economy is composed of a finite set of risk-neutral agents and a finite set of at least two identical firms competing for workers. Agents live for two periods $t \in \{1,2\}$, and can be of type $\theta \in \{l,h\}$, where l stands for low and h for high. Agents' types are *not* observable by agents or firms. The common initial belief about a young agent's type is $\mathrm{pr}\{\theta = h\} = p_1$.

Production and returns. At the beginning of each period, each agent gets an idea about a project $k_t \geq 0$, drawn from a continuous distribution with c.d.f. $F(k_t)$ continuous and differentialble. The distribution of projects may or may not have an upper bound, but if it has one, the upper bound must be greater than 1. It also does not have any hole, in the sense that if $F(k_t)$ is strictly increasing at two projects values k' and k'', it must be strictly increasing at all $k'' \in [k', k'']$.

If an agent becomes an entrepreneur, he can pursue this project and generate a monetary return k_t in case of success and 0 in case of failure. If instead the agent is employed by a firm he will work on an "off-the-shelf" project, generating a monetary return equal to 1 in case of success and 0 in case of failure (this is independent of the number of workers in the firm.) Hence, in each period, with probability $1 - \frac{1}{\lambda}$ an individual realizes that he can improve on the "off-the-shelf" project available within firms, while with probability $\frac{1}{\lambda}$ this individual will not be able to do so.

In each period t and in both occupations, an agent can work either on an Advanced task ($\tau_t = A$) or a Basic task ($\tau_t = B$), and may fail ($s_t = 0$) or succeed ($s_t = 1$). The probability of success depends on the agent's type and the task chosen:[8]

$\tau\backslash\theta$	l	h
B	l_B	h_B
A	l_A	h_A

When each agent is assigned to the task at which he is the most likely to succeed, high types have an advantage over low types:

$$\max(h_A, h_B) \geq \max(l_A, l_B). \tag{1}$$

To avoid trivialities, we assume that individuals have different comparative advantages, high types being better at the advanced task while low types being better at basic tasks:[9]

$$h_A - h_B > 0,\ l_B - l_A > 0. \tag{2}$$

For instance, some agents may excel at finding creative solutions to a new problem but will be unproductive at following strict orders; others flourish and can be creative in a team environment but will be low performers in isolation. The environment described in (1)-(2) is a discrete version of MacDonald (1982a,b) and is consistent with two visions of talent.

- (**Vertical talent**) If $h_B \geq l_B$ the probabilities of success at both tasks are at least as large for type h than type l. Hence types can be ranked in terms of productivity. High types have an absolute advantage over low types: they have higher "quality" independently of the task they are working on. This is the usual interpretation of talent as a vertical dimension.

[8] Note that the specification allows for a task to be uninformative (for instance $l_B = h_B$). In a previous version of the model we considered the possibility of a third type of agent who is "bad" at all tasks but this extension complicated the analysis without bringing additional insights (if there is a minimum productivity threshold for an agent to be hired, then some agents may be unemployable, but otherwise the task allocation problem of employable agents is the same as in the current specification).

[9] If this is not the case, there is a task that maximizes the probability of success of each type, and no firm or entrepreneur will use the other task since learning has no value for task allocation.

- (**Horizontal talent**) When $h_B < l_B$, high type agents have a larger probability of success only if assigned to the advanced task A. Otherwise, if assigned to the basic task, a high type agent is in fact less successful than a low type agent. Talent is *horizontal* rather than vertical, and it is not possible to rank types in terms of productivity unless the task assignment is defined.

Contract offers. We restrict attention to short-term contracts. In every period, a contract consists of a fixed payment f and a bonus payment b contingent on success. We make the following additional assumptions on the contracting environment.

Assumption 1.

(i) Output is not fully contractible: the bonus is strictly bounded above by the monetary return of the firm, that is $b \leq \beta < 1$.

(ii) Task allocations within firms are observable but not contractible.

We interpret the parameter β in (i) as an index of contract completeness. Within a firm, the value of a success is 1, but contracts can be contingent only on β. For instance, if the owners of the firm can "run away" and capture a proportion $1 - \beta$ of the monetary return, bonus payments with a share of monetary returns greater than β are not incentive compatible. Because $\beta < 1$ a worker and a firm cannot sign a contract that leaves the firm completely indifferent between success or failure.

The second part (ii) of the assumption implies that contracts cannot be made contingent on task allocation. This is consistent with the modern literature on delegation which emphasizes that ownership restricts the ability not to interfere with other agents' decisions, in particular in the context of the delegation of tasks (Aghion and Tirole, 1997; Baker et al., 1999). Of course, in a specification of the model with more than two tasks, it may be possible to contract over sets of tasks (for example, different sets of task may require different locations, and location may be contractible). Such an extension would not change our results.

Our restrictions to short-term contracts and observable task allocations simplify the analysis but are not essential. In Appendix B we consider the case of unobserved task allocation, and show that our results hold in this case as well. In Appendix C we introduce the possibility of using long-term contracts. Not surprisingly, long-term contracts improve the value of entering in an employment relationship. However, they do not eliminate the probability that an agent becomes an entrepreneur to learn his type. It follows that our results hold qualitatively in that case as well.

Labor-market frictions. We introduce labor-market frictions in a stark way by assuming that with probability $1-\alpha$ an agent receives no offer from firms, and with probability α he receives some offers. For technical reasons, we also assume that when an agent who was not previously employed receives a wage offer, he receives at least two wage offers.[10] This would be the case for instance if there is a central place where all vacancies are posted and an agent has access to an imperfect search technology.

Timing In period $t = 1, 2$, the timing is the following:

(1) k_t (i.i.d. among agents) are realized. For ease of derivations, we assume that k_t is publicly observable.[11]

[10] If the probability of such agent's receiving a single offer is positive, firms can design their contracts knowing that, with a small probability, they might have monopsony power over the agent. This significantly complicates the firm's problem but does not modify our qualitative results. As we will see, this problem does not arise when a firm sends an offer to an agent who was previously employed. The reason is that agents can always continue an employment relationship, which implies that all other firms compete with the agent's former employer.

[11] The observability of k_t plays a role only if an agent is hired by a firm in period 1 and does not receive any wage offer in period 2, in which case the worker and the former employer need to agree on how to share the surplus generated by continuing the employment relationship. This surplus depends on the agent's outside option, which is entrepreneurship. Assuming that the value of entrepreneurship is observable prevents inefficient bargaining failures. Equivalently, we could assume that k_t is private information but can be disclosed, in which case a standard unravelling logic implies that, in equilibrium, workers who wish to continue an employment relationship in absence of an outside offer will disclose k_t to their former employer. If instead k_t is unobservable and cannot be credibly disclosed, then there is the possibility of a bargaining failure — that is, in period 2, an agent may leave

(2) All firms simultaneously offer contracts to all agents.

(3) **If t = 1**: agents who receive an employment offer choose between accepting an offer and being an entrepreneur. Agents who do not receive an employment offer become entrepreneurs.

If t = 2: Agents who receive an employment offer choose between accepting an employment offer, continuing working for their old employer (if the agent was employed in period 1), and being an entrepreneur. For agents who do not receive an employment offer, their career choice depends on their previous occupation. Former entrepreneurs who do not receive an offer remain entrepreneurs. Former workers who do not receive an offer choose between entrepreneurship and continuing working for their former employers. In this last case, their wage is determined by a take-it-or-leave-it offer made by their former employer.[12]

(4) After a contract is signed, the firm chooses the worker's task. Entrepreneurs choose their own task.

(5) Outcomes (success or failure) are realized and observed by everybody.[13] In case of a success, a firm's output is 1, while an entrepreneur's output is k_t.

Hence, the main differences between the two periods is the possibility of continuing an employment relationship.

Equilibrium. An equilibrium in the second period consists of an occupational choice by individuals and contracts offered by firms such that (i) firms make

a company to become an entrepreneur even if $k_2 < 1$. This will constitute an additional motive for entrepreneurship, from which we prefer to abstract away.

[12] All our results are robust to other assumptions, provided that some of the surplus generated by continuing the employment relationship is captured by the firm.

[13] The fact that entrepreneurial success or failures are observable is uncontroversial. Observability of output within firms is a standard assumption in the career-concerns literature (see the seminal work Holmström, 1999), but it is however more controversial and not universal (for example, in Waldman, 1984, output is non observable). Here we assume observability of output within firms so to simplify the comparison with output produced by entrepreneurs.

zero profit if they compete for an individual, and a firm obtains a share $1-\beta$ of the surplus of an existing worker if no other firm makes an offer and (ii) individuals choose their occupation optimally. An equilibrium in the first period consists of an occupational choice by individuals and contracts offered by firms such that (i) firms make zero profits over the two periods and (ii) individuals choose their occupation to maximize their expected two period surplus, taking as given the continuation values.

Efficient benchmark. In what follows, we will compare the equilibrium outcome with a constrained efficient benchmark. In this benchmark agent's talent is unknown and there are labor market frictions, but there are no contracting frictions. That is, our constrained efficient benchmark corresponds to the above model under the assumption that $\beta = 1$: a firm and an agent can, if they wish, agree that the entire output will be paid to the agent as bonus. This allows us to make transparent how contracting frictions affect the probability that an agent becomes an entrepreneur.

4 Learning

As a first step in solving the model, we study how the probability that the agent is a high type evolves depending on period-1 task allocation and outcome. In the next section we then derive the optimal period-1 task allocation for each profession, and, given this, the choice between entrepreneurship and wage work.

For any belief p_t that the individual is of type h, the probability that there is a success in a given period is:

$$\pi(\tau_t, p_t) \equiv \begin{cases} (1-p_t)\cdot l_A + p_t \cdot h_A & \text{if } \tau_t = A \\ (1-p_t)\cdot l_B + p_t \cdot h_B & \text{if } \tau_t = B. \end{cases}$$

It follows that the probability of success in the current period is maximized by assigning the agent to task B if and only if p_t is smaller than the cutoff value

$$p^* \equiv \left(1 + \frac{h_A - h_B}{l_B - l_A}\right)^{-1}, \tag{3}$$

We define the period-1 probability of success as $\sigma_1(\tau_1) \equiv \pi(\tau_1, p_1)$, that is the probability of instantaneous success at the initial belief p_1. Without loss of generality, we assume that task B is the short-term output maximizing task.

Assumption 2. *$p_1 < p^*$: task B maximizes period-1 probability of success, that is $\sigma_1(B) > \sigma_1(A)$.*

We can also derive the *period-2* probability of success as a function of *period-1* task allocation. Because period 2 is the last period of the game, in that period both entrepreneurs and firms choose the task allocation that maximizes the instantaneous probability of success. For given belief p_2, the *equilibrium* probability of success in period 2 is therefore:

$$\pi^M(p_2) \equiv \max_{\tau_t} \pi(\tau_t, p_2) = \begin{cases} (1-p_2)l_B + p_2 h_B & \text{if } p_2 \leq p^* \\ (1-p_2)l_A + p_2 h_A & \text{if } p_2 \geq p^*. \end{cases} \tag{4}$$

The belief p_2 depends on period-1 task allocation τ_1 and whether there was a success ($s_1 = 1$) or a failure ($s_1 = 0$):

$$p_2(\tau_1, s_1) \equiv \begin{cases} \left(\frac{1-p_1}{p_1}\frac{l_{\tau_1}}{h_{\tau_1}} + 1\right)^{-1} & \text{if } s_1 = 1 \\ \left(\frac{1-p_1}{p_1}\frac{1-l_{\tau_1}}{1-h_{\tau_1}} + 1\right)^{-1} & \text{if } s_1 = 0. \end{cases}$$

We can therefore define the expected period-2 probability of success as a function of the task chosen in period 1 as:

$$\sigma_2(\tau_1) \equiv \mathbb{E}_{s_1 \in \{0,1\}} \pi^M(p_2(\tau_1, s_1)),$$

In what follows, we will use the index

$$\Omega \equiv \frac{\sigma_2(A) - \sigma_2(B)}{\sigma_1(B) - \sigma_1(A)},$$

to measure the benefit of learning—given by the increase in period-2 probability of success $\sigma_2(A)-\sigma_2(B)$—relative to its cost—given by the decrease in the period-1 probability of success $\sigma_1(B)-\sigma_1(A)$. As we will see, a meaningful trade-off between short run profit maximization and learning emerges within firms if, and only if, Ω is positive and sufficiently large (see Assumption 3). We present in Appendix A conditions on the primitives p_1, h_A, h_B, l_A and l_B such that $\sigma_2(A) > \sigma_2(B)$. When these conditions are satisfied and $p_1 \to p^*$, $\sigma_1(B)-\sigma_1(A)$ becomes arbitrarily small. This is because the initial prior is sufficiently ambiguous so that the reduction in the period-1 probability of success of choosing $\tau_1 = A$ over $\tau_1 = B$ is negligible. At the same time $\sigma_2(A)-\sigma_2(B)$ remains bounded away from zero, and hence the value of learning becomes arbitrarily large.

In addition to the index of learning Ω, the ratios $\frac{\sigma_2(A)}{\sigma_1(A)}$ and $\frac{\sigma_2(B)}{\sigma_1(B)}$ will play a role in our analysis and shape the occupational choice and the task assignment in firms.

5 Equilibrium Analysis

In the first subsection we derive the lifetime value of starting a career as a worker or as an entrepreneur. In the next subsection, we solve for the choice of occupation, taking into account that some agents may not receive wage offers.

5.1 Value Functions

Lifetime utility of a period-1 entrepreneur. In period 1, an entrepreneur generates k_1 in case of success. In period 2, the same agent may receive a wage offer. If he accepts this offer he earns the full expected return of the firms' project,[14] which implies that the choice of becoming an entrepreneur or

[14] Because period 2 is the last period of the game, firms and workers have the same preferences over task allocation: they prefer the task allocation that maximizes period-2 output. Hence, the exact structure of a period-2 contract (that is, what part is paid as bonus b and what part is paid as fixed wage f) is not relevant.

employee depends on whether the firm's project or the entrepreneurial project is more valuable. Such agent, however, may not receive a wage offer, in which case he will be again an entrepreneur and earn k_2 in case of success. Hence, for this agent, the expected value of a period-2 success is

$$K(\alpha) \equiv \alpha\mathbb{E}[\max(k_2, 1)] + (1-\alpha)\mathbb{E}[k_2]$$

which is strictly increasing in α. The above expression can be rewritten as

$$K(\alpha) = \mathbb{E}[k_2] + \alpha \cdot Q$$

where Q is the option value of being a worker instead of an entrepreneur:

$$Q \equiv \mathbb{E}[\max(1-k_2, 0)] = F(1)(1 - \mathbb{E}[k_2|k_2 < 1])$$

It follows that a period-1 entrepreneur generates an expected return over the two periods equal to

$$\sigma_1(\tau_1)k_1 + \sigma_2(\tau_1)K(\alpha).$$

Hence, a period-1 entrepreneur chooses $\tau_1 = A$ whenever

$$k_1 \leq K(\alpha)\Omega \tag{5}$$

That is, the entrepreneur will favor learning over short-run profits whenever the value of a period-1 success relative to the value of a period-2 success is bounded above by the value of learning. Note in particular that as labor-market frictions become more severe the value of a period-2 success decreases and the entrepreneur is more likely to choose task B in period 1.

The above discussion directly implies the following lemma:

Lemma 1. *The lifetime utility of a period-1 entrepreneur is:*

$$W^E(k_1, \alpha) = \begin{cases} \sigma_1(A)k_1 + \sigma_2(A)K(\alpha) & \text{if } k_1 \leq K(\alpha)\Omega \\ \sigma_1(B)k_1 + \sigma_2(B)K(\alpha) & \text{if } k_1 \geq K(\alpha)\Omega, \end{cases} \tag{6}$$

which is continuous and strictly increasing in both arguments.

Lifetime utility of a period-1 worker. In period-1, a worker generates a return equal to 1 in case of success. In period-2, the same agent will become an entrepreneur if $k_2 > 1$. Otherwise, if he does not receive a wage offer he will continue working for his old employer, but if he receives a wage offer he may change employer; in either case he produces 1 in case of success. Hence, for given period-1 task allocation, the expected output generated over the two periods by a period-1 worker is:

$$\sigma_1(\tau_1) + \sigma_2(\tau_1)K(1).$$

Competition among firms guarantees that this expression is also equal to the period-1 worker total lifetime utility for given τ_1.

In order for a meaningful tradeoff between between learning and short-run profit maximization to emerge in firms, it must be the case that the expected sum of the two-period outputs is maximized by implementing $\tau_1 = A$, which we assume.

Assumption 3. *Total output within firm is maximized by implementing $\tau_1 = A$, that is*

$$K(1)\Omega \geq 1 \tag{7}$$

However, the output maximizing task allocation may not be incentive compatible because of the moral hazard problem of the firm. We turn to the incentive compatibility condition that insures that the firm will choose an efficient task allocation.

Firms' incentive compatibility. Remember that when a worker does not receive a wage offer in period 2, his former employer will make him a take-it-or-leave-it offer and a firm may earn positive profits in period 2. Because firms earn zero profits in equilibrium, these period-2 profits are front-loaded in the period-1 compensation contract offered to the workers.

They are however relevant for deriving the period-1 task allocation. Indeed, after a contract (f, b) is signed in period 1, the fixed component f is sunk and the determinants of the optimal task choice are the bonus b and the expected period-2 profits. Choosing task A generates a period-1 opportunity cost equal to $(\sigma_1(B) - \sigma_1(A))(1 - b)$, a decreasing function of b. By contrast the *future* benefit of choosing task A in the first period is equal to the value of continuing the employment relationship, which in expected terms, is equal to

$$(1 - \alpha)\sigma_2(\tau_1)\mathbb{E}[\max\{1 - k_2, 0\}] = (1 - \alpha)\sigma_2(\tau_1)Q.$$

These profits are decreasing in α and, crucially, for $\alpha < 1$ are larger when $\tau_1 = A$ than when $\tau_1 = B$. Because of labor market frictions, firms may be able to earn in period 2 part of the benefit of learning their workers' talent.

Because the largest possible bonus is $b = \beta$, the firm can commit to implement task A in the first period if $(\sigma_1(B) - \sigma_1(A))(1 - \beta) \leq (\sigma_2(A) - \sigma_2(B))(1 - \alpha)Q$, that is when

$$\Omega \geq \frac{1 - \beta}{(1 - \alpha)Q}. \tag{8}$$

Quite intuitively, the above condition is more likely to hold whenever the value of learning is sufficiently large. It is also more likely to hold when labor market frictions are large and when contracting frictions are low (i.e., high β). It is also more likely to hold when Q is high, because Q is the expected surplus earned by a firm in period 2 in case the worker does not receive an outside wage offer.

There is a threshold

$$\alpha^F(\beta) \equiv 1 - \frac{1 - \beta}{\Omega \cdot Q}.$$

such that for $\alpha \leq \alpha^F(\beta)$, by offering a sufficiently large bonus b, a firm can commit to implement the most informative task (task A).[15] If instead $\alpha > \alpha^F(\beta)$ firms can only implements task B despite the fact that task A is the output-maximizing one. By construction, $\alpha^F(\beta) < 1$ and hence there are always values of α such that firms can only implement task $\tau_1 = B$. (It is however possible that $\alpha^F(\beta) < 0$, in which case firms can only implement task $\tau_1 = B$ for all values of α. Hence, firms can be short-termists for any value of α.)

Competition for workers among firms allows us to reduce the firm's problem to the choice of a task τ_1 that maximizes the two-period total output subject to the incentive compatibility constraints. This leads to the following lemma.

Lemma 2. *The lifetime utility of a period-1 worker is:*

$$W^F(\alpha,\beta) \equiv \begin{cases} \sigma_1(A) + \sigma_2(A)K(1) & \text{if } \alpha \leq \alpha^F(\beta) \\ \sigma_1(B) + \sigma_2(B)K(1) & \text{otherwise} . \end{cases} \tag{9}$$

hence is constant in α for $\alpha \neq \alpha^F(\beta)$ and has a downward discontinuity at $\alpha = \alpha^F(\beta)$.

Remember that the efficient task allocation within firm is $\tau_1 = A$. This implies that the task allocation within firm is inefficient whenever $\alpha > \alpha^F(\beta)$. The definition of $\alpha^F(\beta)$ implies the following corollary.

Corollary 1. *When $\alpha > \alpha^F(\beta)$ firms are short-termists: they inefficiently choose the short-run output maximizing task allocation. For given $\alpha < 1$, short-termism is more likely to happen when contracting frictions are high (i.e. low β), and the value of learning is small (i.e., Ω small), and the expected surplus generated by continuing an employment relationship is low (i.e., Q small).*

[15] The observation that larger bonuses can generate more learning contrasts with that of Manso (2011) who argues that a principal may motivate a worker to experiment by paying a fixed wage initially and a large bonus for success far in the future. The reason for this contrast is that in Manso (2011) the worker has a moral hazard problem, while in our model the firm has a moral hazard problem. Hence in our world, if a large bonus is paid to the worker, the firm's payoff is less sensitive to the realization of failures and success and therefore the firm is more likely to choose the learning-maximizing task allocation.

5.2 Equilibrium Occupational Choices

Having derived the value of being a period-1 worker or a period-1 entrepreneur, we now close the model by solving for the optimal period-1 occupational choice. In period 1, a fraction $1-\alpha$ of agents do not receive a wage offer and therefore become entrepreneurs. Those who receive a wage offer will become entrepreneurs if and only if their entrepreneurial projects is of sufficiently high value.

To derive the project value leaving an agent indifferent between becoming an entrepreneur or a worker, it is useful to introduce two thresholds. The first is the project value leaving an agent indifferent between becoming an entrepreneur or a worker *in case firms implement the efficient task* $\tau_1 = A$. We call such threshold $k^A(\alpha)$, implicitly defined as

$$W^E(k^A(\alpha),\alpha) = \sigma_1(A) + \sigma_2(A)K(1),$$

that can be explicitly written as

$$k^A(\alpha) = \begin{cases} 1 + \frac{\sigma_2(A)}{\sigma_1(A)}(K(1) - K(\alpha)) & \text{if } k^A(\alpha) \leq K(\alpha)\Omega \\ \frac{\sigma_1(A)}{\sigma_1(B)} + \frac{\sigma_2(A)}{\sigma_1(B)}K(1) - \frac{\sigma_2(B)}{\sigma_1(B)}K(\alpha) & \text{otherwise.} \end{cases}$$

The second threshold is the project value leaving an agent indifferent between becoming an entrepreneur or a worker *in case firms implement the inefficient task* $\tau_1 = B$. We call such threshold $k^B(\alpha)$, implicitly defined as the solution of the equation

$$W^E(k^B(\alpha),\alpha) = \sigma_1(B) + \sigma_2(B)K(1),$$

that can be explicitly written as

$$k^B(\alpha) = \begin{cases} 1 + \frac{\sigma_2(B)}{\sigma_1(B)}(K(1) - K(\alpha)) & \text{if } k^A(\alpha) \geq K(\alpha)\Omega \\ \frac{\sigma_1(B)}{\sigma_1(A)} + \frac{\sigma_2(B)}{\sigma_1(A)}K(1) - \frac{\sigma_2(A)}{\sigma_1(A)}K(\alpha) & \text{otherwise.} \end{cases}$$

Because the level of labor market frictions determine the task allocation within firms, the project value leaving an agent indifferent between being a worker or

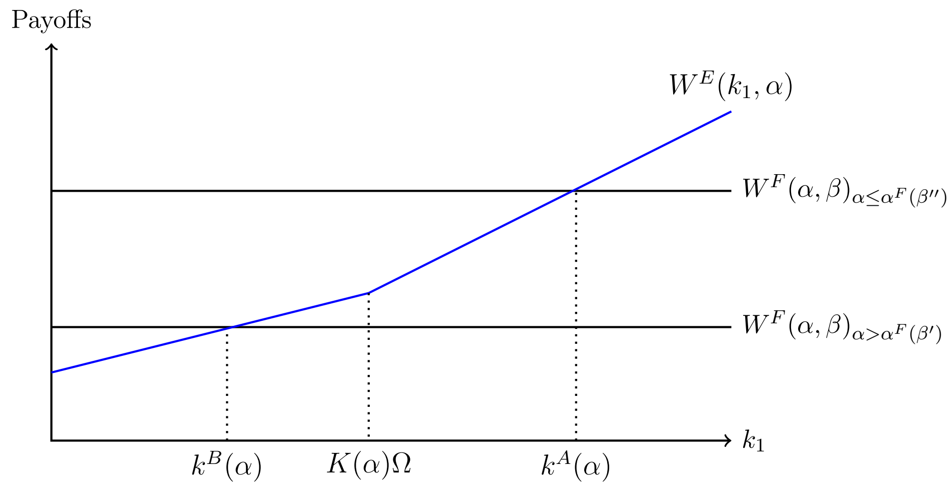


Fig. 1: Lifetime utility of being an entrepreneur in period 1 ($W^E(k_1, \alpha)$) and lifetime utility of working for a firm in period 1 ($W^F(\alpha, \beta)$) as a function of k_1. The graph considers a given value of $\alpha < 1$ and two values of β, one (β') sufficiently low so that firms implement task B, and the other (β'') sufficiently high so that firms implement task A.

an entrepreneur is

$$k^E(\alpha, \beta) \equiv \begin{cases} k^A(\alpha) & \text{if } \alpha \leq \alpha^F(\beta) \\ k^B(\alpha) & \text{if } \alpha > \alpha^F(\beta) \end{cases}$$

Figure 1 derives $k^A(\alpha)$ and $k^B(\alpha)$ for a given value of $\alpha < 1$. Note that, for given α, the firm will implement task A when β is sufficiently large, and task B when β is sufficiently low. Using this, in the graph $k^A(\alpha)$ and $k^B(\alpha)$ are given by the intercept of $W^E(k_1, \alpha)$ and $W^F(\alpha, \beta)$ for β' such that $\alpha > \alpha^F(\beta')$ and for β'' such that $\alpha \leq \alpha^F(\beta'')$.

Figure 2 instead plots $k^A(\alpha)$ (dashed), $k^B(\alpha)$ (dashed) and $k^E(\alpha)$ (solid blue) as a function of α. Note a few things. First, the value of working for a firm is higher when firms implement task A, which implies that $k^A(\alpha) > k^B(\alpha)$. It must also be the case that $k^A(1) = 1$: by Assumption 3 an entrepreneur with project value $k_1 = 1$ chooses to work on task A; this entrepreneur is therefore indifferent between working on task A in a firm or as an entrepreneur.

Also, both $k^A(\alpha)$ and $k^B(\alpha)$ are continuous and decreasing in α. That is because $K(\alpha)$ increases in α, and hence the future payoff of a period-1 entrepreneur increases in α. They are also parallel when they are both above or below $K(\alpha)\Omega$. Interestingly, both $k^A(\alpha)$ and $k^B(\alpha)$ decrease faster when they are below $K(\alpha)\Omega$ then when they are above. Mathematically, this is because Assumptions 2 and 3 imply that $\frac{\sigma_2(A)}{\sigma_1(A)} > \frac{\sigma_2(B)}{\sigma_1(B)}$. Intuitively, an increase in the period-2 payoff of a period-1 entrepreneur has a larger impact on the entrepreneur's lifetime payoff if this entrepreneur chooses $\tau_1 = A$ and hence favors learning in his task allocation. On the other hand, $k^E(\alpha)$ has a downward discontinuity at $\alpha = \alpha^F(\beta)$. Furthermore, at $\alpha = \alpha^F(\beta)$, $k^E(\alpha)$ will either maintain its slope (when $\alpha^F(\beta)$ is sufficiently large or sufficiently small) or may increase its slope (when $\alpha^F(\beta)$ is in an intermediate range, as drawn in the figure).

The probability of becoming an entrepreneur in period 1 is therefore

$$P_1^E(\alpha) = (1-\alpha) + \alpha \cdot \mathrm{pr}\{k_1 \geq k^E(\alpha,\beta)\}.$$

Note that the first part of the above expression is decreasing in α, while the second one is increasing in α, discontinuously so at $\alpha = \alpha^F(\beta)$. It follows that, whenever $\alpha^F(\beta) > 0$, at $\alpha = \alpha^F(\beta)$ there is a first order jump in the number of entrepreneurs.[16] This is due to the fact that firms change their task allocations, switching from the efficient one (for $\alpha < \alpha^F(\beta)$) to the inefficient one (for $\alpha > \alpha^F(\beta)$). Hence, it is possible that as the labor market becomes more efficient, fewer people become workers, preferring entrepreneurship instead.

Because $\alpha^F(\beta)$ is increasing in β, the above reasoning implies that if α is sufficiently above or below $\alpha^F(\beta)$, then changes in β do not affect the probability of becoming an entrepreneur. However, if α is sufficiently close to the threshold $\alpha^F(\beta)$, changes in β may affect the probability of becoming an

[16] The presence of this jump is an artifact of the fact that firms success has constant value equal to 1. In a previous version of this paper, the value of firms' success was drawn randomly at the beginning of each period. In that version of the model, the probability of becoming an entrepreneur is continuous. Also in that version of the model, as α increases the probability of an efficient allocation within firms decreases. Hence, all results are identical to those presented here, but their derivation is significantly lengthier.

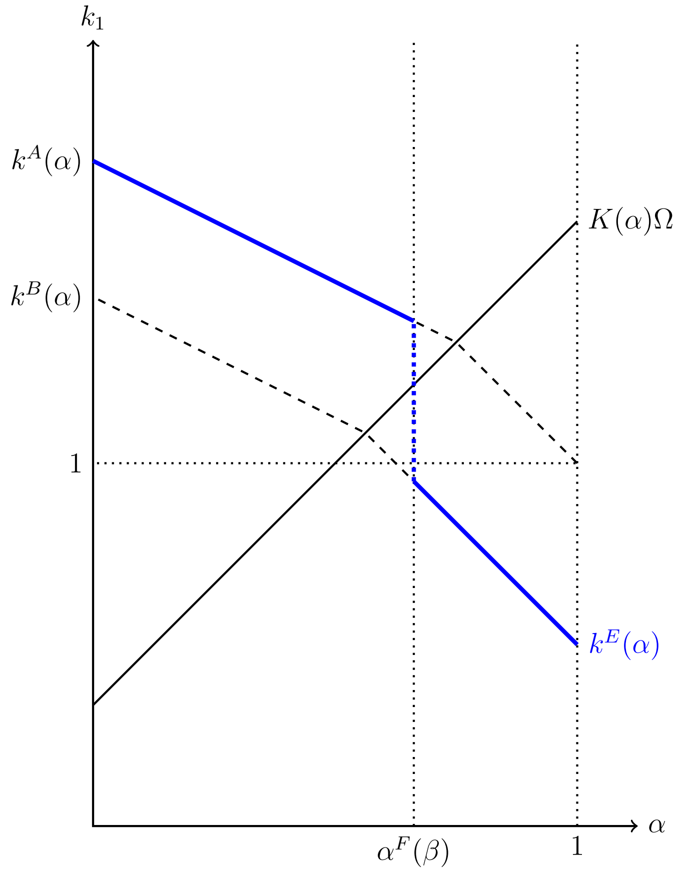


Fig. 2: $k^A(\alpha)$ (dashed), $k^B(\alpha)$ (dashed) and $k^E(\alpha)$ (solid blue) as a function of α (note: the axes are not at scale).

entrepreneur. More precisely, if $\alpha > \alpha^F(\beta)$ but sufficiently close to $\alpha^F(\beta)$, as β increases firms will be able to switch to task A, leading to a drop in the probability of becoming an entrepreneur. Hence, as contracting inefficiencies become less severe, fewer people choose entrepreneurship. The following lemma summarizes these observations (its proof is omitted).

Lemma 3. *Suppose $\beta > 1 - \Omega Q$, so that $\alpha^F(\beta) > 0$. For given β, there are values α', α'' such that $\alpha' < \alpha^F(\beta) < \alpha''$ and $P_1^E(\alpha') < P_1^E(\alpha'')$. For given α, $P_1^E(\alpha)$ is weakly decreasing in β.*

It is possible to derive conditions on the distribution of entrepreneurial projects $F()$ such that the probability of becoming an entrepreneur is locally increasing also far from the threshold $\alpha^F(\beta)$. We focus here on the threshold because the task allocation of workers and entrepreneurs change around the threshold (and not far from it). As we will see, this has additional implications regarding the wage of former entrepreneurs relative to former workers, and also regarding the value of entrepreneurial failures.

We note an interesting interaction between the two sources of market imperfections, labor (α) and contracting ()β). As β increases, $\alpha^F(\beta)$ increases, and the slope of $k^E(\alpha)$ weakly decreases, strictly so over some intermediate range of α. In this sense, as contracting inefficiencies become less severe, the marginal project determining the choice of entrepreneurship reacts less strongly to a decrease in labor market frictions. If the distribution of entrepreneurial projects $F(k)$ is uniform, any change in the slope of the threshold $k^E(\alpha)$ immediately translates in a change in the slope of $P^E(\alpha)$: as β increases $P^E(\alpha)$ increases less strongly in α, which means that β and α are substitutes in $P^E(\alpha)$. Of course, if the distribution of project is not uniform, this is not necessary the case, because the change in $P^E(\alpha)$ will also depends on the hazard rate of the distribution, and how it changes from $k^A(\alpha)$ to $k^B(\alpha)$.[17]

In period 2, all individuals who draw projects $k_2 > 1$ become entrepreneurs. Those with $k_2 < 1$ will be workers if they receive a wage offer, or if they were previously employed (in which case they can continue working for their former employer). Former entrepreneurs with $k_2 < 1$ who do not receive a wage offer will remain entrepreneurs. The probability of becoming an entrepreneur in period 2 is therefore:

$$P_2^E(\alpha) \equiv (1 - F(1)) + F(1)(1 - \alpha)P_1^E(\alpha).$$

We can now compute two commonly used measures of aggregate entrepreneurial

[17] Indeed, the slope of $P^E(\alpha)$ is equal to $-f(k^E(\alpha)\left(\frac{F(k^E(\alpha))}{f(k^E(\alpha))} + \alpha\frac{dk^E(\alpha)}{d\alpha}\right)$ which is non linear in α as long as the hazard rate $\frac{F(k)}{f(k)}$ is not linear in k. For instance, if $F(k)$ is the exponential distribution with parameter $\frac{1}{\lambda}$, the mean project has value λ and teh variation of $P^E(\alpha)$ has opposite sign to $e^{\frac{k^E(\alpha)}{\lambda}-1} - \alpha\frac{\sigma_2(\tau_1)}{\sigma_1(\tau_1)}K(1)$, which is clearly non-linear in α, even if $k^E(\alpha)$ is linear in α.

activity: the probability of being a serial entrepreneur and the average probability of becoming an entrepreneur across periods.[18] The probability of being a serial entrepreneur (that is, an entrepreneur in both periods) is

$$P^E_{\text{serial}}(\alpha) \equiv P^E_1(\alpha) \cdot (1 - \alpha + \alpha \cdot (1 - F(1))) = P^E_1(\alpha) \cdot (1 - \alpha F(1)) \,,$$

and the average probability of becoming an entrepreneur across periods:

$$\begin{aligned} P^E_{(1/2)}(\alpha) &\equiv \frac{1}{2} \left(P^E_1(\alpha) + P^E_2(\alpha) \right) \\ &= \frac{1}{2} \left(P^E_1(\alpha) \left(1 + (1-\alpha) F(1)\right) + 1 - F(1) \right) . \end{aligned}$$

Note that $P^E_{(1/2)}(\alpha)$ and $P^E_{\text{serial}}(\alpha)$ are strictly increasing in $P^E_1(\alpha)$. Hence, they both inherit the upward jump of $P^E_1(\alpha)$ at $\alpha^F(\beta)$. These two observations imply the following corollary.

Corollary 2. *Suppose $\beta > 1 - \Omega Q$, so that $\alpha^F(\beta) > 0$. For given β, there are $\alpha' < \alpha^F(\beta) < \alpha''$ such that $P^E_{(1/2)}(\alpha') < P^E_{(1/2)}(\alpha'')$ and $P^E_{serial}(\alpha') < P^E_{serial}(\alpha'')$. For given α, both $P^E_{(1/2)}(\alpha)$ and $P^E_{serial}(\alpha)$ are weakly decreasing in β.*

5.3 Types of entrepreneurs

Labor market and contracting frictions affect not only the probability of becoming an entrepreneur, but also the type of projects pursued by entrepreneurs and their task allocation. Based on the different motives for becoming an entrepreneur, our framework allows us to distinguish between three types of entrepreneurship:

- *Necessity entrepreneurs*: are those who would prefer to work for a firm, but become entrepreneurs because they do not receive any wage offer. In period 1, they are a fraction $1-\alpha$ of the entrepreneurs with $k_1 < k^E(\alpha)$; in period 2, they are a fraction $1-\alpha$ of the entrepreneurs with $k_1 < 1$.

[18] In an overlapping generation extension of the model, $P_{(1/2)}$ is the probability that, at any given moment in time an agent is an entrepreneur.

- *Opportunity entrepreneurs*: are those who prefer entrepreneurship to working for a firm, even when firms implement the efficient task allocation. In period 1, they are the agents with $k_1 > k^A(\alpha)$; in period 2, they are the agents with $k_1 > 1$.

- *Learning entrepreneurs*: are those who choose entrepreneurship because the task allocation within firms is inefficient. Because the task allocation within firm is always efficient in period 2, learning entrepreneurs can exist only in period 1. They are the ones with project value $k_1 \in [k^E(\alpha), k^A(\alpha)]$.

Hence, in period 1 there can be necessity, learning or opportunity entrepreneurs, while in period 2 there can only be necessity or opportunity entrepreneurs.

The left panel of Figure 3 illustrates how, in period 1, the proportion of different types of entrepreneurs changes with α (for a fixed value of β). Note that, by definition, learning entrepreneurs do not exist when the task allocation within firms is efficient, that is when $\alpha < \alpha^F(\beta)$. However, they always exist when $\alpha > \alpha^F(\beta)$, and their measure is increasing as contracting frictions become more severe (i.e., as β decreases).

The right panel of Figure 3 illustrates how the task allocation of entrepreneurs changes with α. Note how learning entrepreneurs mostly work on task A, but may also work on task B. These entrepreneurs would work for a firm if the task allocation within firms was efficient, but instead choose entrepreneurship. Their project value is however sufficiently high that they prefer task B.[19] It is also possible that opportunity entrepreneurs choose task A. This will happen for α close to 1 and $k_1 \in (1, K(\alpha)\Omega)$: the agent has a project that is better than that of firms, hence if labor market frictions are negligible this agent will become an entrepreneur. At the same time, the value of this project is relatively low, so this agent will favor learning over short-run profit maximization.

[19] Remember that the value of a future success for an entrepreneur is $K(\alpha)$, which is always below the value of a future success for a worker ($K(1)$). Hence, for given $\alpha < 1$ and $k_1 > 1$, it may be efficient to choose task A in firms but task B as an entrepreneur.

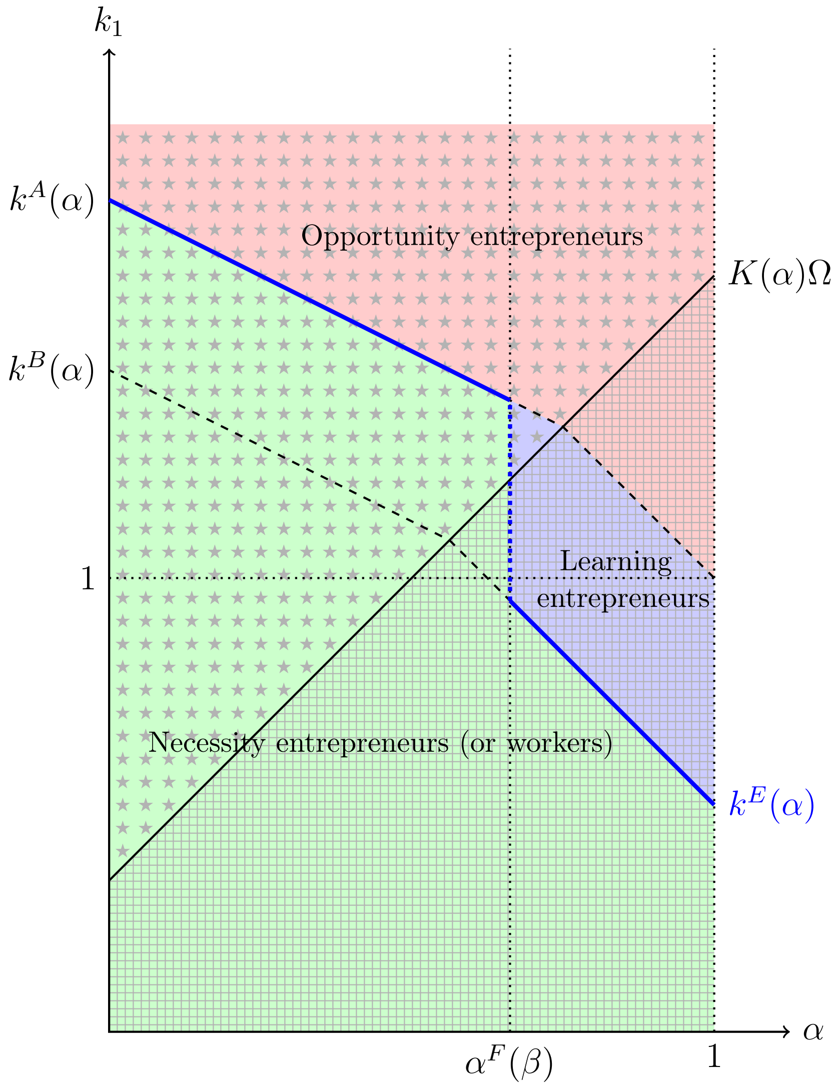


Fig. 3: Types of entrepreneurship and task allocation of entrepreneurs as a function of α. The colors represent the types of entrepreneurship: red for opportunity, blue for learning, and green for necessity. The patterns represent the task choice of entrepreneurs: the stars are task B, and the grid is task A (note: the axes are not at scale).

While both learning and opportunity entrepreneur may work on either task, it is clear that learning entrepreneurs are more likely to choose task A than opportunity entrepreneurs. This is due to the fact that, by definition, learning entrepreneurs work on projects of lower value than opportunity entrepreneurs. Another observation is that, because $k^E(\alpha)$ decreases in α and $K(\alpha)$ increases in α, then as α increases entrepreneurs are, on average, more likely to choose task A. The task choice of entrepreneurs reacts most strongly to changes in α when we compare values below and above the threshold $\alpha^F(\beta)$, because learning entrepreneurs do not exist below the threshold, but exist above the threshold.

5.4 Output

In period 1 a fraction $1-\alpha$ of the population will not receive a wage offer and is forced into entrepreneurship, while a fraction α of the population chooses entrepreneurship or wage work depending on the two period output generated by these two options. Hence, the two-period total expected output in the economy is

$$(1-\alpha)\cdot E[W^E(k_1,\alpha)] + \alpha \cdot E[\max\left\{W^E(k_1,\alpha), W^F(\alpha,\beta)\right\}].$$

Therefore, for a fixed $W^F(k_1,\alpha)$, total expected output increases with α both because fewer agents become necessity entrepreneurs, and because $E[W^E(k_1,\alpha)]$ increases with α. At the same time, $W^F(\alpha,\beta)$ has a downward discontinuity at $\alpha = \alpha^F(\beta)$, and is constant otherwise. Total output is therefore non-monotonic in α: it is increasing for $\alpha \neq \alpha^F(\beta)$ but has downward discontinuity at $\alpha = \alpha^F(\beta)$.

6 Implications for Career Paths

6.1 Wages of Past Workers and Past Entrepreneurs

As already discussed in the literature review, our model generates novel predictions with respect to the wage of former workers relative to the wage of former entrepreneurs who change occupation. As we established in Section 5, as α changes, the task allocations of workers and of entrepreneurs change in opposite directions. As α increases, workers are more likely to be allocated to task $\tau = B$ while entrepreneurs are more likely to choose task $\tau = A$. More precisely, for $\alpha > \alpha^F(\beta)$ sufficiently large, all workers are allocated to $\tau = B$ and a positive mass of entrepreneurs (the learning entrepreneurs) chooses instead task A. It follows, therefore, that for α sufficiently large the period 2 wage of a former entrepreneur is greater than the period-2 wage of a former worker. On the other hand, when $\alpha \leq \alpha^F(\beta)$ all workers are allocated to $\tau_1 = A$, while entrepreneurs with a sufficiently valuable project will choose $\tau_1 = B$.

This difference in task allocation translate in differences in period-2 wage. This is immediate for the case $\alpha > \alpha^F(\beta)$, because in the first period all former workers work on the least informative task, while some former entrepreneurs chose the most informative task. Hence, if hired by firms, former entrepreneurs will receive a higher wage than former workers. In case $\alpha < \alpha^F(\beta)$, all former workers chose the most informative task allocation, while some former entrepreneurs chose the least informative task allocation. Hence, in period 2, former workers are more productive than former entrepreneurs. In this case, the period-2 wage of former workers *who receive a wage offer* is lower than that of entrepreneurs who are hired by firms. However, in period 2, workers who do not receive a wage offer are paid less than their productivity, so it is a priory unclear whether former workers as a whole are paid more or less than former entrepreneurs.[20] Note, however, that if β is large (i.e. degree of

[20] In general, this will depend on the distribution of the entrepreneurial project values: if $\mathbb{E}[k_2|k_2 < 1]$ is close to 1, then workers who do not receive a wage offer are nonetheless paid almost their productivity; while if $\mathbb{E}[k_2|k_2 < 1]$ is close to zero, these workers do not receive

contract incompleteness is low), $\alpha^F(\beta)$ is also large. In this case, there exists an $\alpha < \alpha^F(\beta)$ sufficiently large so that the number of workers not receiving a wage offer is low and, on average, former entrepreneurs receive *lower* wages compared to former workers of equivalent characteristics.

There are unfortunately few empirical analysis relative to the compensations of former entrepreneurs who change occupation. Nevertheless, our results are consistent with the existing empirical evidence. Hamilton (2000) shows that US entrepreneurs who leave entrepreneurship and re-enter the labor market after some years earn higher wages than comparable workers: the median entrepreneur returning to paid employment after 10 years as an entrepreneur earns a wage that is 15% higher than a comparable worker who never left employment[21] See also Luzzi and Sasson (2016), who show that in Norway former entrepreneurs earn a positive wage premium. Our model suggests an opposite result for high labor market friction economies (the wage of former entrepreneurs is lower than the wage of workers who have never left employment) which is consistent with the finding in Baptista, Lima, and Preto (2012) for Portugal.[22]

6.2 The Value of Entrepreneurial Failures

A failure can be beneficial to an agent if it allows for a better allocation of talent in the next period. As we will show shortly, failures have this property only if the agent has worked on the advanced task *and if* talent is horizontal.

Figure 4 illustrates how the maximum probability of success $\pi^M(p_t)$ varies as a function of the belief that the agent is a high type.[23] As is apparent, when talent is vertical, the success probability is monotonically increasing, but if instead talent is horizontal, the success probability is non monotonic.

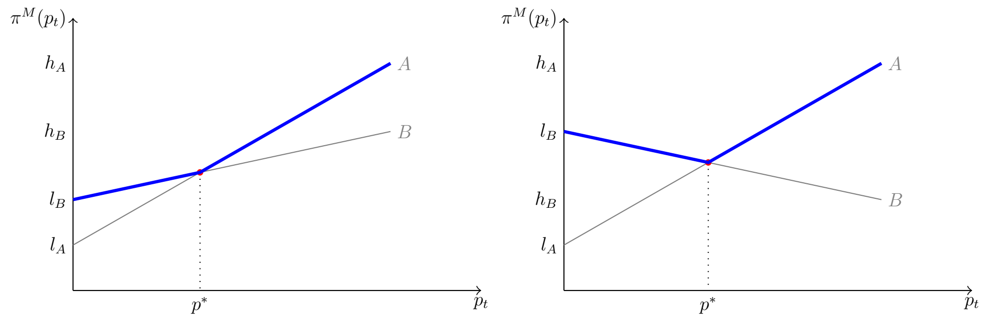
anything.

[21] See Table 6 and the discussion on pages 625-626 of Hamilton (2000). Hamilton notes that this result is consistent with the findings of Evans and Leighton (1990). Both Daly (2015) and Hincapié (2020) find similar results, using again US data.

[22] Neither Hamilton (2000) nor Baptista, Lima, and Preto (2012) discuss why an agent will leave entrepreneurship.

[23] This probability is obtained by allocating an agent to the task with the highest probability of success, see Equation 4 for the formal definition.

That is, if talent is horizontal, an agent is least productive when there is a probability p^* that he is a high type, and productivity increases as the agent becomes more likely to be either a h type or a l type.



(a) Vertical case: $h_B > l_B$ (b) Horizontal case: $h_B < l_B$

Fig. 4: Maximum probability of success as a function of belief p_t.

We established in Section 4 that when talent is vertical, failures reduce the probability of being a h type (more so when the failure is at task A) since h types are more likely to succeed than l types at any task. Hence, when talent is vertical failures are always *bad news* because they decrease the probability of success in period 2 relative to the initial probability of success, that is:

$$\pi^M(p_2(\tau_1, 0)) < \pi^M(p_1) \text{ for all } \tau_1 \in \{A, B\}.$$

In the horizontal talent case, instead, failures at task A increase the probability that the agent is a low type. By Assumption 2, such failures are *good news* because they lead to an increase of the future probability of success (relative to no history). Instead, failures at task B increase the probability that the agent is of type h, and may be good or bad news depending on the prior belief p_1: if p_1 is sufficiently close to p^* failures at task B are also good news; if instead p_1 is sufficiently low (for example, p_1 such that $\pi^M(p_2(B, 0)) < p^*$), then failures at task B are bad news. The following Lemma formalizes these observations.

Lemma 4. *(i) In the vertical-talent case failures are always bad news, that is,* $\pi^M(p_2(\tau_1, 0)) < \pi^M(p_1)$ *for all* $\tau_1 \in \{A, B\}$.

(ii) In the horizontal-talent case, failures at task A are always good news, that is, $\pi^M(p_2(A,0)) > \pi^M(p_1)$. There is a threshold p_B such that failures at task B are bad news for $p_1 < p_B$ and good news for $p_1 > p_B$.

Hence, the vertical view of talent implies that failures should reduce the probability of a future success. Instead, when talent is horizontal, failures can be "good news" depending on the task allocation. In this case, if labor market frictions are low (i.e., high α) and the majority of entrepreneurs are learning entrepreneurs,[24] most entrepreneurs will choose $\tau_1 = A$ and a failure at this task leads to an increase in the future probability of success. This motivates the following proposition that relates the degree of labor market frictions to the value of failures.

Proposition 1. *For a serial entrepreneur, the probability of succeeding as an entrepreneur in period 2 is increasing in α. Furthermore*

(i) If talent is vertical, failures are always "bad news". That is, the probability of succeeding in period 2 as an entrepreneur following an entrepreneurial failure in period 1 is below the initial probability of success $\sigma_1(B)$ for all α.

(ii) If talent is horizontal, there exist parameter values such that failures are good news for α sufficiently high, and bad news for α sufficiently low.

The proposition is based on the fact that the degree of labor market frictions determine the task allocation chosen in period 1 by failed entrepreneurs: if α is large, failures are more likely to be generated by working on task A, while if α is low, they are more likely to be generated on task B. If talent is horizontal, a failure at task A is a strong indication that the agent should instead work on task B in the following period, while a failure at task B increases the uncertainty relative to the optimal period-2 task allocation. It is possible that, in this case, failures are a good news for α large but bad news

[24] Whether at α close to 1 the majority of entrepreneurs are learning or opportunity depends on the shape of the distribution of entrepreneurial project values. If it decreases sufficiently fast (or has an upper bound sufficiently low), then there are more learning entrepreneurs than opportunity entrepreneurs.

when α is low. If talent is vertical, instead, failures are always bad news, independently from the task. That is because low types are more likely to fail than high types at any task, meaning that a failure increases the probability that an agent is a low type and will fail in the future.

With respect to the existing evidence, in the US entrepreneurial failures seem to lead to entrepreneurial success. For example, Gompers, Kovner, Lerner, and Scharfstein (2010) show that entrepreneurs who previously failed are marginally more likely to succeed than first time entrepreneurs.[25] Again the evidence available for Europe tells a very different story. Using German data, Gottschalk, Greene, Höwer, and Müller (2014) show that entrepreneurs who have previously failed are subsequently more likely to fail than first time entrepreneurs. Our model explains these different values of failure if talent is *horizontal*: different agents have an absolute advantage at different tasks. Instead, when talent is *vertical* (that is, the same agent has an absolute advantage at all tasks) failures are always bad news, independently of the level of labor market frictions, a finding which seems counterfactual.

6.3 Age Profile of Entrepreneurs

At $\alpha = 1$, there are no necessity entrepreneurs and in period 2 an agent with project value equal to that of firms is indifferent between joining a firm or becoming an entrepreneur. However, in period 1 such an agent strictly prefers to become an entrepreneur, because this allows him to learn: to implement task A instead of B. By continuity, therefore, for α sufficiently large young agents are more likely than old agents to become entrepreneurs.

For lower values of α, however, other effects come into play. For example, in period 1 agents anticipate that, if they become entrepreneurs, they may not be able to find a job in the future. This concern is absent in period 2. It is

[25] See also Lafontaine and Shaw (2016), who use data from Texas to show that the past experience as an entrepreneur predicts entrepreneurial success. This is consistent with our model for the case of "low labor market frictions" in which, in period-1, entrepreneurs are more likely to choose an informative task allocation than workers. It follows that, in period 2, an entrepreneur who was formerly an entrepreneur is more likely to succeed than an entrepreneur who was formerly a worker.

therefore possible that, for some intermediate α, there are more entrepreneurs in period 2 than in period 1.

We are not aware of any evidence linking the probability of becoming an entrepreneur at different ages with the degree of labor market friction. Using US data, Hincapié (2020) shows that people are the most likely to become entrepreneurs when in their mid thirties. This is consistent with our model for the "low labor market friction" case provided that we interpret "mid thirties" as part of period 1 of the model (which is the only period of our model in which learning is valuable). A recent paper by Azoulay, Jones, Kim, and Miranda (2020) shows that old entrepreneurs are more likely *to succeed* than young entrepreneurs. This is consistent with the model, because experience generates learning (independently from an agent occupation or task allocation), which can then be used in the choice of task allocation.

I do not understand this last sentence: do you have in mind learning as in our model or learning-by-doing?

6.4 Other comparative statics

We already discuss the comparative statics wrt to β. The other comparative statics we may want to discuss is that with respect to the distribution of projects. Remember that, an agent will choose task A if an only if

$$k_1 \leq (\mathbb{E}[k] + \alpha F(1)(1 - \mathbb{E}[k|k < 1]))\,\Omega.$$

Finally, the distribution of projects also determines the threshold $\alpha^F(\beta)$ that is

$$\alpha^F(\beta) = 1 - \frac{1-\beta}{\Omega F(1)(1 - \mathbb{E}[k|k < 1])}$$

You can shift upward the distribution of projects, by only shifting the distribution above 1, leaving unchanged the distribution below 1. This has no impact on $k^E(\alpha)$, and hence increases the probability of becoming an entrepreneur. At the same time, you expand the project value for which entrepreneurs learn, without any impact on the probability of learning in firms.

You can also shift upward the distribution of projects, by only shifting the distribution *below* 1, leaving unchanged the distribution above 1. This decreases $\alpha^F(\beta)$ hence, despite the fact that $k^A(\alpha)$ and $k^B(\alpha)$ are unchanged, $k^E(\alpha)$ decreases. Overall, the probability of entrepreneurship increases. For given project value k_1, entrepreneurs are now less likely to learn. However, because $k^E(\alpha)$ decreases, there are now entrepreneurs working on projects of low value and hence more likely to learn. The overall effect on the probability that an agent chooses task A is unclear. Learning within firms becomes less likely. (of course, all this can be further refined by considering values of α sufficiently far or sufficiently close to the threshold $\alpha^F(\beta)$)
If this is interesting we can probably formalize it better.

Not sure: the difficulty of making comparative statics with respect to F is similar to those encountered in models with real options: need to make sure that the shifts happen "at the right place".

7 Discussion

We have shown that, when contracts are incomplete, occupational choice can be partially explained by the difference in decision rights across occupations. This approach allows us to highlight a novel motive for entrepreneurship (learning one's comparative advantage) that is especially important when firms compete fiercely for workers. The literature already showed that learning one's comparative advantage is an important driver of *career* choices and wage dynamics across firms. We highlight its importance in explaining *occupational* choices and the resulting wage dynamics.

In order to focus on this motive for entrepreneurship, we have ignored other important determinants of entrepreneurial activity, such as financial constraints, learning by doing, or the possibility of working on multiple tasks.

Financial constraints are a barrier to entry into entrepreneurship. In our model, when entrepreneurs face financial constraints, the effect of labor market frictions on entrepreneurial activity will in fact be stronger. Indeed, if the labor market is frictionless, firms' competition insures that workers are able to appropriate the full benefit of learning. Hence firms adopt a less informative task allocation independently of the importance of financial constraints, and some agents may become learning entrepreneurs. On the other hand, when labor-market frictions are severe, financial constraints limit the exit of workers into entrepreneurship and therefore increase the ability of firms to appropriate the benefit of learning.[26] The presence of financial constraints, therefore, increases the effect of a change in α on whether learning occurs within or outside firms.

There is an element of learning-by-doing in our model because agents acquire information about their comparative advantage, are better able to match their talent to a task, and therefore increase their productivity over time. We do not however allow agents to increase their productivity on a given task by simply working on that task, that is, there is no task-specific human capital accumulation (see Gibbons and Waldman, 1999 and Gibbons and Waldman, 2004). Our results stand as long as this increase in productivity is small compared to the benefit of learning one's comparative advantage.

We have assumed that the production process involves only one task. By contrast, Lazear (2004) assumes that workers work at a single task while entrepreneurs work at multiple tasks. He shows, both theoretically and empirically, that people with a more balanced skill set enter entrepreneurship. Åstebro, Chen, and Thompson (2011), building on Lazear (2004), propose a model in which agents choose between self-employment (in which case they work on multiple tasks) and wage work (in which case they are allocated to a specific task). Exogenous frictions prevent both the efficient assignment of agents to firms, and also the efficient assignment of workers to tasks. These frictions are the reason why some agents may become self employed. Both in Lazear (2004) and Åstebro et al. (2011) agents' productivity at different tasks are perfectly known, and hence there is no learning. This implies that, for example, these models do not make predictions with respect to the wage of

[26] On the role of financial constraints, see Hellmann (2007), who shows that cash constraints shape the way ideas are financed, within or outside the firm, and Terviö (2009), who argues that, absent long-term contracts, financial constrains may prevent optimal talent discovery in firms.

former entrepreneurs. It would be interesting to add uncertainty about talent to Lazear's framework, and study whether learning affects agents' occupational choices. This extension is left for future work.

Finally, one may be tempted to interpret the case of high labor market frictions as illustrative of developing countries, and there is indeed ample evidence that many people living in developing countries are "reluctant" entrepreneurs (Banerjee and Duflo, 2011). However, we refrain from this temptation. We use the model to explore the effect of labor market and some contracting frictions keeping everything else constant. This may be a reasonable way to proceed when comparing countries such as the US and European countries that are otherwise similar in their contracting abilities,legal enforcement, the development of their financial markets, and their level of human capital. But this is hardly the case for developing countries. These other dimensions are not part of our model but are likely to affect the type, frequency and market rewards of entrepreneurial ventures.

A Mathematical Appendix

Conditions for $\sigma_2(A) > \sigma_2(B)$.

Proposition 2. *In the vertical talent case $\sigma_2(A) > \sigma_2(B)$ if and only if*

$$p_1 > \left(1 + \frac{h_A}{l_A}\frac{h_A - h_B}{l_B - l_A}\right)^{-1}. \tag{10}$$

In the horizontal talent case $\sigma_2(A) > \sigma_2(B)$ if condition (10) holds and

$$h_A - l_A > l_B \cdot h_A - l_A \cdot h_B > l_B - h_B.$$

Proof. Independently of the task assignment in the first period, Bayesian updating implies that

$$\mathbb{E}_{s_1 \in \{0,1\}} \pi(\tau_1, p_2(\tau_1, s_1)) p_2(\tau_1, s_1) = p_1. \tag{11}$$

Because of Assumption 2, there is a realization of s_1 such that the posterior $p_2(\tau_1, s_1)$ is inferior to p^*, leading to task B being adopted in period 2. Since the expected probability of success $\pi^M(p_t)$ is linear when $p \leq p^*$, a necessary condition for A to be more informative than B is that $\max_{s_1} p_2(A, s_1) > p^*$. Because in both the vertical and horizontal cases $\frac{h_A}{l_A} > \frac{1-h_A}{1-l_A}$, the maximum posterior following task A is achieved following a success. More informativeness of A therefore requires that $p_2(A, 1) > p^*$, that is

$$p_1 > q_A \equiv \left(1 + \frac{h_A}{l_A}\frac{h_A - h_B}{l_B - l_A}\right)^{-1} \tag{12}$$

Sufficient condition for (weak) informativeness. Since the maximum probability of success is a convex function of the posterior, whenever the distribution of posteriors following $\tau_1 = A$ is a mean preserving spread of the distribution of the distribution following $\tau_1 = B$, we will have $\sigma_2(A) \geq \sigma_2(B)$. Using our previous remark that $\max_{s_1} p_2(A, s_1) = p_2(A, 1)$, the distribution of posteriors following A is a mean-preserving spread of the distribution following B whenever:

$$p_2(A, 0) < \min_{s_1} p_2(B, s_1) < p_1 < \max_{s_1} p_2(B, s_1) < p_2(A, 1). \tag{MPS}$$

Under the above condition, $\sigma_2(A) = \sigma_2(B)$ if and only if $p_1 \leq q_A$, that is if and only if no matter the task allocation and the realization of success and failure in period 1 the agent is always allocated to task B in period 2. Hence, (MPS) and $p_1 > q_A$ are sufficient for $\sigma_2(A) > \sigma_2(B)$.

When talent is vertical, $h_A > h_B > l_B > l_A$, and the posteriors are ordered as

$$p_2(A, 0) < p_2(B, 0) < p_1 < p_2(B, 1) < p_2(A, 1).$$

and (MPS) is automatically satisfied.

When talent is horizontal, $l_B > h_B$ implies that

$$p_2(B, 1) < p_1 < p_2(B, 0) \text{ and } p_2(A, 0) < p_1 < p_2(A, 1),$$

but not necessarily (MPS). The distribution of posteriors following A is a mean preserving spread of the distribution of posterior following B whenever $p_2(A,1) > p_2(B,0)$ and $p_2(A,0) < p_2(B,1)$. Simple algebra shows that these conditions are equivalent to $h_A - l_A > l_B h_A - l_A h_B > l_B - h_B$, which is therefore sufficient for $\sigma_1(A) < \sigma_1(B)$ but $\sigma_2(A) > \sigma_2(B)$ in the horizontal case.

□

Proof of Lemma 4

When talent is vertical, we showed in the proof of Proposition 2 that $p_2(A,0) < p_2(B,0) < p_1$, which implies that failures always reduce the probability of being a h type (more so when the failure is at task A). Because the function $\pi^M(p_t)$ is monotonically increasing, we have the inequalities $\pi^M(p_2(A,0)) < \pi^M(p_2(B,0)) < \pi^M(p_1)$, and hence and failures decrease the probability of success in period 2 relative to the initial probability of success.

Instead, in the horizontal case low types are more likely to succeed at task B than high types and therefore $p_2(A,0) < p_1 < p_2(B,0)$. Furthermore, the function $\pi^M(p_2)$ is decreasing for $p_2 < p^*$ and then increasing, implying that $\pi^M(p_2(A,0)) > \pi^M(p_1)$. Note also that there is a threshold value of p_1 below which $\pi^M(p_2(B,0)) < \pi^M(p_1)$ (failures at B are bad news) and above which $\pi^M(p_2(B,0)) > \pi^M(p_1)$ (failures at B are good news). If p_1 is so low that $p_1 < p_2(B,0) < p^*$, then quite immediately failures are bad news. Whenever instead $p_1 < p^* < p_2(B,0)$ we have that $\pi^M(p_1)$ is monotonically decreasing in $p_1 < p^*$, but $\pi^M(p_2(B,0))$ is monotonically increasing in p_1. The statement therefore follows by continuity.

Proof of Proposition 1

For given project value k_1 the probability that an entrepreneur sets $\tau_1 = A$ increases with α. At the same time α determines the set of k_1 that will be pursued by agents who receive a wage offer and become entrepreneurs. For these agents, as α increases, the set of projects that are pursued enlarges: smaller k_1 are pursued by entrepreneurs. These projects are the ones for which the entrepreneurs are more likely to choose $\tau_1 = A$. Overall, the probability of setting $\tau_1 = A$ increases with α, which implies that the probability of succeeding in period 2, also increase with α.

Parts (i) and (ii) of the Proposition follows by Lemma 4. For part (i), note that in the vertical talent case the probability of period-2 success following a failure is always below the initial probability of success $\pi^M(p_1) \equiv \sigma_1(B)$. For part (ii), in the horizontal talent case failures at task A are always good news, while if $p_1 < p_B$ failures at task B are bad news. Furthermore, suppose the distribution of project values has an upper bound sufficiently close to 1. If talent is horizontal, for $\alpha = 1$ and any $p_1 < p_B$ the majority of entrepreneurs are motivated by learning and set $\tau_1 = A$. In this case, failures are good news. When $\alpha \leq \alpha^F(\beta)$, entrepreneurs are either opportunity entrepreneurs or necessity entrepreneurs. They set $\tau_1 = A$ whenever $k_1 \leq K(\alpha)\Omega$, and B otherwise. In the limit case $p_1 \to 0$, we have $\Omega \to 0$ and all entrepreneur choose task B and entrepreneurial failures are bad news. By continuity, there exists a p_1 and $\alpha < 1$ such that entrepreneurial failures are bad news.

B Unobservable Task Allocation

When past task allocation is not observable outside of the firm, at the beginning of period 2 there may be asymmetry of information between firms and any agent who did not work for the same firm previously. We restrict our analysis of this problem to the case $\alpha = 1$. Our goal is to show that the basic finding of the model in the text persists: the learning motive for entrepreneurship emerges when α is high. (It is quite immediate to see that as α decreases the learning motive for entrepreneurship disappears.)

Screening equilibria. Suppose that in period 2, for every observable history, firms offer a contract for every possible type, where a contract has the form $\{b, f, \tau_2\}$ i.e., a bonus, fixed payment, and a task allocation. Clearly, if the agent produced a success in the previous period, a menu of contracts $\{b, f, \tau_2 = A\}$ and $\{b', f', \tau_2 = B\}$ such that $f + qb = f' + qb' = 1$ is an equilibrium screening menu of contracts, because each firm makes zero profits, agents of different types prefer different contracts (strictly so if $b, b' > 0$), and the firm has no incentive to implement a task allocation that is different from that specified in the contract.[27]

However, in order to use such contracts, it must be the case that conditional on a given outcome s_1, those who worked at different period-1 tasks maximize period-2 probability of success by working at different period-2 tasks. In other words, after observing a failure, screening is possible if those who worked at task $\tau_1 = A$ should work in period 2 on task $\tau_2 = B$, and vice versa. Similarly, after observing a success, screening is possible if those who worked at task $\tau_1 = A$ should work in period 2 again on task $\tau_2 = A$, and the same for those who worked on task $\tau_1 = B$.

This condition is never satisfied when talent is vertical. In this case, successes (whether at task $\tau_1 = A$ or task $\tau_1 = B$) increase the probability that the agent is of type h and that he should be allocated to task $\tau_2 = A$. Similarly failures (whether at task $\tau_1 = A$ or task $\tau_1 = B$) increase the probability that the agent is of type l and that he should be allocated to task B. Hence, in general, screening is not possible when talent is vertical.[28]

Screening is possible whenever talent is horizontal and p_1 is sufficiently close to $p^\star$. In this case, successes at task $\tau_1 = A$ or task $\tau_1 = B$ make it more likely that the agent should work at that task in period 2 as well. Similarly, failures at task $\tau_1 = A$ or task $\tau_1 = B$ makes it more likely that the agent should work at the other task in period 2. If the initial prior is sufficiently uncertain, conditional on the outcome s_1 there is a one-to-one correspondence between τ_1 and τ_2 maximizing period-2 probability of success.

No-screening equilibrium. If workers past task allocation is not observable and screening is not possible, then the contract offered by firms to former work-

[27] Note that this contract amounts to delegating task allocation to the worker. Delegation is possible because, in period 2, workers and firms have aligned preferences regarding task allocation.

[28] It may still, however, be possible to screen conditional on a given period-1 outcome, but not on the other outcome.

ers depends on the market belief over the workers previous task allocation. In this case, the only possible equilibrium is that firms always set $\tau_1 = B$. Suppose not: the market expects $\tau_1 = A$ with some positive probability. Period-1 employer is better off by maximizing period-1 output and setting $\tau_1 = B$, while the worker can then leave the firm and receive a wage which is greater than the expected output. Hence, in equilibrium, firms implement $\tau_1 = B$ and some agents may decide to become learning entrepreneurs.

C Long-Term Contracts

In the text we assume that long-term contracts are not available. In this section, we relax this assumption by introducing the possibility that, in period 1, firms and workers can sign a contract specifying a wage for period 2. Again, we limit our attention to the case $\alpha = 1$ (no labor-market frictions) and show that the learning motive for entrepreneurship also emerges with long-term contracts. (As in the previous extension of the model, as α decreases the learning motive for entrepreneurship disappears since firms use the efficient task allocation.)

To start, note that if firms can shutdown at no cost, then there is no equilibrium in which firms set $\tau_1 = A$ with positive probability. As long as workers can freely leave a firm, competition requires that firms' make zero profits in period 2. Hence, a firm period-2 profits are always zero, whether it continues its operation or not. However, if in equilibrium $\tau_1 = A$, a firm is better off by switching to $\tau_1 = B$ and then shutting down the firm (to avoid having to pay the wage corresponding to $\tau_1 = A$ in period 2). Hence, the equilibrium is the same as with short-term contracts.

Suppose instead that firms can commit not to shut down. Long-term contracting does not affect our main qualitative result as long as workers are free to move across firms and occupations. Our argument rests on the fact that a period-1 worker may become an entrepreneur in period 2, which limits the period-2 profits a firm may expect to make from learning its worker's talent in period 1.

If workers are free to leave, any long-term contract signed in period-1 should pay in period 2 at least the period-2 market wage. Therefore, in period 2 a long-term contract pays the worker a wage — contingent on success or failure in period 1 — equal to the market value of this worker *if he had been allocated to task* A in period 1.

Assume that such a contract is signed. We argue here that the firm may deviate and set $\tau_1 = B$. This deviation delivers an expected loss in period-2 equal to $\sigma_2(A) - \sigma_2(B)$, because the employee will have to be paid as if he had worked on task A while instead he worked on task B. However, this loss is realized only if the agent does not become an entrepreneur and continues working for the firm, and hence it is discounted by the probability that $k_2 > 1$. At the same time, such deviation increases the probability of success in period 1 and therefore delivers a period-1 gain equal to $(\sigma_1(B) - \sigma_1(A))(1 - b)$.

It is easy to see that if $F(1)$ is sufficiently small, the probability that the worker will continue working for the same firm vanishes to zero and the firm will deviate to $\tau_1 = B$. Hence, for $F(1)$ small, long-term contracts do not always implement the worker-preferred task allocation and therefore the learning motive for entrepreneurship survives.

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