

# The Value of Entrepreneurial Failures: Task Allocation and Career Concerns

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## **Abstract**

Entrepreneurs are free to work on tasks that are likely to fail but generate learning about their comparative advantage at different tasks. The same level of learning can be achieved within firms if and only if labor-market frictions are high. When labor-market frictions are low, entrepreneurial failures breed entrepreneurial successes and failed entrepreneurs are rewarded when re-entering the labor market. The opposite holds when labor-market frictions are large. These results are consistent with the evidence available for the US and continental Europe. We also show that the relationship between entrepreneurial activity and aggregate output may be non-monotonic.

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

**Keywords:** Entrepreneurship, entrepreneurial failures, career paths, task allocation, career concerns.

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# 1 Introduction

Highly visible and publicized success stories of entrepreneurship hide a much longer list of less documented failures. Failed entrepreneurs may become “serial entrepreneurs” and start a new enterprise, or decide to abandon this activity and go back into the regular labor market. Among the ones who start a new enterprise, a past entrepreneurial failure may breed success and increase the probability of a future entrepreneurial success, or breed more entrepreneurial failures. Entrepreneurs who go back to the regular labor market may command a positive or negative wage premium relative to workers who never left employment. Because entrepreneurial ventures are more likely to fail than to succeed, understanding whether entrepreneurial failures provide negative information about the quality of the entrepreneur and lead to negative outcomes (as argued by the theoretical literature on career concerns), or provide learning and lead to positive outcomes (as argued by the management literature and the media) is crucial for understanding the selection into entrepreneurship and the type of projects pursued by entrepreneurs.

The existing empirical literature looking at the consequences of an entrepreneurial failure documents contrasting findings, mostly depending on whether these failures occur in the U.S. or in Europe. In the US, entrepreneurial failures seem to lead to positive outcomes. For example, Gompers, Kovner, Lerner, and Scharfstein (2010) show that entrepreneurial failures breed success, in the sense that entrepreneurs who previously failed are more likely to succeed than first time entrepreneurs. They find that first-time entrepreneurs have only a 21% chance of succeeding, second-time entrepreneurs who previously failed have a 22% chance of succeeding, while second-time entrepreneurs who previously succeeded have a 30% chance of succeeding (where succeeding is defined as starting a company that goes public).<sup>1</sup> There is also evidence that entrepreneurial exits are rewarded by the American labor market. Hamilton (2000) compares the earning history of entrepreneurs with the earning history

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<sup>1</sup> See also Lafontaine and Shaw (2014), who find similar results among entrepreneurs in the retail sector in Texas.

of workers of identical characteristics. He finds that entrepreneurs earn less than workers (with the exception of few ‘superstar’ entrepreneurs). For example, the median entrepreneur after 10 years in business earns 35% less than a similar individual who never left employment. At the same time entrepreneurs who leave entrepreneurship and re-enter the labor market after some years of entrepreneurship earn higher wages than comparable workers. The median entrepreneur returning to paid employment after 10 years as entrepreneur earns a wage that is 15% higher than a worker who never left employment.

The evidence available for Europe tells a very different story. Using German data, Gottshalk, Greene, Höwer, and Müller (2014) show that entrepreneurs who previously failed are more likely than first time entrepreneurs to fail. Using Portuguese data, Baptista, Lima, and Preto (2012) find that the wage of former entrepreneurs is lower than the wage of workers who never left employment.<sup>2</sup> Hence the US and Europe seem to differ significantly in the consequences of entrepreneurial failures, and in the value of a past entrepreneurial experience. In the US, failures breed entrepreneurial successes and a past entrepreneurial experience leads to wages that are larger than the wage of comparable workers. In Europe however, failures breed more failures and past experience as an entrepreneur is negatively valued by the labor market. The US evidence suggests that viewing failures as indicative of being a “bad” type may be unwarranted. But the European example shows that viewing failures as “good” signals is also unwarranted.<sup>3</sup>

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<sup>2</sup> Neither Hamilton (2000) nor Baptista, Lima, and Preto (2012) discuss the reason for re-entry.

<sup>3</sup> In general, the available estimates of the return on entrepreneurship and of the wage of former entrepreneurs differ substantially depending on the time horizon, the sector and the data considered. See for example Hyytinen, Ilmakunnas, and Toivanen (2013) (looking at Finnish twins, find that entrepreneurs earn a negative earning premium), Tergiman (2011) (the entrepreneurial earning premium can be positive or negative depending on age), Williams (2000) (in the US, the wage premium of formerly self-employed workers is negative for women), Bruce and Schuetze (2004) (the wage premium of formerly self-employed workers depends on gender and job turnover), Kaiser and Malchow-Møller (2011) (using Danish data, wage premium of formerly self-employed workers can be positive if the transition between entrepreneurship and wage work is done within the same sector), Hyytinen and Rouvinen (2008) (looking at a panel of European households, find that there is a negative wage premium of formerly self-employed workers, but this effect becomes significantly

In this paper we argue that these contradicting findings illustrate the subtle interplay between labor market frictions and the willingness of firms to sacrifice short term profits in order to get information about a worker’s comparative advantage at different tasks. We develop an equilibrium model of career choice where in every period agents can choose between entrepreneurship and employment. Following Gibbons and Waldman (2004), we model talent in a horizontal rather than a vertical fashion: each agent has a comparative advantage at one task. Hence, two workers of different talents may have the same productivity if assigned to two different tasks, but may have different productivity if they work on the same task. For instance, two agents with the same human capital may be differentially good in their ability to interact with others, implying that tasks involving teams may be good for one agent but not for the other; one agent may like precise guidelines while another may prefer flexibility or fuzzy missions; some managers may be good at improving on an existing project but may be uncomfortable at embarking on a totally new project. The business literature is rich of examples pointing out the importance for HR departments and recruiters to make sure that the agent’s talent matches the task in which he or she will have to work on.

However, whether horizontal or vertical in nature, talent is rarely perfectly known and often requires hands-on learning. In this context, failures can reveal that the agent is likely to be productive at some other task than the one where she is currently employed.<sup>4</sup> Any task assignment therefore generates costs and benefits, both privately and socially. From a static perspective, one would be tempted to assign an agent to the task that maximizes the static expected return, the likely outcome if firms are “short-termists” as corporate governance studies tend to show. From a dynamic perspective one would like to learn as fast as possible the talent of the agent, which may require assigning this agent to a task that does not necessarily maximize the static expected return.

In the model, the value of failures — that is the continuation expected smaller when the wage before becoming self employed is introduced as control for unobserved ability).

<sup>4</sup> Hence, while close in spirit, here talent discovery is different from the usual “experimentation” motive for entrepreneurship where agents learn about the returns of a project.

utility of an agent following a failure — is higher when the task assignment favors learning over the static expected return. Crucially, task assignment within firms depends on the severity of labor market frictions, modeled as the probability that an agent receives a wage offer. When the labor market is frictionless firms choose the task allocation of their workers to maximize static expected profits, because they expect that any learning benefit will be captured by the worker. If instead labor market frictions are sufficiently severe, firms capture part of the benefits of learning, and therefore may choose a task assignment that favors discovering their workers' talent. It follows that, depending on the severity of labor market frictions, two possible equilibrium regimes emerge in the model.

In the first regime, labor market frictions are low and firms only value short-run output. Because entrepreneurs have the right to choose their own task allocation, some agents choose entrepreneurship even when the instantaneous payoff of an entrepreneur is lower than the instantaneous payoff of a worker. Entrepreneurs choose to work on the most informative task, which does not maximize short-term profits, because learning is rewarded in the following period by the labor market. Besides entrepreneurs who favor learning in their task allocation, there are agents who choose entrepreneurship because they have valuable projects that they want to pursue. For this second type of entrepreneurs, the static gain of a success outweighs the dynamic gain of learning, and they prefer the task allocation maximizing short-term output. In this regime, on average, entrepreneurs learn more than workers and, in the following periods, can be matched with the right task with a higher probability. It follows that past entrepreneurs receive a higher wage than past workers when re-entering the labor market. Overall, this regime matches the empirical evidence available for the US.

In the second regime, labor market frictions are high, firms capture part of the benefit of learning their workers' talent, and workers can discover their comparative advantage by working for a firm. In this case, agents become entrepreneurs only to pursue valuable projects and choose the short-run output maximizing task allocation. It follows that, on average, past workers are

more valuable than past entrepreneurs, because past workers are more likely than past entrepreneurs to have worked on tasks that are informative of their talent. This regime matches the evidence available for Europe. It follows that entrepreneurial failures in Europe are less valuable than entrepreneurial failures in the US, both when starting a new venture and when re-entering the labor market. The reason is that the fraction of entrepreneurs choosing the most informative task allocation is greater in the US than in Europe. Note that a model where talent is exclusively a vertical characteristics may be able to generate different values of failure in different contexts, depending on how the selection into entrepreneurship is regulated. However, in such a model failures always carry a stigma, and hence the value of failures is always negative, which seems counterfactual.

Beyond the causal link between economic fundamentals and the market rewards for failures, there are other differences between these regimes worth emphasizing. Under some parametric restrictions, the level of entrepreneurial activity is higher in the US regime than in the EU regime. This is because, in the EU regime, learning can happen within firms and the only motive for entrepreneurship is short-run output maximization. In the regime corresponding to the US instead, the pool of entrepreneurs is larger because some agents choose entrepreneurship to learn their type. The same mechanism also explains the higher proportion of “serial entrepreneurs” in the US compared to the EU.

Finally, in our model we assume that any person can become an entrepreneur at no cost. Therefore, we deliberately abstract away from other important determinants of entrepreneurial activity such as credit market frictions or business start-up costs. Despite this abstraction, the model can match several important stylized facts regarding entrepreneurship in Europe and the US. The overall message is that the labor market (and in particular the wage premium of former entrepreneurs) is an important determinant of both the level and the type of entrepreneurial activity, that has been so far overlooked both in the academic literature and in the policy debate.

## Literature

Several business leaders argued that failures are conducive to future successes. Henry Ford famously said

*Failure is only the opportunity to begin again more intelligently.*

A recent issue of Harvard Business Review is entirely dedicated to failures (April 2011). Several papers collected under the heading "Failure Chronicles" describe examples of failures, and how they ultimately lead to business successes. A recent book by journalist Tim Harford titled "Adapt: Why Success Always Starts with Failure" well summarizes the attitude toward entrepreneurial failures of most media outlets.

By contrast, most of the economic literature assumes that entrepreneurial failures lead to more entrepreneurial failures. The paper closest to ours is Gromb and Scharfstein (2002) who develop an equilibrium model where failed entrepreneurs are hired by firms. Their key intuition is that looking for jobs after failing in a start-up is not as bad a signal as being fired from an established firm. It follows that firms will replace failed managers with failed entrepreneurs. Landier (2005) also builds a model of entrepreneurial failures. He shows that when failures are widespread, little information regarding the entrepreneur's type is revealed by a failure and hence there is a high level of entrepreneurship. On the other hand, when failures are rare, they carry a larger stigma and entrepreneurship is deterred. Both in Gromb and Scharfstein (2002) and in Landier (2005) talent is viewed as a vertical characteristic and failing always decreases the expected productivity of the agent.

Our paper is also related to the theoretical literature on career paths between employment and entrepreneurship. For example, Hellmann (2007) builds a model where the availability of external funds and the property right regime determine whether a worker will explore new ideas, and whether new ideas will be financed internally (intrapreneurship) or externally (entrepreneurship). We are mostly interested in explaining the reverse career trajectory: past entrepreneurs who start working for firms. Lazear (2004) also analyzes the sorting between entrepreneurship and wage work. His main assumption

is that workers work at a single task, while entrepreneurs work at multiple tasks. He then shows, both theoretically and empirically, that people with a more balanced skill set enter entrepreneurship. Interestingly, also in our model those with a more balanced skill set are more likely to become entrepreneurs, where having a balanced skill set here means being equally likely to generate a success at either task. However, whereas in Lazear (2004) the agents' occupational choice is static, in our model this choice is repeated. This allows us to focus on the effect of the future labor market conditions on the decision to become an entrepreneur.

In our model, an entrepreneur's willingness to perform a task that is not short-term profit maximizing is motivated by career concerns, i.e., future market wages or future entrepreneurial profits. Reducing current expected output to learn and increase future expected output is often called experimentation. Our approach is different from most of the literature on experimentation where payoffs from choosing different actions are typically assumed to be exogenous but unknown to the agent. Exceptions are Jeitschko and Mirman (2002), Manso (2011), Gomes, Gottlieb, and Maestri (2013) and Drugov and Macchiavello (2014), who analyze contexts where experimentation by an agent is valuable to a principal, and solve for the optimal incentive scheme. In these papers, as in our paper, the reward from experimenting is endogenous. However, instead of looking at the optimal incentives for experimentation set by a principal, we focus on the *market incentives* for experimentation, which are particularly important whenever long-term contracts are not feasible.

In this respect, our work is related to models of Bayesian learning on the workplace where learning is worker specific and can be transferred across firms (for example Harris and Holmström, 1982, Farber and Gibbons, 1996). Recently, Antonovics and Golan (2010) address the issue of experimentation defined as choosing a job where the expected probability of success is low, but where outcomes are strongly correlated to the agent's type. Similarly, Terviö (2009) argues that the absence of long-term contracting and cash constraints prevent optimal talent discovery, in the sense that too few workers will be employed in jobs where their productivity can be revealed. Very close to our



model, Papageorgiou (2013) analyzes a problem of talent discovery via task allocation in the presence of labor market frictions (see also Eeckhout and Weng, 2009 for a similar model without labor market frictions). Papageorgiou (2013) assumes that each job corresponds to a specific task, and that workers learn their comparative advantage over different tasks by working at a specific job. Calibrating his model, he argues that a model of comparative advantage and horizontal talent performs better than a model in which talent is a vertical characteristic. We depart from Papageorgiou (2013) by introducing an on-the-job task allocation problem, which is the main determinant of the overall rate of talent discovery. In our framework, the main difference between entrepreneurship and employment is the allocation of the decision right over on-the-job task allocation. In addition, task allocation is a function of the labor market frictions. It follows that whereas in Papageorgiou (2013) labor market frictions always reduce learning, in our model labor market frictions increase the rate of on-the-job talent discovery.

Formally, our model is close to MacDonald (1982a) and MacDonald (1982b), that also analyze a task-assignment problem in which the task at which each worker is the most productive is not known *ex ante*. MacDonald (1982a) and MacDonald (1982b) consider a frictionless labor market and assume that agents can only be employed by firms, who therefore always assign workers to the short-run profit maximizing task. Here instead we introduce entrepreneurship and labor market frictions, and show that the equilibrium task allocation depends both on the agent's occupational choice and on the severity of those frictions.

Also related is the task allocation model of Gibbons and Waldman (2004), building on Gibbons and Waldman (1999) where talent and human capital are task specific. They argue that this approach can help explain several well-established empirical findings concerning wage and promotion dynamics inside firms. In their framework, human capital is accumulated by working on a specific task, and does not affect the worker's expected productivity at other tasks. Here, we explicitly model human capital accumulation as a learning process, which can be informative about the worker's productivity at several

tasks. In addition, we are concerned with the implication of this framework for career paths across different professions.

The rest of the paper proceeds as follows. In section 2 we introduce the model. In section 3 we consider a simplified version of the model where entrepreneurial activity is driven exclusively by the desire to learn about one's talents. In section 4 we consider the full model and the possibility for entrepreneurial activity to be also motivated by short-term profit maximization. We conclude in section 5. All proofs missing from the text are in the Appendix.

## 2 The model

The economy is composed of a continuum of identical agents and a continuum of identical firms. The measure of agents is smaller than that of firms, implying that some firms are always inactive in equilibrium. Each agent lives for 2 periods and can be of type  $\theta \in \{0, 1\}$ . Agents' types are not observable to agents and firms. The common initial belief about a young agent's type is  $p_0 = E[\theta]$ ; without loss of generality we assume that  $p_0 > 1/2$ .

**Production** The production process may involve one of two tasks denoted by  $\tau \in \{0, 1\}$ , and leads to an outcome  $s \in \{0, 1\}$  that can be success ( $s = 1$ ) or failure ( $s = 0$ ). There is a good match between the individual's type and the task when  $\theta = \tau$ , in which case the output is produced with probability  $q \in (0, 1)$ . There is no output however if there is a mismatch, that is if  $\theta \neq \tau$ . Hence, an agent's type  $\theta$  is best interpreted as innate talent. For example, agents may excel either at finding creative solutions or at implementing existing solutions; they may excel either at working in teams or at performing independent work; or they may excel either at implementing radical changes or at implementing incremental changes. The agent's talent determines the task at which she can be productive.<sup>5</sup> Without loss of generality, we assume that choosing a task over the other has no cost to the agent.

<sup>5</sup> We consider in Appendix C the case in which the probability of succeeding at a given task is independent of the probability of succeeding at the other task.

It follows that a failure can happen for two reasons: either there is a mismatch between talent and task, or there is a good match but the process fails with probability  $1 - q$  for exogenous reasons. The probability that there is a success is therefore dependent on the task allocation and the belief  $p$  that the individual is of type  $\theta = 1$ :

$$\Pr\{s = 1|\tau, p\} = q[p \cdot \tau + (1 - p) \cdot (1 - \tau)].$$

**Timing** There are two periods indexed by  $t = 1, 2$ . In each period  $t$ , firms offer contracts to agents, and agents choose whether to be an entrepreneur or a worker. The timing of each period is as follows.

1. All firms draw the same project with return  $K_t$  from the uniform distribution on  $[0, 2]$ . There is no time dependence, that is the project at time 2 is independent of the project at time 1. The firms' projects are publicly observable. Because  $K_t$  is equal across firms, it is better interpreted as a aggregate (or average) productivity in a given period.
2. Each agent draws a project with return  $k_t$  from the uniform distribution  $[0, \lambda K_t]$ . The agents' projects are publicly observable. In the next section we consider the case  $\lambda = 1$ , meaning that the entrepreneurial returns are always lower than that of a firm for a given task allocation.<sup>6</sup> In section 4 we consider the general case  $\lambda \geq 1$ , so that the return on an entrepreneurial project can be larger than the return on the firm's project.
3. Firms simultaneously offer contracts to all agents. A contract consists of a fixed payment  $f$  and a bonus payment  $b$  contingent on success. Each agent decides whether to be an entrepreneur, or to work for one of the firms.

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<sup>6</sup> The idea being that firms produce a "standard" product whose market return depends on demand shocks. If the standard technology constrains also the ability of individuals to find new ideas, there will be a bound on how much more profitable new ideas could be.

4. After the contract is signed, the firm chooses the worker's task allocation and entrepreneurs choose their own task allocation.
5. A firm- and entrepreneur-specific idiosyncratic shock  $\beta_{i,t}$  is realized.  $\beta_{i,t}$  is uniformly distributed over  $[\underline{\beta}, \bar{\beta}]$ , with  $\underline{\beta} < 1$  and  $\bar{\beta} = 2 - \underline{\beta}$  (so that  $E[\beta_{i,t}] = 1$ ). The realization of  $\beta_{i,t}$  is private information to the firm (for projects carried out within a firm) and to the entrepreneur (for projects carried out by entrepreneurs).
6. Each firm and each entrepreneur can decide to terminate their projects. The termination of a project leads to a failure with probability one.
7. If the project is kept running, outcomes are realized and observed by everybody. In case of success, a firm's output is  $\beta_{i,t}K_t$ , while an entrepreneur's output is  $\beta_{i,t}k_t$ .

Outcomes and project values are perfectly observable and contractible. Idiosyncratic shocks are private information and therefore are not contractible. Furthermore, we assume that task allocation and whether the project is terminated are observable but not contractible,<sup>7</sup> and we solve in appendix B for the case of non-observable task allocation and project termination.<sup>8</sup>

The presence of the idiosyncratic shock  $\beta_{i,t}$  prevents agents and firms from writing contracts in which firms are completely indifferent between success or failure, and between project termination or project continuation. In particular, for sufficiently large bonus payments  $b$ , the firm may terminate the project whenever the realization of  $\beta_{i,t}$  is low. Competition among firms guarantees

<sup>7</sup> Non contractability of task allocation 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; see for instance, Aghion and Tirole (1997) and Baker et al. (1999).

<sup>8</sup> Unobservable task allocation and project termination generate asymmetric learning. The reason is that, at the beginning of period 2, the firm for which the agent worked previously is better informed than other firms regarding the agent's type. We show in appendix that, for some parameter values, firms can offer a menu of contracts that will screen workers depending on their previous task allocation. When screening is not possible, we show that the equilibrium with asymmetric information is qualitatively similar to the one derived here.

that all contracts have a bonus payment  $b$  that is sufficiently low, so that there is never project termination under any realization of  $\beta_{i,t}$ .

We interpret the parameter  $\underline{\beta}$  as an index of contract completeness. Within a firm, the value of a success is  $\beta_{i,t}K_t$ , but contracts can be contingent only on  $K_t$ , and  $\underline{\beta}$  measures the importance of this non-contractible component. Compared to other areas of the world, the US and EU have sophisticated legal systems and courts, and we will mostly consider below the case where  $\underline{\beta}$  is close to one.

Finally, we introduce labor-market frictions by assuming that a contract offered by a firm to an agent reaches the agent with probability  $\alpha \leq 1$ . To simplify, we assume that the arrival of offers made to the same agent is perfectly correlated, so that an agent either receives all contract offers or no contract offer.<sup>9</sup>

## 2.1 Learning

In period 2, the probability that the agent is of type 1 conditional on period-1 task allocation and period-1 outcome is:

$$\begin{aligned} \text{pr}\{\theta = 1 | \tau_1 = 1, s_1\} &= \begin{cases} 1 & \text{if } s_1 = 1 \\ \frac{p_0(1-q)}{1-p_0q} & \text{if } s_1 = 0 \end{cases} \\ \text{pr}\{\theta = 1 | \tau_1 = 0, s_1\} &= \begin{cases} 0 & \text{if } s_1 = 1 \\ \frac{p_0}{1-q(1-p_0)} & \text{if } s_1 = 0. \end{cases} \end{aligned} \quad (1)$$

If there is success, the agent learns his type perfectly. In case of failure at task  $\tau_1 = 0$ , the agent is more likely to be type 1 since  $\frac{p_0}{1-q(1-p_0)}$  is greater than  $1/2$ . Intuitively, because the agent is ex-ante more likely to be type 1, after failing at task 0 she becomes even more convinced to be type 1. In case of failure at task  $\tau_1 = 1$  the agent may conclude that her most likely type is 1 or may

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<sup>9</sup> Without this assumption, with some positive probability the agent receives a single offer. Hence, firms design their contract anticipating that there is a small probability that they have monopsony power over the agent.

conclude that her most likely type is 0 since  $\frac{p_0(1-q)}{1-p_0q}$  may be greater or lower than  $1/2$ .

It follows that the task allocation maximizing the period-2 probability of success, given the history of task allocation and successes/failures is:

- If  $\tau_1 = 1, s_1 = 1$ : the agent is of type 1 and therefore  $\tau_2 = 1$  is optimal.
- If  $\tau_1 = 1, s_1 = 0$ : the agent is more likely to be of type 1 when  $p_0(2-q) > 1$  and therefore  $\tau_2 = 1$ ; but if  $p_0(2-q) < 1$  the agent is more likely to be of type 0 and therefore  $\tau_2 = 0$  is optimal.
- If  $\tau_1 = 0, s_1 = 1$ : the agent is of type 0 with probability one and therefore  $\tau_2 = 0$  is optimal.
- If  $\tau_1 = 0, s_1 = 0$ : the agent is more likely to be of type 1 and therefore  $\tau_2 = 1$  is optimal.

It follows that the probability of success in period 2 assuming that the agent will be allocated to the task with the highest probability of success is:

$$\begin{aligned} \text{pr}\{s_2 = 1 | \tau_1 = 1, s_1\} &= \begin{cases} q & \text{if } s_1 = 1 \\ q \max \left\{ \frac{p_0(1-q)}{1-p_0q}, \frac{1-p_0}{1-p_0q} \right\} & \text{if } s_1 = 0 \end{cases} \\ \text{pr}\{s_2 = 1 | \tau_1 = 0, s_1\} &= \begin{cases} q & \text{if } s_1 = 1 \\ \frac{qp_0}{1-q(1-p_0)} & \text{if } s_1 = 0. \end{cases} \end{aligned}$$

Note that if  $s_1 = 0$ , the probability of success at time 2 is greater if the agent had worked on task 0 initially. Intuitively, a failure on task  $\tau_1 = 0$  increases the belief that the agent is type 1, and hence increases the future probability of success. Relative to a failure at task 0, a failure at task  $\tau_1 = 1$  makes the agent's type more uncertain (i.e. posterior probability that the agent is of type 1 closer to  $1/2$ ) and lowers the future probability of success. Overall, simple algebra shows that, at the time of task allocation, the expected probability of success in period 2 is greater when the agent is allocated to  $\tau_1 = 0$  than  $\tau_1 = 1$ . However, this increase in the expected probability of success in period 2 has a static cost

because  $\tau_1 = 0$  reduces the probability of success in period 1 relative to  $\tau_1 = 1$ . There is therefore a basic trade off between the task allocation maximizing the current probability of success, and the task allocation maximizing the future probability of success.

It is interesting to compare our framework with a model of "skill acquisition" in which working on a task *by itself* increases the agent's future probability of success at that task. Formally, in such a model the agent's "type" in every period is endogenous and depends on the sequence of tasks this agent worked on previously. Relative to the results discussed above, now failing at task  $\tau_1 = 1$  has the additional effect of increasing the probability that the agent is  $\theta = 1$ . It is easy to see that if this effect is small, then the "learning effect" will dominate and our main result will continue to hold: the probability of success following a failure is larger when the agent worked on task  $\tau_1 = 0$  rather than  $\tau_1 = 1$ . If instead the "skill acquisition" effect is strong, then our results may change. Further exploring this case is left for future work.

Finally, note that the two tasks could be specific to a given field or occupation, as long as they are performed by both entrepreneurs and workers. For example, they could correspond to two activities that are commonly performed by scientists in a biotech lab, independently on whether these scientists are entrepreneurs or instead work for large companies. In this case, the learning generated by the sequence of success/failures is specific to that field of occupation. In other words, past experience makes the agent more likely to generate a future success (and more so if  $\tau_1 = 0$ ) only if the agent stays within the same field or occupation.

### 3 The Learning Motive for Entrepreneurship

Because entrepreneurs have control over their task allocation, an agent may choose entrepreneurship to work on task  $\tau_1 = 0$  (which is the most informative task) whenever a firm would chose instead  $\tau_1 = 1$ . To highlight this learning motive for entrepreneurship, we ignore in this section any potential advantage that entrepreneurs could have in terms of project return, and remove the

possibility for firms to internalize the benefits of learning. We therefore make the following assumptions.

- $k_t$  is drawn from a  $[0, K_t]$  uniform distribution. In other words, the agent's project is always of lower value than the firm's one.
- The labor market is frictionless, that is agents get wage offers with probability one:  $\alpha = 1$ .

**Period-1 workers.** Remember that a contract consists of a fixed payment  $f$  and a bonus payment contingent on success  $b$ . Because the idiosyncratic shock  $\beta_{i,t}$  is not observable, when  $b$  is greater than the lowest project value  $\underline{\beta}K_t$  the project may be inefficiently terminated by the firm. Therefore efficient contracting requires a bonus  $b \leq \underline{\beta}K_t$ .<sup>10</sup>

An agent who worked for a firm and succeeded in period 1 will generate an expected revenue for the firm equal to is  $K_2 E(\beta) \cdot q$ . By competition, the contract  $\{b, f\}$  offered by firms to this agent must satisfy  $b \leq \underline{\beta}K_2$ . In addition, because  $E(\beta) = 1$ , the expected payoff earned by the worker in case she accepts the contract must be:

$$w_2(s_1 = 1) = K_2 \cdot q.$$

For the same reasoning, following a period-1 failure, there are two possible expected payoffs to the worker, depending on period-1 task allocation:

$$\begin{aligned} w_2(s_1 = 0, \tau_1 = 1) &= K_2 \cdot q \cdot \max \left\{ \frac{p_0(1-q)}{1-p_0q}, \frac{1-p_0}{1-p_0q} \right\} \\ w_2(s_1 = 0, \tau_1 = 0) &= K_2 \cdot q \cdot \frac{p_0}{1-q(1-p_0)}. \end{aligned}$$

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<sup>10</sup> Because  $\beta_{i,t}$  is private information to the firm, renegotiation of the bonus payment after the shock  $\beta_{i,t}$  is realized does not avoid inefficient project termination. If project termination is a credible threat for some realizations of  $\beta_{i,t}$ , the firm may propose to renegotiate the bonus, and the worker will accept or reject the offer based solely on the size on the bonus and on the firm's strategy. It is easy to see that in equilibrium the worker will reject the offer to renegotiate with positive probability, leading to inefficient project termination for some  $\beta_{i,t}$ . Termination is efficiently avoided only if the firm prefers project continuation for every realization of  $\beta_{i,t}$ .



Because workers are free to change firm in period 2, a period 1 employer needs to pay its worker her market wage in period 2. Hence, all firms (including period 1 employers) earn zero profits in period 2. It follows that the task choice in period 1 is the one that maximizes period 1 profit given the contract signed.

**Lemma 1.** *Firms optimally choose task allocation to maximize short-run profits and set  $\tau_1 = 1$*

*Proof.* To avoid project termination the equilibrium contract requires  $b \leq \underline{\beta}K_1$ . Therefore, for every realization of  $\beta_{i,1}$ , the firm maximizes the probability of success in period 1 by assigning the worker to task 1.  $\square$

**Period-1 entrepreneurs.** Consider an entrepreneur in period 1. For a given  $k_1$ , the total expected payoff of choosing task 1 in period 1 is:

$$V(\tau_1 = 1) = qp_0(k_1 + q) + (1 - qp_0) \cdot q \cdot \max \left\{ \frac{p_0(1 - q)}{1 - p_0q}, \frac{1 - p_0}{1 - p_0q} \right\},$$

and the total expected payoff over the two periods, that we will call “dynamic payoff” from now on, of choosing task 0 in period 1 is:

$$V(\tau_1 = 0) = q(1 - p_0)(k_1 + q) + (1 - q(1 - p_0)) \frac{qp_0}{1 - q(1 - p_0)}.$$

Because an entrepreneur is the residual claimant, he never shuts down a project. Therefore, he chooses  $\tau_1 = 0$  when  $V(\tau_1 = 0) \geq V(\tau_1 = 1)$ , that is when:

$$k_1 \leq \min \left\{ \frac{q(1 - p_0)}{2p_0 - 1}, 1 - q \right\}. \quad (2)$$

This condition holds when the value  $k_1$  of the project is low or when  $p_0$  is close to 1/2.

**Equilibrium career choice** Consider a project  $k_1$  such that an entrepreneur would set  $\tau_1 = 0$ . For  $k_1 = K_1$  the agent strictly prefers entrepreneurship to working for a firm, because she can set  $\tau_1 = 0$  and enjoy a greater dynamic

surplus than if the task allocation was  $\tau = 1$ . Therefore, by continuity, the agent will decide to choose entrepreneurship even if her project has a strictly lower return than that of the firm.

**Lemma 2.** (i) *An agent becomes entrepreneur in period 1 if and only if*

$$k_1(1 - p_0) > K_1 p_0 - \min\{q(1 - p_0), (2p_0 - 1)(1 - q)\}.$$

(ii) *Entrepreneurs always choose task 0.*

An increase in  $k_1$  clearly increases the desire to be an entrepreneur. However the desire to become an entrepreneur is not monotonic in  $p_0 \in [1/2, 1]$ . When  $p_0$  is close to 1, the agent has a strong prior regarding her optimal task allocation and does not value learning, implying that working for a firm is optimal. If  $p_0$  is close to 1/2, the two tasks are almost equally informative, and the agent is unwilling to pay the opportunity cost  $K_t - k_t$  and become an entrepreneur. Figure 1 is an illustration of this non-monotonicity.

**Comparing the Career Path of Workers and Entrepreneurs.** We have established that agents who work for a firm are allocated to the short-run profit-maximizing task  $\tau_1 = 1$  but that agents who choose entrepreneurship favor the learning-maximizing task  $\tau_1 = 0$ . Therefore, compared to workers, entrepreneurs work on projects of lower value and are more likely to fail. Overall, the period-1 payoff of entrepreneurs is lower than the period-1 payoff of workers, consistent with one of the stylized facts for the US we highlighted in our introduction.

In addition, direct comparison shows that the average period-2 wage of a period-1 entrepreneur is always greater than the average period-2 wage of a period-1 worker.<sup>11</sup> This result is consistent with the empirical evidence described in the introduction. Using US data, Hamilton (2000) shows that yearly earnings of entrepreneurs are lower than yearly earnings of workers

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<sup>11</sup> A period-1 entrepreneur earns an expected period-2 wage of  $K_2 \cdot q(q(1 - p_0) + p_0)$ , while a period-1 worker earns an expected period-2 wage equal to  $K_2 \cdot q(qp_0 + \max\{p_0(1 - q), 1 - p_0\})$ .

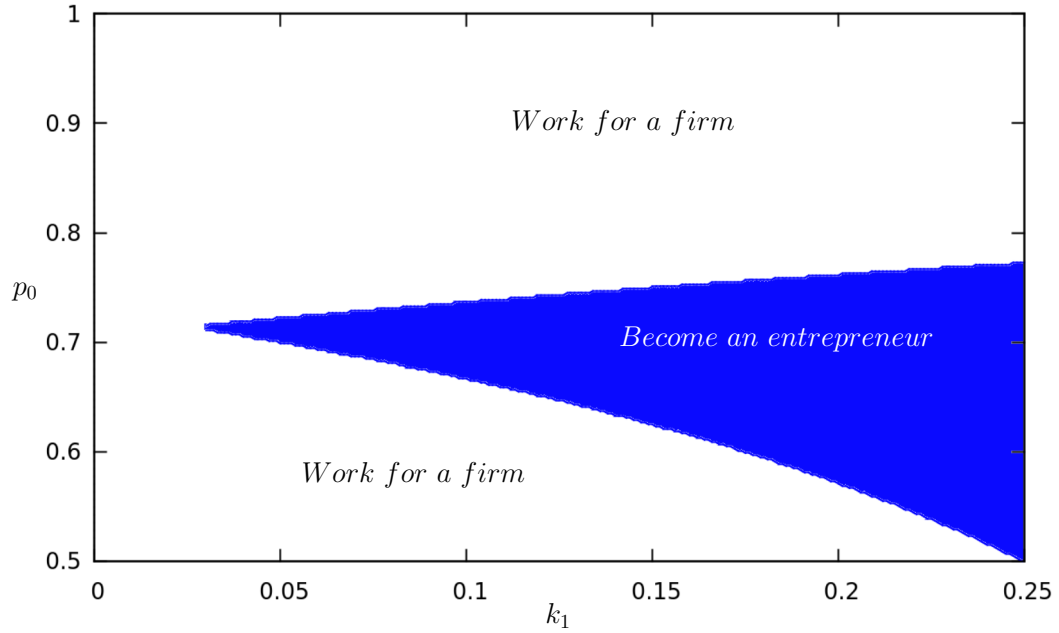


Fig. 1: Range of  $p_0$  and  $k_1$  leading to entrepreneurship when  $K_1 = 0.25$  and  $q = .6$

(with the exception of a few 'superstar' entrepreneurs), but at the same time entrepreneurs who leave entrepreneurship and re-enter the labor market after few years of entrepreneurship earn higher wages than comparable workers. The model suggests that people value entrepreneurship because they have control over their task allocation even if this comes at the cost of a lower initial payoff than workers.

To conclude this section, note that the assumption that the entrepreneurs' output is always inferior to the firms' output ( $k_t \leq K_t$ ) is sufficient but by no means necessary for entrepreneurs to choose the most informative task allocation. What matters for choosing task 0 is whether condition (2) holds. In the model just discussed the selection into entrepreneurship is such that condition (2) always holds for entrepreneurs. The next section explores a more general case in which some entrepreneurs may set  $\tau_1 = 1$ .

## 4 General Analysis

In this section, we introduce the possibility that entrepreneurs may have projects of greater value than firms' by assuming that  $k_t \sim U[0, \lambda K_t]$  with  $\lambda \geq 1$ . This assumption creates an additional motive for entrepreneurship, because some agents may become entrepreneurs to pursue high-value projects and maximize short-run profits.

In addition, we introduce labor-market frictions, modeled as a probability  $\alpha \leq 1$  of receiving a wage offer. This assumption has two implications. First, whenever a worker does not receive a wage offer at time 2, the previous employer can "hold-up" the worker and extract a positive surplus. This hold-up problem is anticipated and, because of competition, in period 1 firms offer wages that reflect the expected profits derived from the hold up. While neutral from an expected payoff point of view, hold up implies that firms may implement task  $\tau_1 = 0$  at time 1 because firms expect to capture some of the benefits of learning about their worker. Second, labor market frictions create the possibility that some agents become "involuntary" entrepreneurs because they do not receive any job offer.

We structure our analysis in the following way. First, we derive the optimal task allocation of period-1 workers and period-1 entrepreneurs as a function of  $\alpha$ . We show that, as  $\alpha$  decreases, entrepreneurs are more likely to choose  $\tau_1 = 1$  over  $\tau_1 = 0$ , while the opposite is true for workers. Second, we look at the period-2 wage conditional on former occupation. Because period-1 task allocation determines period-2 market value, as  $\alpha$  decreases, the period-2 wage of former entrepreneurs decreases and the period-2 wage of former workers increases. We therefore replicate the two regimes described in the introduction, whereas low labor-market frictions (high  $\alpha$ ) correspond to a positive wage premium for former entrepreneurs (the "US" case), and high labor-market frictions (low  $\alpha$ ) correspond to a negative wage premium for former entrepreneurs (the "EU" case). Third, we derive period-1 occupational choice endogenously and we show that, under some parametric restrictions, entrepreneurial activity is higher in the US than in the EU regime. Finally, in section 4.4 we discuss

the relation between the predictions of the model and the empirical evidence.

## 4.1 Optimal Task Choice

**Period-1 workers.** Consider a period 1 worker. We assume that whenever the hold up problem arises, the firm and the worker split the surplus equally.<sup>12</sup> Call  $p_1$  the probability of being type 1 at the beginning of period 2. If there is no outside offer, at the beginning of period 2 a period-1 employer enjoys a payoff equal to

$$q \max\{p_1, 1 - p_1\} \max\{(K_2 - k_2), 0\} / 2.$$

Since workers receive outside offers with probability  $\alpha$ , taking expectations with respect to  $k_2$  and  $K_2$ , the expected profits of the firm in the second period are equal to:

$$(1 - \alpha) \frac{q \max\{p_1, 1 - p_1\}}{4\lambda}.$$

Because  $E[\max\{p_1, 1 - p_1\}]$  is larger when  $\tau_1 = 0$  compared to  $\tau_1 = 1$ , expected period-2 profits are larger when  $\tau_1 = 0$  compared to  $\tau_1 = 1$ . In other words, the firm can appropriate part of the benefit of learning between periods 1 and 2, and this benefit increases as  $\alpha$  decreases.

In addition, contrary to the simple model discussed in the previous section, here project termination has a negative impact on period-2 profits in the form of forgone learning. As a consequence, firms can offer period-1 contracts with a bonus component  $b$  that is greater than  $\underline{\beta}K_1$ , and still not trigger project termination under any realization of  $\beta_{i,t}$ . The maximum such bonus is a decreasing function of  $\alpha$ .

Note that the highest is  $b$ , the more likely is the firm to allocate a worker to task  $\tau = 0$ . From a static point of view the expected profits derived from task 1 are  $p_0(K_1 - b)$  and from task 0 are  $(1 - p_0)(K_1 - b)$ . Therefore, the

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<sup>12</sup> Using Nash bargaining is without loss of generality. What matters is that the firm is able to pay a wage lower than the worker's expected productivity.

static opportunity cost of choosing task 0 is equal to  $(2p_0 - 1)(K - b)$ , which is decreasing in  $b$ . Hence, as  $b$  increases, the static cost eventually falls below the learning benefit coming from period-2 profits.

By choosing  $b$  firms effectively commit to assign a worker to a given task allocation. Because firms compete for workers, the choice of  $b$  will be made in order to maximize the expected payoff to the worker under the non-termination constraint. Overall, the no-termination maximum value of  $b$  is a decreasing function of  $\alpha$ , which implies that worker will be assigned to task 0 more often when  $\alpha$  is small. We confirm this in the following proposition.

**Proposition 3.** *Let*

$$K(\alpha) \equiv \left( \frac{(1 - \alpha)}{4\lambda(1 - \underline{\beta})} \min \left\{ 1, \frac{p_0 q}{2p_0 - 1} \right\} \right)$$

*and*

$$\overline{K} \equiv \frac{1}{2} \left( \frac{1}{\lambda} + \lambda \right) \min \left\{ \frac{q(1 - p_0)}{2p_0 - 1}, 1 - q \right\}.$$

- (i) *Firms implement task  $\tau_1 = 0$  if and only if  $K_1 \leq \min\{K(\alpha), \overline{K}\}$ .*
- (ii) *There exists  $\alpha^* \in (0, 1)$  such that  $K(\alpha) > \overline{K}$  if and only if  $\alpha < \alpha^*$ .*
- (iii) *The task allocation within a firm maximizes a worker's total expected payoff when  $\alpha < \alpha^*$*
- (iv) *If instead  $\alpha > \alpha^*$  when  $K_1 \in (K(\alpha), \overline{K})$  workers' total expected payoff is larger if they are allocated to task 0, but firms implement task 1.*

When the labor market is frictionless, firms choose task allocation to maximize short-term output (from Proposition 3(iv) for  $\alpha = 1$ ). When the labor market has sufficient frictions, as in Proposition 3 (iii) above, firms assign workers to task 0 whenever this task maximizes the worker's life-time expected payoff.

**Period-1 entrepreneurs.** Consider a period 1 entrepreneur. The expected payoffs from choosing task 0 or 1 are:

$$\begin{aligned}
 V(\tau_1 = 1) &= qp_0 (k_1 + q (\alpha E [\max\{K_2, k_2\}] + (1 - \alpha) E [k_2])) \\
 &\quad + (\alpha E [\max\{K_2, k_2\}] + (1 - \alpha) E [k_2]) (1 - qp_0) \cdot q \cdot \max \left\{ \frac{p_0(1 - q)}{1 - p_0q}, \frac{1 - p_0}{1 - p_0q} \right\} \\
 V(\tau_1 = 0) &= q(1 - p_0) (k_1 + q (\alpha E [\max\{K_2, k_2\}] + (1 - \alpha) E [k_2])) \\
 &\quad + (\alpha E [\max\{K_2, k_2\}] + (1 - \alpha) E [k_2]) (1 - q(1 - p_0)) \frac{qp_0}{1 - q(1 - p_0)}
 \end{aligned}$$

where

$$E [\max\{K_2, k_2\}] = \frac{1}{2} \left( \frac{1}{\lambda} + \lambda \right),$$

and

$$E [k_2] = \frac{\lambda}{2}.$$

As  $\alpha$  decreases, period-2 expected project value decreases, learning becomes less valuable, and the entrepreneur is more likely to choose task  $\tau = 1$ . Indeed  $V(\tau_1 = 0) - V(\tau_1 = 1)$  is positive if:

$$k_1 \leq \left( \frac{\alpha}{2} \left( \frac{1}{\lambda} + \lambda \right) + (1 - \alpha) \frac{\lambda}{2} \right) \min \left\{ \frac{q(1 - p_0)}{2p_0 - 1}, 1 - q \right\} \quad (3)$$

where the right hand side is an increasing function of  $\alpha$ .

## 4.2 Market wage conditional on previous occupational choice.

As  $\alpha$  changes, the task allocation of workers and entrepreneurs change in opposite directions. As  $\alpha$  increases, workers are more likely to be allocated to task  $\tau = 1$  while entrepreneurs are more likely to choose task  $\tau = 0$ . We therefore obtain two regimes wherein former entrepreneurs who go back to the labor market either have higher or lower expected period-2 wages than former workers.

**Lemma 4.** *The expected period-2 wage of a period-1 entrepreneur is increasing*

in  $\alpha$ . The expected period-2 wage of a period 1 worker is decreasing in  $\alpha$ . There exists  $\alpha^*$  such that the period 2 wage of a former entrepreneur is greater than the wage of a former worker if and only if  $\alpha > \alpha^*$ .

Note that the two regimes are determined by a cut-off value of  $\alpha$ . This is the main result of the paper: labor market frictions determine the wage of former workers and former entrepreneurs in a way that is consistent with the empirical evidence available for US and the UE (see section 4.4). This implies that differences in labor market frictions can explain differences in the correlation between an entrepreneurial failure and the success of a new venture.

### 4.3 Endogenous occupational choice

We have argued that when the probability of receiving a wage offer  $\alpha$  is large, firms assign workers to the short-run profits maximizing task and individuals who receive a wage offer may become entrepreneurs in order to choose their own task assignment. For larger labor market frictions however, depending on  $\underline{\beta}$ , firms may be able to allocate workers to task 0, and individuals who receive a wage offer choose entrepreneurship only if they have a very valuable project. Hence, among those who receive a wage offer, the probability of becoming an entrepreneur increases with  $\alpha$ . At the same time, the fraction of "unintentional entrepreneurs", i.e., agents who become entrepreneurs for lack of a wage offer, decreases with  $\alpha$ . Therefore,  $\alpha$  has two opposite effects on the probability of becoming an entrepreneur. The next proposition characterizes the relationship between the probability of being an entrepreneurs and labor market frictions, for the case where the index of contract completeness  $\underline{\beta}$  is large.

**Proposition 5.** *There exists  $\underline{\beta}^* < 1$  such that whenever  $\underline{\beta} \geq \underline{\beta}^*$ , there is a U-shaped relationship between the probability of becoming an entrepreneur in period 1 and  $\alpha$ .*

As we already discussed,  $\underline{\beta}$  and  $\alpha$  jointly determine whether task 0 can be implemented within firms for given  $K_1$ . In particular, for given  $\alpha < 1$  the larger is  $\underline{\beta}$  the easiest it is to implement task 0. A larger  $\underline{\beta}$  implies that a



firm and a worker can sign a contract in which most of the wage payment is contingent on success, so that the cost to a firm of choosing one task over the other is low. However, for  $\alpha = 1$ , for any  $\underline{\beta} < 1$  firms always implement task 1. Hence, the closer  $\underline{\beta}$  is to one, the stronger the effect of decreasing  $\alpha$  from 1 to something slightly below 1 on the task allocation of firms and on the selection into entrepreneurship.

Whenever  $\underline{\beta}$  is sufficiently large, three regimes emerge. For  $\alpha = 1$ , there is a relatively high level of entrepreneurial activity, which is motivated, for the most part, by the desire to learn. For lower  $\alpha$ , the level of entrepreneurial activity decreases because learning can occur within firms. In this regime, agents become entrepreneurs mainly because they have a valuable project that they want to explore. Finally, for  $\alpha$  very small, most agents become entrepreneurs because they do not receive wage offers. These "involuntary" entrepreneurs engage in projects that have, on average, very small returns.

When  $\underline{\beta}$  is low instead, the probability of becoming an entrepreneur may decrease monotonically with  $\alpha$ . In this case, the number of agents who choose entrepreneurship to learn their type is large also for  $\alpha$  strictly below one. The main effect of a drop in  $\alpha$  is an increase in the number of "involuntary" entrepreneurs.

**Corollary 6.** *If  $\underline{\beta} \geq \underline{\beta}^*$ , the probability of becoming an entrepreneur in both periods (serial entrepreneurship) and the probability of becoming an entrepreneur in at least one period are in a U-shaped relationship with  $\alpha$ .*

For given  $\alpha$ , the probability of becoming an entrepreneur in period 2 is independent on period-1 career choice. Hence, the probability of being a serial entrepreneur is simply the product of the probability of becoming an entrepreneur in period 1 and the probability of becoming an entrepreneur in period 2. Similarly, the probability of becoming an entrepreneur in either period 1 or period 2 is simply the sum of probability of becoming a entrepreneur in period 1 and the probability of becoming an entrepreneurs in period 2.

The probability of becoming an entrepreneur in period 2 decreases with  $\alpha$ . At the same time, by Proposition 5, the probability of becoming an entrepreneur in period 1 increases in  $\alpha$  for  $\alpha$  close to one. We show in the

proof of Proposition 5 that the rate at which the probability of becoming an entrepreneur in period 1 increases with  $\alpha$  can be made arbitrarily large by choosing a  $\underline{\beta}$  sufficiently close to 1. Therefore, whenever  $\underline{\beta}$  is large, the probability of being a serial entrepreneur and the probability of being an entrepreneur in at least one period are increasing with  $\alpha$  for  $\alpha$  close to one.

**Corollary 7.** *If  $\underline{\beta} \geq \underline{\beta}^*$ , there is a U-shaped relationship between total output and  $\alpha$ .*

If  $\underline{\beta}$  is sufficiently close to one, even a very small amount of labor market frictions can induce the output maximizing task allocation within firms. In this case, learning can happen within firms, and all agents who receive a wage offer choose entrepreneurship or wage work so to work on the most valuable project. The fraction of agents not receiving a wage offer will negatively impact total output, but the size of this effect is negligible because  $\alpha$  is close to 1.

**Lemma 8.** *The probability of succeeding as an entrepreneur in period 2 following a period-1 failure is increasing with  $\alpha$ .*

The lemma follows from the fact that as  $\alpha$  decreases, for given entrepreneurial project  $k_1$ , fewer entrepreneurs choose  $\tau_1 = 0$  and learn their type. In addition, as  $\alpha$  decreases, fewer agents become entrepreneur when receiving a wage offer. Overall, only entrepreneurial projects of large enough value are pursued, which are the ones from which the entrepreneur is more likely to set  $\tau_1 = 1$ .

## 4.4 Discussion

The available estimates for labor market frictions show that frictions in Europe are significantly higher than in the US. Ridder and Berg (2003) estimate search frictions in the labor market as a rate of arrival of job offers for employed workers for the US, France, UK, Germany and Holland. All the European countries (with the exception of the UK) 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.

According to our model, differences in labor market frictions should translate into differences in the value of an entrepreneurial failure, and in the wage premium earned by former entrepreneurs in the US and in the EU. We find strong empirical support for these predictions. In the "US regime", frictions are low and the fraction of entrepreneurs who set  $\tau_1 = 0$  is large, because learning cannot occur within firms. It follows that past entrepreneurs are more valuable than past workers on the labor market (as found by Hamilton, 2000). In the "EU regime", frictions are sufficiently severe to make firms internalize part of the benefit of learning. Most people become entrepreneurs because they have a valuable project that they want to pursue, and they choose the short-run profit maximizing action  $\tau_1 = 1$ . It follows that past entrepreneurs are less valuable than past workers on the labor market (as found by Baptista et al., 2012). The probability of succeeding as an entrepreneur after an entrepreneurial failure is greater if  $\alpha$  is large (i.e., in the US), than if  $\alpha$  is intermediate (i.e., in the EU), which is consistent with the findings of Gottshalk et al. (2014) and Gompers et al. (2010).

In addition, under an appropriate assumption on the value of  $\underline{\beta}$ , our model can match differences in the observed number of entrepreneurs in the EU and in the US. The EU regime should see less entrepreneurial activity than the US regime. Indeed, in the EU regime agents become entrepreneurs only if they have a valuable project, while in the US regime agents become entrepreneurs also to learn their type. This prediction is consistent with available data (see, for example, the Global Entrepreneurship Monitor 2013 global report<sup>13</sup>).

Finally, somewhat trivially, if  $\alpha$  is very small, most agents become involuntary entrepreneurs and pursue low value projects, leading to low average output. One might be tempted to interpret the low  $\alpha$  case as representative of developing countries. However, while US and EU are relatively similar in other dimensions such as contracting abilities, financial market and human capital levels, this is hardly the case for developing countries. These dimensions are not modeled here, but are likely to affect the type and frequency of entrepreneurial failures as well as the market rewards of entrepreneurial

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<sup>13</sup> Available at <http://www.gemconsortium.org/docs/3106/gem-2013-global-report>

failures.

## 5 Conclusion

We have developed an equilibrium model of career choice where each agent has a comparative advantage over tasks, but neither the agent nor the firm knows the agent's comparative advantage. An agent can learn her optimal task allocation by working on a given task when young, and generating either a success or a failure. Some tasks are more informative about comparative advantage but may have a higher probability of failure. There is therefore a trade off between learning an agent's comparative advantage and short-run output maximization.

We show that the intensity of labor market frictions determines the proportion of different types of entrepreneurs in the economy, the wage of former entrepreneurs and former workers, and the probability of becoming an entrepreneur, in a way that is consistent with evidence for the US and the EU. Labor market frictions imply that firms may benefit from learning their workers' type, and may start to favor learning over short-run output in their task allocation. Hence, when labor market frictions increase, the learning motive for entrepreneurship may disappear. Alternatively, when labor market frictions are small, entrepreneurship may be a second-best response to the fact that learning cannot happen within firms. Because there is a non-monotonic relation between the level of aggregate output and the proportion of entrepreneurs, the model challenges the view that countries with more entrepreneurial activity should have higher welfare and output.

The US regime and the EU regime emerge because labor market frictions make European firms more willing to maximize long-run rather than short-run output. We speculate that the same results could be achieved through other mechanisms. For example, US corporations are more prone to "shareholder dictatorship" than European corporations, and differences in corporate governance may explain why European firms have a longer view when allocating workers to different tasks.

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## A Mathematical appendix

### Proof of lemma 2

The value of entrepreneurship is:

$$\max\{V(\tau_1 = 1), V(\tau_1 = 0)\}$$

Where

$$V(\tau_1 = 1) = qp_0(k_1 + q) + (1 - qp_0) \cdot q \cdot \max\left\{\frac{p_0(1 - q)}{1 - p_0q}, \frac{1 - p_0}{1 - p_0q}\right\},$$

and

$$V(\tau_1 = 0) = q(1 - p_0)(k + q) + (1 - q(1 - p_0))\frac{qp_0}{1 - q(1 - p_0)}.$$

are the values of working on task 1 and 0 respectively for a given entrepreneurial project  $k_1$ . The value of working for a firm is

$$V_w = qp_0(K_1 + q) + (1 - qp_0) \cdot q \cdot \max\left\{\frac{p_0(1 - q)}{1 - p_0q}, \frac{1 - p_0}{1 - p_0q}\right\},$$

The lemma follows by solving for

$$\max\{V(\tau_1 = 1), V(\tau_1 = 0)\} > V_w.$$

### Proof of Lemma 3.

To start, let's derive the worker-preferred task allocation. Despite the presence of labor market frictions, in period 1 the worker is the short side of the market and captures the entire surplus of working for a firm. Hence, the benefit of each task allocation is the total surplus generated by that allocation. For task



1 total surplus is

$$V(\tau_1 = 1) = qp_0 (K_1 + E[\max\{K_2, k_2\}]q) + \\ E[\max\{K_2, k_2\}] (1 - qp_0) \cdot q \cdot \max\left\{\frac{p_0(1-q)}{1-p_0q}, \frac{1-p_0}{1-p_0q}\right\},$$

where

$$E[\max\{K_2, k_2\}] = E[E[\max\{K_2, k_2\} | K_2]] \\ = E\left[\frac{K_2}{\lambda} + \left(1 - \frac{1}{\lambda}\right) \left(\frac{K_2 + \lambda K_2}{2}\right)\right] = \frac{1}{2} \left(\frac{1}{\lambda} + \lambda\right).$$

For task 0 total surplus is:

$$V(\tau_1 = 0) = q(1 - p_0) \left(K_1 + \frac{1}{2} \left(\frac{1}{\lambda} + \lambda\right) q\right) + \\ \frac{1}{2} \left(\frac{1}{\lambda} + \lambda\right) (1 - q(1 - p_0)) \frac{qp_0}{1 - q(1 - p_0)}.$$

Hence, the worker prefers  $\tau_1 = 0$  if and only if

$$k_1 \leq \frac{1}{2} \left(\frac{1}{\lambda} + \lambda\right) \min\left\{\frac{q(1-p_0)}{2p_0-1}, 1-q\right\} \equiv \bar{K} \quad (4)$$

Assume first  $V(\tau_1 = 1) \geq V(\tau_1 = 0)$ : the worker prefers task 1. This task is implementable if there is a bonus payment  $b$  such that the firm prefers to allocate the worker to task 1 (incentive compatibility) and the project is never terminated. The incentive compatibility constraint is

$$qp_0 \left(K_1 - b + \frac{q(1-\alpha)}{4\lambda}\right) + \frac{q(1-\alpha)}{4\lambda} \max\{p_0(1-q), 1-p_0\} \\ \geq (1-p_0)q \left(K_1 - b + \frac{q(1-\alpha)}{4\lambda}\right) + \frac{p_0q(1-\alpha)}{4\lambda} \\ \Leftrightarrow (2p_0-1) \left(K_1 + \frac{q(1-\alpha)}{4\lambda}\right) + [\max\{p_0(1-q), 1-p_0\} - p_0] \frac{(1-\alpha)}{4\lambda} \geq b(2p_0-1),$$

simple algebra shows that whenever  $V(\tau_1 = 1) \geq V(\tau_1 = 0)$  the LHS of the above expression is positive. The IC constraint is satisfied at  $b = 0$ . The non termination constraint is

$$qp_0 \left( \underline{\beta}K_1 - b + \frac{q(1-\alpha)}{4\lambda} \right) + \frac{q(1-\alpha)}{4\lambda} \max \{p_0(1-q), 1-p_0\} \geq \frac{p_0q(1-\alpha)}{4\lambda}$$

which is satisfied at  $b = 0$ . Hence, whenever the worker prefers task 1, this task is implementable by signing a contract with  $b = 0$ .

Suppose now that  $V(\tau_1 = 1) \leq V(\tau_1 = 0)$ : the worker prefers task 0. The IC constraint is

$$(2p_0-1) \left( K_1 + \frac{q(1-\alpha)}{4\lambda} \right) + [\max \{p_0(1-q), 1-p_0\} - p_0] \frac{(1-\alpha)}{4\lambda} \leq b(2p_0-1),$$

and the non-termination constraint is

$$q(1-p_0) \left( \underline{\beta}K_1 - b + \frac{q(1-\alpha)}{4\lambda} \right) + \frac{p_0q(1-\alpha)}{4\lambda} \geq \frac{p_0q(1-\alpha)}{4\lambda}$$

$$\Leftrightarrow b \leq \underline{\beta}K_1 + \frac{q(1-\alpha)}{4\lambda}.$$

By plugging the highest  $b$  for which there is no termination into the IC constraint we get that  $\tau = 0$  is implementable if

$$K_1 \leq \frac{(1-\alpha)}{4\lambda(1-\beta)} \min \left\{ 1, \frac{p_0q}{2p_0-1} \right\} \equiv K(\alpha).$$

Hence, as  $\alpha$  decreases, the set of  $K_1$  for which it is possible to implement  $\tau = 0$  expands. Finally, by using condition 4, we establish that  $\tau = 0$  will be implemented if and only if

$$K_1 \leq \min \{ \bar{K}, K(\alpha) \}.$$

## Proof of lemma 4

The fact that the expected period-2 wage of former entrepreneurs increases continuously with  $\alpha$  and the expected wage of former workers decreases continuously with  $\alpha$  follows from the way in which  $\alpha$  changes the optimal task allocation within professions for given  $K_1$  and  $k_1$ .

In case  $\alpha = 1$  all worker set  $\tau_1 = 1$ , while entrepreneurs set  $\tau = 0$  with positive probability. Hence the expected wage of a former entrepreneur is above the expected wage of a former worker.

We want to show that there exists an  $\alpha$  sufficiently small such that workers are more likely to set  $\tau_1 = 0$  than entrepreneurs, so that former workers receive a higher wage than former entrepreneurs. Consider the case  $\lim_{\alpha \rightarrow 0} \alpha$ . If an agent works for a firm, she is allocated to task  $\tau_1 = 0$  if and only if

$$K_1 \leq \frac{1}{2} \left( \frac{1}{\lambda} + \lambda \right) \min \left\{ \frac{q(1-p_0)}{2p_0-1}, 1-q \right\} \equiv \hat{K}.$$

At the same time, entrepreneurs set  $\tau_1 = 1$  if and only if

$$k_1 \leq \lambda \min \left\{ \frac{q(1-p_0)}{2p_0-1}, 1-q \right\} \equiv \hat{k} \leq \hat{K}.$$

It follows immediately that if all agents who receive a wage offer become workers, the probability that a worker is allocated to  $\tau = 0$  is greater than the probability that an entrepreneur is allocated to  $\tau = 0$ .

To conclude the proof, we show that among the agents who receive a wage offer, those who choose to work for a firm are more likely to be allocated to task  $\tau = 0$  than those who choose entrepreneurship. Note that an agent who receives a wage offer chooses to work for a firm rather than being an

entrepreneur if

$$\begin{aligned} & \max \left\{ qp_0 (k_1 + \lambda q) + \lambda(1 - qp_0) \cdot q \cdot \max \left\{ \frac{p_0(1 - q)}{1 - p_0 q}, \frac{1 - p_0}{1 - p_0 q} \right\}, \right. \\ & \quad \left. q(1 - p_0) (k_1 + \lambda q) + \lambda(1 - q(1 - p_0)) \frac{qp_0}{1 - q(1 - p_0)} \right\} \geq \\ & \max \left\{ qp_0 \left( K_1 + \frac{1}{2} \left( \frac{1}{\lambda} + \lambda \right) q \right) + \frac{1}{2} \left( \frac{1}{\lambda} + \lambda \right) (1 - qp_0) \cdot q \cdot \max \left\{ \frac{p_0(1 - q)}{1 - p_0 q}, \frac{1 - p_0}{1 - p_0 q} \right\}, \right. \\ & \quad \left. q(1 - p_0) \left( K_1 + \frac{1}{2} \left( \frac{1}{\lambda} + \lambda \right) q \right) + \frac{1}{2} \left( \frac{1}{\lambda} + \lambda \right) (1 - q(1 - p_0)) \frac{qp_0}{1 - q(1 - p_0)} \right\} \end{aligned}$$

Therefore, for every  $K_1$ , there is a threshold  $k(K_1) > K_1$  such that for every  $k_1 \geq k(K_1)$  the agent becomes an entrepreneur, and for every  $k_1 \leq k(K_1)$  the agent becomes a worker. Suppose that  $K_1 \leq \hat{K}$ , so that all workers are allocated to  $\tau = 0$ . It is easy to see that entrepreneurs are allocated to task  $\tau = 1$  with positive probability. Suppose instead that  $K_1 \geq \hat{K}$ , so that workers are allocated to task  $\tau = 1$ . Again, because  $k(K_1) > K_1 > \hat{k}$  all agents who become entrepreneurs also set  $\tau = 1$ . It follows that, among agents who receive an offer, the unconditional probability (i.e. for any  $K_1, k_1$ ) of being allocated to task 0 is greater for workers than for entrepreneurs.

## Proof of Proposition 5

The probability of becoming an entrepreneur is equal to

$$\text{pr}\{\text{entrepreneurship}\} = (1 - \alpha) + \alpha \text{pr}\{\text{entrepreneurship} \mid \text{wage offer}\}$$

Where  $\text{pr}\{\text{entrepreneurship} \mid \text{wage offer}\}$  is the probability of choosing entrepreneurship given that the agent received a wage offer. It follows that

$$\begin{aligned} & \frac{\partial \text{pr}\{\text{entrepreneurship}\}}{\partial \alpha} = \\ & -1 + \alpha \frac{\partial \text{pr}\{\text{entrepreneurship} \mid \text{wage offer}\}}{\partial \alpha} + \text{pr}\{\text{entrepreneurship} \mid \text{wage offer}\} \end{aligned}$$

The above derivative is positive if

$$\frac{\partial \text{pr}\{\text{entrepreneurship} \mid \text{wage offer}\}}{\partial \alpha} > \frac{1 - \text{pr}\{\text{entrepreneurship} \mid \text{wage offer}\}}{\alpha}$$

and decreasing otherwise.

We compute the probability of becoming an entrepreneur in case of a wage offer as a function of  $K_1$ :

- In case  $K_1 \leq \min\{K(\alpha), \bar{K}\}$  (where  $K(\alpha)$  and  $\bar{K}$  are defined in lemma 3), the firm will choose  $\tau_1 = 0$ , which is the worker-preferred task allocation given  $K_1$ . Hence the agent will choose entrepreneurship only if  $k_1 \geq K_1$ , which happens with probability  $1 - 1/\lambda$ .
- similarly to the previous case, when  $K_1 \geq \bar{K}$  the firm will choose  $\tau_1 = 1$ , which is the worker-preferred task allocation given  $K_1$ . Again, the agent will choose entrepreneurship only if  $k_1 \geq K_1$ , which happens with probability  $1 - 1/\lambda$ .
- whenever  $K(\alpha) \leq K_1$ , the firm will implement  $\tau_1$ , but the agent-preferred task allocation is  $\tau_1 = 0$ . Hence, the agent may choose entrepreneurship also for some  $k_1 \leq K_1$ . More precisely, the benefit of working for a firm is

$$p_0 q \left( \frac{q \left( \lambda + \frac{1}{\lambda} \right)}{2} + K_1 \right) + q (1 - p_0 q) \max \left( \frac{1 - p_0}{1 - p_0 q}, \frac{p_0 (1 - q)}{1 - p_0 q} \right) \left( \lambda + \frac{1}{\lambda} \right) \frac{1}{2}$$

the benefit of being an entrepreneur is

$$((1 - p_0) q^2 + p_0 q) \left( \frac{\alpha \left( \lambda + \frac{1}{\lambda} \right)}{2} + \frac{(1 - \alpha) \lambda}{2} \right) + k_1 (1 - p_0) q$$

the agent chooses entrepreneurship if

$$k_1 \geq k(\alpha, K_1) \equiv \frac{\max\{1 - p_0, p_0(1 - q)\}(\lambda^2 + 1) - (q + p_0 - 2p_0 q)(\lambda^2 + \alpha) + 2p_0 \lambda K_1 + (1 - \alpha)p_0 q}{2(1 - p_0)\lambda}$$

note that

$$\frac{\partial k(\alpha, K_1)}{\partial \alpha} = -\frac{p_0 + q - p_0 q}{2(1 - p_0)\lambda} < 0,$$

that

$$\frac{\partial k(\alpha, K_1)}{\partial K_1} = \frac{p_0}{1 - p_0} > 0,$$

and that  $k(\alpha, K_1) \geq 0$  if and only if

$$K_1 \geq \tilde{K}(\alpha) \equiv \frac{(q + p_0 - 2p_0 q)(\lambda^2 + \alpha) - (1 - \alpha)p_0 q - \max\{1 - p_0, p_0(1 - q)\}(\lambda^2 + 1)}{2p_0 \lambda}$$

For  $\alpha$  sufficiently close to 1,  $K(\alpha) \leq \tilde{K}(\alpha) \leq \bar{K}$ . Given this, for  $\alpha$  sufficiently close to 1

$$\text{pr}\{\text{entrepreneurship} \mid \text{wage offer}\} =$$

$$\frac{1}{2} \left( \frac{\lambda - 1}{\lambda} \right) (K(\alpha) + 2 - \bar{K}) + \frac{1}{2} (\tilde{K}(\alpha) - K(\alpha)) + \frac{1}{2} \int_{\tilde{K}(\alpha)}^{\bar{K}} \left( 1 - \frac{k(\alpha, K_1)}{\lambda K_1} \right) dK_1$$

$$\frac{\partial \text{pr}\{\text{entrepreneurship} \mid \text{wage offer}\}}{\partial \alpha} =$$

$$K'(\alpha) \left( \frac{\lambda - 1}{2\lambda} - \frac{1}{2} \right) + \frac{1}{2} \tilde{K}'(\alpha) + \frac{1}{2} \int_{\tilde{K}(\alpha)}^{\bar{K}} \frac{p_0 + q - p_0 q}{2(1 - p_0)\lambda^2 K_1} dK_1 - \frac{1}{2} \tilde{K}'(\alpha) =$$

$$- K'(\alpha) \frac{1}{2\lambda} + \frac{p_0 + q - p_0 q}{4(1 - p_0)\lambda^2} (\log(\bar{K}) - \log(\tilde{K}(\alpha))) > 0$$

so that

$$\left. \frac{\partial \text{pr}\{\text{entrepreneurship} \mid \text{wage offer}\}}{\partial \alpha} \right|_{\alpha=1} > 1 - \text{pr}\{\text{entrepreneurship} \mid \text{wage offer}\}|_{\alpha=1}$$

becomes

$$-K'(1)\frac{1}{2\lambda} + \frac{p_0 + q - p_0q}{4(1-p_0)\lambda^2}(\log(\bar{K}) - \log(\tilde{K}(1))) > \\ 1 - \frac{1}{2} \left( \frac{\lambda - 1}{\lambda} \right) (2 - \bar{K}) - \frac{1}{2} \tilde{K}(1) - \frac{1}{2} \int_{\tilde{K}(1)}^{\bar{K}} \left( 1 - \frac{k(1, K_1)}{\lambda K_1} \right) dK_1$$

Note that  $\underline{\beta}$  enters in the above equation only through  $K'(1)$  which is equal to

$$K'(1) = -\frac{1}{4\lambda(1-\underline{\beta})} \min\left\{1, \frac{p_0q}{2p_0-1}\right\}$$

Hence, for  $\underline{\beta}$  sufficiently close to 1, the above inequality is always satisfied, and the probability of becoming an entrepreneur is increasing in  $\alpha$  for  $\alpha$  close to 1.

## Proof of corollary 7

The expression for  $K(\alpha)$  derived in proposition 4 shows that for every  $\underline{\beta}$ , there is an  $\alpha$  such that firms implement the output-maximizing task allocation. In addition, as  $\underline{\beta}$  approaches 1, the  $\alpha$  inducing the output-maximizing task allocation approaches 1 as well. Hence, when  $\underline{\beta}$  is arbitrarily close to 1, any arbitrary small amount of labor-market frictions induces the output-maximizing task allocation among workers, and the output-maximizing sorting into entrepreneurship and wage work. On the other hand, market frictions create an output loss, as some agents will not receive a wage offer and will work on low-value projects, but this output loss is arbitrarily small if  $\alpha$  is very close to 1.

## Proof of Lemma 8

For given project value  $k_1$  the probability that an entrepreneur sets  $\tau_1 = 0$  increases with  $\alpha$ . At the same time  $\alpha$  determines the set of  $k_1$  that will be pursued by agents who receive a wage offer and become entrepreneurs. For these agents, as  $\alpha$  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  $\tau_1 = 0$ . Overall, the probability of setting  $\tau_1 = 0$  increases with  $\alpha$ , which implies that the probability of succeeding in period 2 also increases with  $\alpha$ .

## B Unobservable Task Allocation (For Online Publication)

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. From the point of view of a firm, after observing a success, the agent is either type  $p = 1$  or  $p = 0$ . After observing a failure, an agent can be one of two types, corresponding to the beliefs obtained under each task allocation as in (1).

In this situation, there are several possible equilibria, because firms' period-2 beliefs and period-2 wages affect period-1 task allocation, and vice versa. We consider two classes of equilibria: equilibria in which for every observable history firms offer a menu of contracts, one for each possible unobservable type (screening), and equilibria in which firms offer contracts that are contingent only to observable history (no screening). We restrict our analysis to the case  $k_t \in [0, K_t]$  and  $\alpha = 1$ .

Note that, whenever  $\alpha = 1$ , the fact that project termination is unobservable is not relevant. Remember that project termination leads to a failure with probability 1. For any market belief regarding the worker's productivity in case of failures, the worker prefers not to terminate the project, and strictly so if  $b > 0$ . Competition among firms assures that  $b \leq \underline{\beta}K_1$ . Hence, project termination never occurs in equilibrium: in case of failures, the only uncertainty is relative to period-1 task allocation.

**Screening equilibria** Suppose that, for every observable history, in period 2 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  $\{b, f, \tau_2 = 1\}$  and  $\{b', f', \tau_2 = 0\}$  such that  $f + qb = f' + qb' = K_2$  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 what specified in the contract.<sup>14</sup>

If the agent produced a failure in period 1, then screening on the base of task allocation is possible only if agents who failed at task  $\tau_1 = 1$  are the most productive at task 0 in period 2, i.e. if  $p_0(2 - q) < 1$ . If we write the bonus payment as a fraction  $\eta$  of total output, and use the zero profit condition on each contract, incentive compatibility implies

$$1 > \mu' \left(1 - \frac{qp_0}{1 - q(1 - p_0)}\right) + (1 - \mu') \frac{q(1 - p_0)}{1 - p_0q}$$

$$1 > \mu \left(1 - \frac{q(1 - p_0)}{1 - p_0q}\right) + (1 - \mu) \frac{qp_0}{1 - q(1 - p_0)}$$

for some  $\eta, \eta' \leq \underline{\beta}$ , which is always satisfied. Therefore, for  $p_0(2 - q) < 1$  the firm can screen and learn each worker's previous task allocation. Instead, whenever  $p_0(2 - q) > 1$ , it is not possible to use period-2 task allocation as a screening mechanism because following a failures the agent should be allocated to task  $\tau_2 = 1$  independently on period 1 task allocation.

More in general, we show here that there are no equilibria in which firms can screen for different types only by offering a menu of  $\{b, f\}$ . Define:

$$\pi \equiv q \max\{p_1, 1 - p_1\}$$

Where  $p_1$  is the belief on the agent's type at the beginning of period 2. Suppose that firms are screening by mean of  $\{b, f\}$  only. Consider two agents with the same observable history. Let  $\{f, b\}$  be a contract intended for type  $\pi$  and

<sup>14</sup> 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.

$\{f', b'\}$  be a contract for type  $\pi'$ . Incentive compatibility requires that

$$\begin{aligned} U(\pi) &= f + b\pi \\ &\geq f' + b'\pi \\ &= U(\pi') + b'(\pi - \pi') \end{aligned}$$

if profits are zero on both contracts, we have  $U(\pi) = \pi K_2$  and  $U(\pi') = \pi' K_2$ , so that

$$K_2(\pi - \pi') \geq b'(\pi - \pi'),$$

The above condition is trivially true whenever  $\pi \geq \pi'$ , but is never satisfied for  $\pi' \geq \pi$  (remember that no-termination implies  $b' < K_2$ ). Hence it is not possible to satisfy both incentive compatibility conditions and have zero profit on each type, because screening implies that firms will earn positive profits on the contract offered to the high types. It follows that a firm, instead of offering the entire menu of contracts, could deviate and offer only the contract that makes positive profit. Hence, screening never happen in equilibrium.

To sum up, if  $p_0(2 - q) < 1$  there is a screening equilibrium in which period-1 task allocation is revealed in period 2. Instead, whenever  $p_0(2 - q) > 1$  there is no screening equilibrium.

**No screening equilibrium** We now restrict our attention to equilibria in which, in period 2, firms offer contracts of the form  $\{b, f\}$ , with  $b = \eta K_2$  for  $0 < \eta \leq \underline{\beta}$ , and fixed payment  $f$ . We assume that the fraction of the project value paid as bonus is independent on observable history, but the fixed part depends on the observable history, where the observable history is period-1 occupation, success or failures, and project value  $k_1$ . We show that, when firms offer such contracts, the agent's type at the beginning of period 2 depends exclusively on her observable history, and therefore for every observable history there is a degenerate distribution of types.

The same argument made in the body of the paper guarantees that, in

period 1, firms allocate their worker to task  $\tau_1 = 1$ . Therefore, the period-2 payoff of a period-1 worker who failed is

$$q \max \left\{ \frac{p_0(1-q)}{1-p_0q}, \frac{1-p_0}{1-p_0q} \right\} K_2$$

and the period-2 payoff of a worker who succeeded is  $qK_2$ .

The task allocation of entrepreneurs instead depends on firms beliefs in period 2 over their period-1 task allocation, and therefore can be determined only in equilibrium. We restrict our attention to equilibria in which an entrepreneur's period-1 allocation is a monotonic function of  $k_1$ .

**Lemma 9.** *Consider a period-1 entrepreneur. There exist an equilibrium in which this entrepreneur chooses task  $\tau_1 = 0$  whenever  $k_1 \leq k(\eta)$  and task  $\tau_1 = 1$  otherwise, where*

$$k(\eta) \equiv \frac{1}{2p_0 - 1} \left( p_0 - q(2p_0 - 1) - \eta \cdot \max \{ p_0(1-q), 1-p_0 \} - \frac{(1-\eta)p_0(1-qp_0)}{1-q(1-p_0)} \right) \quad (5)$$

*Proof.* To start, note that in period 2 part of the wage will be paid in form of bonus contingent on success, making learning in period 1 valuable. Following a success, the payoff of a former entrepreneur is always  $qK_2$  and is independent on period-1 task allocation. Following a failure, for given period-2 contract  $\{f, b\}$  the agent's payoff depends on period 1 task allocation.

The total expected payoff of choosing each task is:

$$\begin{aligned} V(\tau_1 = 1) &= qp_0(k_1 + q) + (1 - qp_0) \left( E \left[ \max \left\{ q \eta K_2 \max \left\{ \frac{p_0(1-q)}{1-p_0q}, \frac{1-p_0}{1-p_0q} \right\} \right. \right. \right. \\ &\quad \left. \left. \left. + f_e(k_1, K_2), k_2 q \max \left\{ \frac{p_0(1-q)}{1-p_0q}, \frac{1-p_0}{1-p_0q} \right\} \right\} \right] \right), \\ V(\tau_1 = 0) &= q(1-p_0)(k_1 + q) + (1 - q(1-p_0)) \left( E \left[ \max \left\{ q \eta K_2 \frac{p_0}{1-q(1-p_0)} \right. \right. \right. \\ &\quad \left. \left. \left. + f_e(k_1, K_2), k_2 q \frac{p_0}{1-q(1-p_0)} \right\} \right] \right). \end{aligned}$$

where  $f_e(k_1, K_2)$  is  $(1 - \eta)K_2 \frac{qp_0}{1 - q(1 - p_0)}$  if  $k_1 \leq k(\eta)$  (so that firms expect the entrepreneur to choose  $\tau_1 = 0$ ), and is equal to  $(1 - \eta)qK_2 \max \left\{ \frac{p_0(1 - q)}{1 - p_0q}, \frac{1 - p_0}{1 - p_0q} \right\}$  if  $k_1 \geq k(\eta)$ .

Given this, the equilibrium task allocation of an entrepreneur is  $\tau_1 = 0$  for given  $k_1$  if:

$$\begin{aligned} & q(1 - p_0)(k_1 + q) + (1 - q(1 - p_0)) \frac{qp_0}{1 - q(1 - p_0)} \geq qp_0(k_1 + q) + \\ & (1 - qp_0) \left( E \left[ \max \left\{ q \eta K_2 \max \left\{ \frac{p_0(1 - q)}{1 - p_0q}, \frac{1 - p_0}{1 - p_0q} \right\} + \right. \right. \right. \\ & \left. \left. \left. (1 - \eta)K_2 \frac{qp_0}{1 - q(1 - p_0)}, k_2 q \max \left\{ \frac{p_0(1 - q)}{1 - p_0q}, \frac{1 - p_0}{1 - p_0q} \right\} \right\} \right] \right) \end{aligned}$$

Note that, in period-2, the agent never chooses entrepreneurship: the market believes that the entrepreneur chose  $\tau_1 = 0$ , and therefore the agent's period-2 payoff is greater when working for a firm than as an entrepreneur (both on- and off-equilibrium). Hence the above expression simplifies to

$$k_1(2p_0 - 1) \leq p_0 - q(2p_0 - 1) - \eta \max \{p_0(1 - q), 1 - p_0\} - \frac{(1 - \eta)p_0(1 - qp_0)}{1 - q(1 - p_0)} \equiv A$$

The equilibrium task allocation of an entrepreneur is  $\tau_1 = 1$  for given  $k_1$  if:

$$\begin{aligned} & qp_0(k_1 + q) + (1 - qp_0) \cdot q \cdot \max \left\{ \frac{p_0(1 - q)}{1 - p_0q}, \frac{1 - p_0}{1 - p_0q} \right\} \geq q(1 - p_0)(k_1 + q) + \\ & (1 - q(1 - p_0)) \left( E \left[ \max \left\{ q \eta K_2 \frac{p_0}{1 - q(1 - p_0)} + (1 - \eta)qK_2 \max \left\{ \frac{p_0(1 - q)}{1 - p_0q}, \frac{1 - p_0}{1 - p_0q} \right\}, \right. \right. \right. \\ & \left. \left. \left. k_2 q \frac{p_0}{1 - q(1 - p_0)} \right\} \right] \right). \end{aligned}$$

or

$$\begin{aligned} & k_1(2p_0 - 1) \geq 1 - p_0 - \max \{p_0(1 - q), 1 - p_0\} + \\ & E \left[ \max \left\{ K_2 \left( \eta p_0 + (1 - \eta) \frac{(1 - q(1 - p_0))}{(1 - p_0q)} \max \{p_0(1 - q), 1 - p_0\} \right), k_2 p_0 \right\} \right] \equiv B \end{aligned}$$

Note that  $B \leq A$ , because the continuation value whenever an agent chooses

$\tau_1 = 0$  is greater than the continuation value whenever the agent chooses  $\tau_1 = 1$ . Hence we have multiple equilibria. For simplicity, we pick the simpler expression and focus on the equilibrium in which the entrepreneur chooses task  $\tau_1 = 0$  whenever condition 5 holds, and task  $\tau_1 = 1$  otherwise.  $\square$

It follows that, from period-2 point of view, observing the occupational choice and the project  $k_1$  is sufficient to infer the task allocation in period 1. There is no asymmetry of information in period 2. Note that the set of  $k_1$  for which the entrepreneur chooses learning depends on whether period-2 wage is mostly paid as bonus for success or fixes payment. Because  $k(\eta)$  is increasing in  $\eta$ , the largest is the contingent part of period-2 wage, the most likely the entrepreneur is to choose learning over short-run profit maximization.

We can now derive the optimal period-1 career choice. Clearly, the agent will never choose entrepreneurship whenever  $k_1 \geq k(\eta)$ , because by working for a firm she would work on a project of greater value. If instead  $k_1 \leq k(\eta)$  then the agent may choose entrepreneurship. The agents become an entrepreneur if the lifetime utility of being an entrepreneurs is greater than the lifetime utility of working for a firm. We compared the two in lemma 2 and the condition derived there applies here as well.

**Corollary 10.** *The agent chooses entrepreneurship in period 1 if both  $k_1 \leq k(\eta)$  and*

$$k_1(1 - p_0) > K_1 p_0 - \min\{q(1 - p_0), (2p_0 - 1)(1 - q)\}$$

Note that the largest the contingent part of the wage in period-2, the more likely is the agent to choose entrepreneurship in period 1.

Therefore, when tasks are unobservable, there are multiple equilibria. Some of these equilibria are qualitatively similar to the equilibrium with observable task allocation: all entrepreneurs choose  $\tau_1 = 0$  and all workers choose  $\tau_1 = 1$ . The only difference between observable and unobservable task allocation is in the thresholds determining the selection into entrepreneurship.

## C Uncorrelated Probability of Success across Tasks (For Online Publication)

So far, we assumed that the agent is always productive at exactly one task, implying that the agent's expected productivity at different tasks is negatively correlated: when, after observing a failure, the probability of success at a given task is revised downward, the probability of success at the other task must be revised upward.

In this section, we assume that the probability of succeeding at a given task is independent on the probability of succeeding at the other task. This version of the model is closely related to Gibbons and Waldman (2004) and Gibbons and Waldman (1999) who argue that talent and human capital are task specific, in the sense that by working on a given task a worker increases her productivity at that specific task. Here, learning is task specific, in the sense that succeeding or failing at a given task is informative only regarding the future probability of success at that specific task.

We show that the learning motive for entrepreneurship may emerge in this case as well: agents may become entrepreneurs to learn their type, and to be rewarded in the future labor market. In addition, also here failures may be "good" signals and increase the probability of future success. The key assumption is that the task at which the agent is less likely to succeed when young is also more valuable in the long term.

Assume that each agent can be of type  $\{\theta^0, \theta^1\}$  where  $\theta^0 \in \{0, 1\}$  represents whether the agent can succeed at task 0 and  $\theta^1 \in \{0, 1\}$  whether the agent can succeed at task 1. We assume that  $\theta^0$  and  $\theta^1$  are independent. Call  $p_0^0$  the probability that a young agent is of type  $\theta^0 = 1$ , and call  $p_0^1$  the probability that a young agent is of type  $\theta^1 = 1$ . For given beliefs  $p^1, p^0$ , the probability of success at a given task  $\tau \in \{0, 1\}$  is:

$$\Pr\{s = 1 | \tau, p^0, p^1\} = q^1 p^1 \cdot \tau + q^0 p^0 \cdot (1 - \tau).$$

The above formulation implies that, whenever  $\Pr\{\theta^1\} = \Pr\{\theta^0\}$  the agent will be allocated to the task with the highest  $q$ . Intuitively, independently

on the agent's type, one task is intrinsically more valuable than the other. Also here, we assume that a young agent is more likely to succeed at task 1:  $q^0 p_0^0 < q^1 p_0^1$ . However, we assume that task 0 is intrinsically more valuable than task 1:  $q^0 > q^1$ .

Similarly to the main model, there is a fundamental trade off between the task allocation maximizing short-run profits and the task allocation maximizing long-run profits. Because being productive at task 0 is more valuable than being productive at task 1, it may be optimal to allocate the agent to task 0 in period 1. However, this task allocation generates a short-run cost in the form of a higher probability of failing.<sup>15</sup>

We solve the model under the same assumptions made in section 3. In particular,  $k_t$  is drawn from a  $[0, K_t]$  uniform distribution, and there is a perfect labor market. It is quite easy to see that lemma 1 holds here as well: in period 1 firms always allocate the agent to task 1.

If, in period 1, the agent chooses entrepreneurship, the payoff of choosing task 1 is:

$$V(\tau_1 = 1) = q^1 p_0^1 (k_1 + q^1) + (1 - q^1 p_0^1) \cdot \max \left\{ \frac{q^1 p_0^1 (1 - q^1)}{1 - q^1 p_0^1}, q^0 p_0^0 \right\}$$

and the payoff of choosing task 0 is:

$$V(\tau_1 = 0) = q^0 p_0^0 (k_1 + q^0) + (1 - q^0 p_0^0) \cdot q^1 p_0^1$$

Which implies that an entrepreneur set  $\tau_1 = 0$  if and only if

$$k_1 \leq \frac{\min\{q^0 p_0^0 (q^0 - q^1 p_0^1), q^1 p_0^1 (1 - q^1)\}}{q^1 p_0^1 - q^0 p_0^0} \quad (6)$$

Hence, an entrepreneur will choose  $\tau = 0$  for some  $k_1$  as long as  $q^0 > q^1 p_0^1$ , and always choose  $\tau = 1$  otherwise.

Following the same steps as in the main model, we can derive the full

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<sup>15</sup> The intuition is similar to several results in option-value theory: efficient discovery may require the agent to experiment first with the high-reward/high-probability-of-failing option.

dynamic payoff of a worker:

$$q^0 p_0^0 (K_1 + q^0) + (1 - q^0 p_0^0) \cdot q^1 p_0^1$$

Hence, if  $k_1$  is sufficiently close to  $K_1$  and  $K_1$  satisfies equation 6, then the agent chooses to be an entrepreneur. In addition, entrepreneurs always set  $\tau = 0$ . Similarly to the previous model, the probability of success of period-1 entrepreneurs ( $q^0 p_0^0$ ) is smaller than the probability of success of former entrepreneurs who failed ( $q^1 p_0^1$ ). For workers instead, the probability of success in period 1 ( $q^1 p_0^1$ ) is larger than the probability of success in period 2 following a failure ( $\max \left\{ \frac{q^1 p_0^1 (1 - q^1)}{1 - q^1 p_0^1}, q^0 p_0^0 \right\}$ ). Finally, it is possible to show that the wage of a former entrepreneur is always greater than the wage of a former worker.

Similarly to section 4, also here if labor market frictions are sufficiently large, the firm internalizes the benefit of talent discovery and may implement the worker-preferred task allocation. Hence, agents will choose entrepreneurship only if they have a valuable project, making them less likely than workers to choose task  $\tau = 0$ . The results derived in section 4 carry over qualitatively to this case as well.