Journal of Financial Economics 144 (2022) 1–21

Contents lists available at ScienceDirect

Journal of Financial Economics

journal homepage: www.elsevier.com/locate/jfec

Keeping options open: What motivates entrepreneurs?☆,☆☆

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ARTICLE INFO

Article history:
Received 11 October 2021
Revised 2 January 2022
Accepted 2 January 2022
Available online 20 January 2022

JEL classification:
L26
G3
D91
D92

Keywords:
Entrepreneurship
Life-Cycle model
Structural estimation
Learning

ABSTRACT

Using French administrative data on job-creating entrepreneurs, I estimate a life-cycle model in which risk-averse individuals can start businesses and return to paid employment. Then, I use the dynamic model to value the option of returning to the labor market in case of failure. For new entrepreneurs, this option is worth 6.4× the average net wage in the country, which represented 136,000€ in 2018. This option value is explained by the unobserved heterogeneity in entrepreneurial abilities and the random-walk component of productivity. Estimated unobserved benefits of entrepreneurship represent 38.6% of the average net wage pre-tax per year (some 15% of profits), or 8,250€ in 2018. Unobserved benefits add up to 90,700€ over the average entrepreneurial spell. Together, unobserved benefits and the option value of returning to paid employment explain 42% of firm creations.

1. Introduction

What drives individuals to leave paid employment and strike out on their own? Early studies suggest that financial earnings alone cannot explain this decision because entrepreneurs appear to earn less and bear more risk than employees (Hamilton, 2000; Moskowitz and Vissing-Jorgensen, 2002). One possible solution to this puzzle is that earnings data understate the benefits of entrepreneurship. Apart from declared earnings, entrepreneurs may enjoy unobserved benefits, such as nonpecuniary (psychic) benefits, unreported earnings, and legal tax avoidance. Another possibility is that cross-sectional studies overstate the downsides of entrepreneurship by overlooking entrepreneurs' option to return to paid employment if they fail. This option's value may motivate individuals to experiment with entrepreneurship (Manso, 2016).

Though some studies quantify unreported earnings (Pissarides and Weber, 1989; Hurst et al., 2014), little is known about the size of nonpecuniary benefits. Likewise, there is evidence that policies mitigating downside risk foster entrepreneurship (Hombert et al., 2020; Gottlieb et al., 2021), but there are no estimates of the value of the option to return to paid employment. In addition, the extent to which this option and unobserved benefits explain the creation of entrepreneurial firms and

☆ Toni Whited was the editor for this article. This paper greatly benefited from the comments of the editor and the anonymous referee. I would like to thank my advisors David Thesmar and Denis Gromb for their guidance and support, as well as Augustin Landier, David Sraer, Jean-Noël Barrot, Joao Cocco, Toni Whited, Luke Taylor, Gustavo Manso, Boris Vallée, Johan Hombert, Thomas Åstebro and Christopher Stanton for helpful feedback. I am also thankful to conference participants at the WFA, Adam Smith conference, FIRS, EFA, Columbia 5-star workshop and the Belgrade Young Economist Conference, as well as seminar participants at Wharton, the London School of Economics, London Business School, Carnegie Mellon, Texas A&M, Bocconi, Imperial College, University of Notre-Dame, University of Wisconsin-Madison, EIEF, Boston University and ITAM.

☆☆ This work was supported by the French National Research Agency [reference: ANR-10-EQPX-17 – Centre d'accès sécurisé aux données – CASD]

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https://doi.org/10.1016/j.jfineco.2022.01.001
0304-405X/

the entrepreneur-employee earnings differential remains unexamined.

To explore these questions, I estimate a structural life-cycle model in which risk-averse individuals can become entrepreneurs who retain the ability to later return to paid employment. While they are entrepreneurs, individuals learn about the productivity of their firm and enjoy unobserved benefits, which in the model capture nonpecuniary benefits and unreported earnings. I estimate the model using detailed French administrative data which allow me to follow transitions in and out of entrepreneurship, match entrepreneurs' employment records with their firm's accounting data, and compare their earnings to a benchmark group of paid employees.

My main findings are as follows. First, estimated yearly unobserved benefits represent 38.6% of the average net salary in France, or 8,250€ in 2018[1] and less than 15% of profits. Over the average entrepreneurial spell, unobserved benefits add up to 90,700€. Second, despite their seemingly modest valuation, unobserved benefits are critical to entrepreneurship: without them, firm creations would drop by 12% and exit rates would increase such that, overall, there would be 27% fewer entrepreneurial firms. Third, the option to return to paid employment is worth 136,700€ to new entrepreneurs, which is close to the cumulated difference between their earnings and the salaries of a benchmark group over the first ten years (149,400€). The option value explains 16% of firm creations on its own and 42% of firm creations when combined with unobserved benefits. Finally, the main driver of the option value is the random-walk component of productivity, not entrepreneurs' need to learn about their abilities as suggested by the existing literature.

In the model, individuals work until retirement and experience persistent and transitory labor income shocks. The main innovation is that they can also leave paid employment when they have an entrepreneurial idea. In that case, they invest in a firm with Cobb-Douglas technology and decreasing returns to scale. Ideas arrive randomly, and their quality determines the initial productivity of capital. As in Lucas (1978), heterogeneity in the quality of ideas drives the dispersion of firm size. As in Jovanovic (1982), entrepreneurs learn about their productivity by observing their profits. Learning is slowed down by transitory productivity shocks, which, together with permanent shocks, make investment risky. Entrepreneurs can borrow to invest in their firm but are not protected by limited liability. Finally, they observe how much they would earn in paid employment and can return to the labor market.

I estimate the model using French corporate tax files and individual employment records from 1994 to 2013. These datasets allow me to compare the income trajectories of entrepreneurs to a benchmark group by matching each new entrepreneur with a paid employee who had the same occupation, gender, age and a similar earnings trajectory in the years preceding firm creation. However, the two datasets can only be matched when entrepreneurs report wages as employees of their own firms. This restriction creates large selection bias for the smallest firms but not for those with other employees, which motivates me to focus on job-creating entrepreneurs. Specifically, I restrict my sample to entrepreneurs whose firm hired at least one employee in the year of its creation. Though constrained by data limitations, this restriction acknowledges the growing literature arguing that self-employment alone is a poor proxy of entrepreneurship.[2] For example, Levine and Rubinstein (2017) argue that incorporation is a better proxy and find that, unlike their unincorporated peers, incorporated US entrepreneurs earn more than they would in paid employment. Similarly, I find that, over the first 10 years of their firm's existence, French job-creating entrepreneurs earn 49% more than peers in their benchmark group. This premium falls under 10% when accounting for failed entrepreneurs who returned to paid employment and adjusting for a hypothetical 6% opportunity cost of equity. Whether this premium is enough to compensate for entrepreneurial risk is unclear.

My estimation strategy has two steps. First, I use the volatility of wages among my benchmark group of salaried employees to estimate the labor income process entrepreneurs would face in paid employment. Second, I use the Simulated Method of Moments (SMM) to estimate the parameters related to entrepreneurship. The three most important parameters are unobserved benefits, initial uncertainty over productivity, and the standard deviation of permanent shocks. I disentangle permanent and transitory shocks by matching the volatility of value added at different time horizons. Unobserved benefits are estimated by targeting the earnings differential between entrepreneurs and their benchmark group, as larger benefits lead individuals with relatively unpromising ideas to become and remain entrepreneurs. Likewise, I estimate initial uncertainty over productivity by targeting empirical exit rates, as higher uncertainty encourages experimentation, which in turn increases the likelihood of failure.

As mentioned previously, the results suggest that unobserved benefits and the option to return to paid employment are both important in explaining the decision to become an entrepreneur. By contrast, a series of counterfactual experiments I conduct with the model show that only unobserved benefits affect the cross-sectional earnings differential between active entrepreneurs and paid employees. Removing unobserved benefits improves the quality of new firms and, later on, discourages the persistence of unproductive entrepreneurs. Combined, these two effects would cause the earnings differential between active entrepreneurs and paid employees to double. By contrast, making it difficult to return to paid employment also im-

[1] In the paper, monetary variables are normalized by the average net salary in France. In early versions of the drafts, all estimates were converted into euros using the average net salary over the 1994–2013 sample period. In this version, the conversion is based on the average net salary of 21,360€ in 2018.

[2] Hurst and Pugsley (2011) document that most self-employed workers have no intention to grow or innovate. Haltiwanger et al. (2013) show that after controlling for firm age, small businesses do not create jobs. Henrekson and Sanandaji (2014) find that the rate of self-made billionaires correlates negatively with self-employment rates. Schoar (2010) discusses the need to differentiate subsistence and transformational entrepreneurs.

proves entrepreneurs' quality at entry but prevents unsuccessful entrepreneurs from exiting later on. Quantitatively, these two effects exactly offset each other, and, thus, the entrepreneurial premium does not depend on the ease with which entrepreneurs can return to paid employment.

What drives the value of the fallback option? To match cumulative exit rates, the model requires a substantial level of initial uncertainty over permanent log productivity (σ=0.48), while matching the volatility of value added requires large permanent productivity shocks (σ=0.18). At horizons exceeding seven years, permanent shocks generate more risk and option value than initial uncertainty. Moreover, while removing initial uncertainty has little consequences on entrepreneurial activity, eliminating permanent shocks reduces the average firm's value added by 40%. This shows that permanent shocks explain the growth of successful businesses. Direct evidence of these shocks in the data is given by the increase in dispersion of firm size and earning inequalities among surviving entrepreneurs with firm age. If initial uncertainty were the main source of risk, selection by learning would gradually reduce inequalities among surviving entrepreneurs by eliminating the least efficient ones.

Finally, I run several experiments related to policies intended to promote entrepreneurship. I reestimate the model under the assumptions that entrepreneurs either (i) temporarily experience a 20% reduction in wages when returning to paid employment, (ii) lose 20% of their capital when they close their firm, or (iii) face progressive personal income taxes. I then remove each of these three elements and find them to have only marginal impact. This suggests that policies seeking to reduce labor market frictions, liquidation costs and marginal tax rates would have only limited impact on entrepreneurship.

This paper contributes to the entrepreneurship literature on nonpecuniary benefits and unreported earnings. Hurst and Pugsley (2011) document that over 50% of new US entrepreneurs cite nonpecuniary benefits among their motives. Pissarides and Weber (1989) and Hurst et al. (2014) infer from expenditure data that self-employed workers underreport their income by 25% to 35% in tax forms and household surveys. My approach differs in two ways. First, I measure the magnitude of unobserved benefits necessary to rationalize observed earnings differentials between entrepreneurs and paid employees. In that sense, my methodology is closer to Jones and Pratap (2020)'s structural estimate of nonpecuniary benefits of US dairy farmers. Aside from the very specific nature of their sample, a key limitation of Jones and Pratap (2020)'s study is their inability to observe farmers' earnings outside of self-employment. Consequently, their estimate of nonpecuniary benefits depends on their calibration of farmers' outside option. Second, I focus on job-creating entrepreneurs, who might be less prone to underreporting than self-employed workers running smaller and more informal businesses.[3] Moreover, unlike the previous literature, I also estimate the extent to which unobserved benefits contribute to entrepreneurial entry and persistence.

Manso (2016) argues that the option to return to salaried work is important and shows that, in the U.S., self-employed workers have, on average, similar lifetime earnings as comparable salaried workers. My structural model improves on this study in three ways. First, one cannot rule out the importance of non-pecuniary benefits without taking uncertainty into account. Just as two assets with identical expected cash flows can have different prices, career paths with identical expected earnings can have vastly different values to a risk-averse agent. This is particularly important when the agent is not diversified and the difference in risk is substantial: in my data, the standard deviation of entrepreneurial earnings is four times larger than that of salaried workers. Second, one cannot compute the value of a real option without solving a dynamic model.

A third benefit of the model is that it can be used to run counterfactual experiments in order to quantify the importance of entrepreneurs' fallback option. These experiments build on reduced-form studies that focus on specific forms of downside protection, such as job-protected maternity leave (Gottlieb et al., 2021) or unemployment insurance benefits (Hombert et al., 2020). The structural estimation sheds light on why these studies find that fallback options matter so much: entrepreneurs face significant uncertainty -regarding their own skills or the quality of their project - and, even more importantly, are vulnerable to large permanent productivity shocks.

Finally, I contribute to a nascent literature on structural models of entrepreneurship. Dillon and Stanton (2018) develop a semi-structural model in which risk-neutral individuals can switch to self-employment to learn about their productivity and can subsequently return to paid employment. Humphries (2021) develops a life-cycle model without learning but where agents can choose between various forms of self-employment. Relative to these papers, my model is closer to standard life-cycle models of consumption and portfolio choices as it allows for endogenous savings and investment decisions, risk-aversion, and permanent productivity shocks, which turn out to be the main source of option value. These additions put the risk-return tradeoffs between entrepreneurship and paid employment at the center of the model. Finally, in a contemporaneous study, Choi (2018) shows that entrepreneurs with better outside options undertake more risky projects, which is consistent with my findings that marginal entrepreneurs' expected utility increases with the variance of permanent productivity shocks.

2. Stylized facts

This section presents the data and stylized facts on entrepreneurial earnings and the evolution of young firms.

2.1. Data and sample

I rely on two confidential administrative datasets from the French statistical institute (INSEE): employee earning records and corporate tax files.

[3] Schuetze (2002) documents that entrepreneurs receiving more payments in cash are more likely to underreport their income. Hurst et al. (2014) report some weak evidence that underreporting decreases with education.

Employee earnings Every year, French firms are required by law to provide detailed information on each of their employees. These filings are known as *Déclarations Annuelles des Données Sociales* (DADS). The DADS currently cover the 1976–2013 period and include information on wages, working period, hours, and occupation.

Among 24 occupations, three identify business owners, which INSEE defines as workers "who exploit economic capital as managers of their own firm." These three groups include "craftmen" (e.g. bakers, plumbers, construction businesses...), "merchants" (grocery stores, restaurants, realtors...) and other "business owners." "Liberal professions" such as lawyers, notaries and doctors are excluded. INSEE provides the data in a series of cross sections that cover the entire population but in which workers get a new identifier every year. INSEE also provides a panel dataset for a representative subsample in which workers have unique identifiers. This subsample covers 1/25th of the population until 2000 and 1/12th thereafter.

Corporate tax files The second dataset contains income statements and balance sheets collected by the Treasury for the entire universe of French firms between 1994 and 2013. Because this dataset uses the same company identification number as the DADS, I can match business owners with their firm's accounting data as long as they receive a salary from their own firm. I discuss the effect of this condition on my analysis in the next section.

Sample I study firms created after 1993 with at least one employee in the year of their creation. I exclude subsidiaries and businesses with more than 50 employees or more than 1M euros of equity at creation. Financial and real-estate firms are also excluded, as well as independent professionals working in highly regulated sectors (lawyers, notaries, doctors). Of firms respecting these conditions that have no employee in their first year, only 17% eventually hire someone else than their owner. Overall, my main sample contains slightly more than 1 million firms and 4.7 million firm-year observations.

As will be discussed, the French administrative data is not without limitations. However, it has key advantages over the US survey data widely used in the entrepreneurship literature. First, it gives me the ability to follow a large set of individual entrepreneurs before, during, and after their entrepreneurial spell, an undertaking that is not viable with US survey data. Second, the use of administrative data is likely more reliable than survey data on businesses, as Bhandari et al. (2020) find very large differences between the average business income reported in US surveys and administrative IRS data.

2.2. Income trajectories

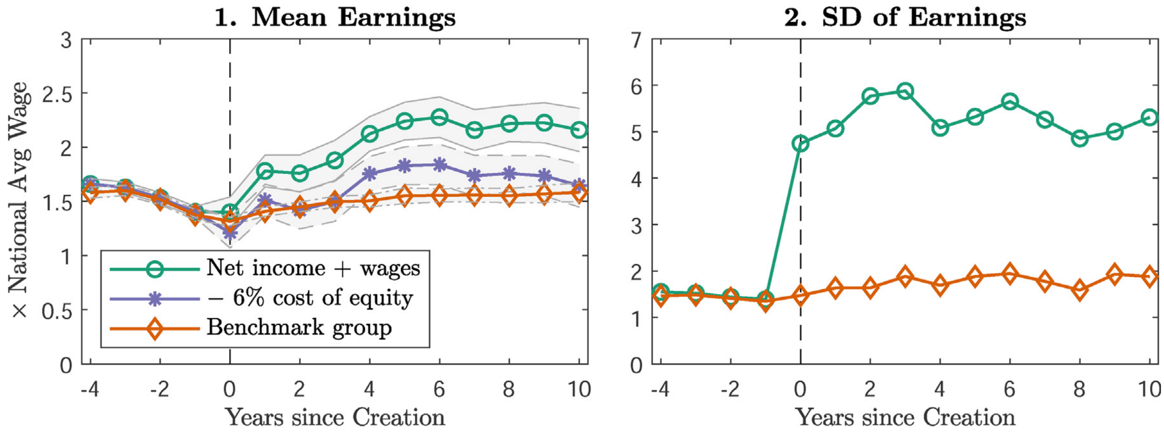
Figure 1 reports the evolution of the earnings distribution of individuals becoming entrepreneurs and that of a benchmark group of paid employees constructed via matching. Earnings include wages (net of payroll taxes) and, for entrepreneurs, the net income of their firm.

In Panel A, I follow all entrepreneurs, including those who closed their firm and returned to paid employment. The left plot shows that entrepreneurs earn on average 36% more than the benchmark group over the first ten years. Of course, this comparison is somewhat misleading because entrepreneurs need to invest equity that could otherwise generate interests on a savings account. Ideally, we would like to compare earnings in paid employment to the net income of entrepreneurs, net of the opportunity cost of their equity. The latter would include both dividends and capital gains in the form of retained earnings. For strictly illustrative purposes, we can assume an opportunity cost of equity of 6% and compute equity as net assets minus liabilities. The purple line shows that, under these assumptions, the earnings differential falls slightly under 10%. The structural model will take into account that entrepreneurs need to reinvest part of their earnings and forgo the income from interest that their equity would generate in a saving account.

The right plot shows that entrepreneurial entry is followed by a large increase in the dispersion of earnings, which is three times larger than in the benchmark group. This large variance suggests that entrepreneurs face much more risk than paid employees. Whether the premium observed in the left plot is enough to compensate this risk is the quantitative question my structural model seeks to answer.

In Panel B, I compare the earnings of active entrepreneurs to that of their benchmark group, but I remove entrepreneurs (and their match) from the data as soon as they close their firm. This leads to a survival bias that causes the earnings differential to be larger and increase faster than in Panel A, averaging 49% over the first ten years. Despite the exit of the least efficient firms, the dispersion of earnings among surviving entrepreneurs increases with firm age.

These plots are based on a subsample of 11,830 entrepreneurs and 107,701 entrepreneur $\times$ year observations. The sample size is strongly reduced for two reasons. First, while cross-sectional data cover the entire population of workers, the panel data, in which workers keep the same identifier over time, only covers a representative sample of 1/20th of the population. The second limitation of the data is that business owners can only be followed before and after their entrepreneurial spell if they ever receive a wage from their own firm. Otherwise, firm data cannot be linked with the entrepreneurs' earnings records. This condition creates a selection bias if it correlates with success. I try to address this problem by restricting my sample to cases in which the entrepreneur paid himself a salary from the very beginning (year 0 or 1). In theory, this decision could still reflect confidence on the part of the entrepreneur and predict future success. However, I find evidence that this subsample does not significantly differ from the overall population of job-creating entrepreneurs. As reported in appendix Table B.2, firms in my subsample generate only 1,700€ more in yearly earnings (net income + salary paid to the entrepreneur), a difference that becomes statistically insignificant by year six. Similarly, differences in exit rates are small: survival rates after ten years are 49% and 44% for the subsample and the full sample respectively. Though dictated by the data, the focus on entrepreneurs paying themselves a wage improves the comparability with the benchmark group of paid employees, as these entrepreneurs enjoy similar social security coverage.



B. Conditional on Still Running a Business

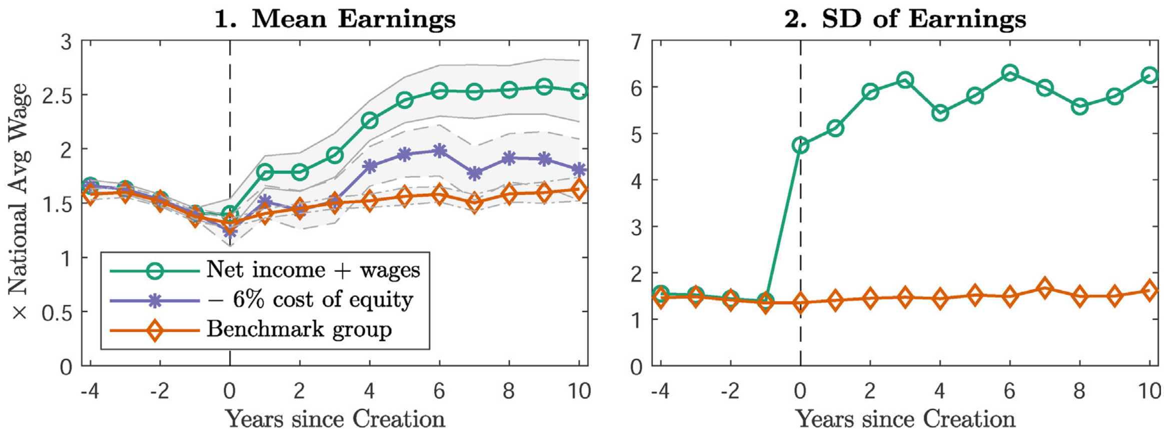


Fig. 1. Evolution of Earnings around Entrepreneurial Entry. These graphs report the evolution of the income distribution among workers becoming entrepreneurs at time 0 and a benchmark group of paid employees constructed by matching. The mean income of entrepreneurs is defined as the sum of wages (net of payroll taxes) and firm's net income. The " -6% cost of equity" line illustrates what would be the earnings of the entrepreneurs after adjusting for a hypothetical opportunity cost of equity of 6%. Equity is defined as net assets minus current liabilities. In Panel A, it includes entrepreneurs who returned to paid employment. By contrast, Panel B only reports income of entrepreneurs as long as they are still running their business. The matching algorithm takes into account sex, last occupation, age, and earnings received over each of the three years preceding the entrepreneurial spell. Shaded areas represent 95% confidence intervals estimated by block bootstrap.

I match each new entrepreneur with a paid employee using pre-entrepreneurial characteristics. Specifically, matches are drawn from the sample of individuals who had the same employment status (working or not) over each of the three years preceding entrepreneurial entry. They must also have the same gender and main occupation, which is defined at the two-digit level (24 groups)[4], as the one that generated the highest total earnings over the last two years. The best match is picked among paid employees satisfying these conditions by minimizing the Mahalanobis distance to the entrepreneur with respect to four variables: age and income over each of the last three years. The quality of the benchmark group is reported in appendix Table B.1.

The closest element of comparison for Panel A is Manso (2016), who finds no statistically significant difference in earnings between US self-employed individuals and similar paid employees. The use of self-employment as a proxy for entrepreneurship is the most likely explanation for this difference in results. By contrast, Levine and Rubinstein (2017) distinguish US incorporated entrepreneurs from other self-employed workers and find that the former earn 29% more than they would in paid employment, which is more consistent with my findings.

2.3. Early years of businesses

Table 1 reports summary statistics for firms with at least one employee at creation. The first indication that the option value of returning to paid employment may be substantial is that entrepreneurs tend to create their firm in their early forties 40, more than twenty years before retirement age, yet most firms die within ten years.

[4] Using a more granular definition of occupations yields similar results but causes some entrepreneurs to be matched to salaried workers with very different earnings trajectory for small occupation groups.

Table 1
Firm characteristics by age
This table reports summary statistics for firms with at least one employee at creation between 1994 and 2013. Ebit is normalized by the average national wage (net of payroll taxes). The volatility of value added is estimated by computing the standard deviation of the residuals of an OLS regression in which the dependent variable is the change in log value added and the explanatory variables are a set of year, sector and firm age dummies. All variables but the entrepreneur's age are winsorized at the 1st and 99th percentiles by firm age-year-sector groups. Incomplete business years are excluded.

	Firm Age									
	1	2	3	4	5	6	7	8	9	10
Cumulative exit rate	0.10	0.18	0.25	0.31	0.37	0.42	0.45	0.48	0.52	0.55
Adj. Ebit	1.96	2.42	2.70	2.97	3.22	3.35	3.42	3.53	3.65	3.53
SD of log Value Added	1.00	0.99	1.01	1.02	1.03	1.05	1.06	1.07	1.08	1.09
1-Year Vol. of log VA	0.46	0.41	0.39	0.39	0.38	0.37	0.36	0.36	0.35	0.36
3-Year Vol. of log VA	0.64	0.59	0.57	0.55	0.54	0.53	0.53	0.51	0.50	0.51
Age of Entrepreneur	41.2	42.3	43.3	44.2	45.0	45.0	46.6	47.4	47.9	48.3
# Employees	3.60	3.89	4.17	4.38	4.60	4.76	4.91	5.01	5.09	5.11
Observations (in th.)	951	773	625	511	424	353	291	237	192	153

Two important features of the data suggest that entrepreneurial exits may be difficult to explain with a simple model of selection in which entrepreneurs learn about their productivity. First, exit rates do not drastically fall as firms get older. Second, the dispersion of firm size, measured by the standard deviation of log value added, increases with age. These facts suggest that permanent productivity shocks could be the main determinant of the evolution of the firm size distribution. If selection was caused solely by learning, exits would be concentrated among young firms. Moreover, heterogeneity would decrease with age as the least efficient entrepreneurs return to paid employment. The observed trends are better explained by permanent productivity shocks, which can both cause the death of mature businesses and increase heterogeneity among surviving firms. A final and more direct piece of evidence that entrepreneurs experience large permanent productivity shocks is that the volatility of log value added (SD of log $\text{VA}_{it+k} - \log\text{VA}_{it}$) increases with horizon (k).

Disentangling permanent and transitory productivity shocks is important for at least two reasons. First, only permanent shocks should significantly increase the entrepreneurial risk premium, as business owners can self-insure against transitory shocks through consumption smoothing. Second, just like initial uncertainty, permanent shocks increase the option value of experimentation. However, unlike initial uncertainty, permanent shocks also create option value among mature nonperforming firms and can therefore encourage their owners to keep running their business.

Though the majority of firms in my sample cease operations before reaching 10 years old, exit rates are much lower than in Manso (2016), who finds that the majority of self-employment spells last less than two years. Again, the difference likely comes from his broader definition of entrepreneurs. However, exit rates in my sample are nearly identical to those observed among incorporated firms in Norway (van Praag and Raknerud, 2017). Cabral and Mata (2003) also report that the size dispersion of Portuguese manufacturing firms, measured by the number of employees, continually increases with age, even after 20 years old. Finally, the age of business owners is consistent with Levine and Rubinstein (2017) who report an average of 43.6 for incorporated businesses.

3. Model

This section presents a life-cycle consumption model in which individuals can leave paid employment to become entrepreneurs and run a firm with Cobb-Douglas technology. Entrepreneurs learn about the productivity of their firm through experimentation as in Jovanovic (1982) and can return to paid employment in case of disappointment.

For the sake of clarity, some aspects of the entrepreneur's problem that may seem important but do not ultimately have a significant effect on my key results are left aside in this section. These aspects include collateral constraints, progressive personal taxes, irreversibility of investments and frictions when returning to the labor market. They are introduced in the model individually in Section 6.

Figure 2 illustrates the timing of events and decisions by decomposing a period (year) into sub-periods. First, individuals get a business idea with probability p. Ideas arrive only once in a lifetime but do not have to be implemented right away. Individuals also receive labor income shocks, regardless of whether they are entrepreneurs or paid employees.[5] The first decision of the agents is to choose between paid employment and entrepreneurship for the rest of the year. Individuals can only become entrepreneurs once. If they choose to run a firm, they also decide how much to invest in capital. What is not invested in their firm is saved at the risk-free rate. Finally, at the end of the year, paid employees and entrepreneurs receive their earnings and decide how much to consume.

[5] I also solved the model assuming that individuals choose their occupation before their labor income shocks and find its predictions to be quantitatively close, with one exception. If labor income shocks happen after the occupation choice, paid employees must wait for an entire year before becoming entrepreneurs when they receive large negative shocks (are fired). This lag causes wages to drop more sharply in $t-1$ in the model than in the data. It seems more reasonable to assume that when being fired, individuals can immediately become entrepreneurs if they have a business idea.

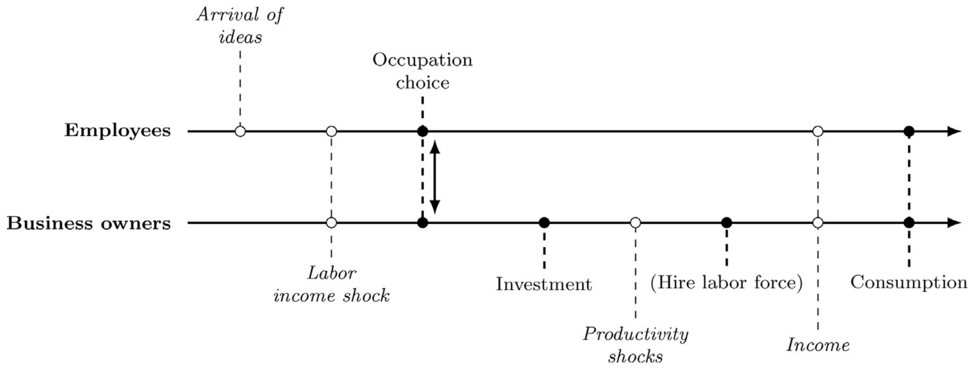


Fig. 2. Timeline of each period.

3.1. Agent

The agent has constant relative risk aversion (CRRA), and his expected utility at time t is

$$V_{it} = \mathbb{E}_t \sum_{s=t}^{R-1} \beta^{s-t} \frac{\left(C_{it} + \mathbf{1}_{K_{it}>0} B\right)^{1-\gamma}}{1-\gamma} + \beta^{R-t} V_{iR}, \tag{1}$$

where C is consumption, B a unobserved benefit received by entrepreneurs, β the discount factor, γ the coefficient of relative risk aversion, and V_{iR} the terminal value at retirement age R. K denotes capital employed, with $K_{it} > 0$ implying entrepreneurship.

3.2. Entrepreneurship

3.2.1. Production

The distribution of firm size partially arises from heterogeneity in talents and project quality among entrepreneurs facing decreasing returns to scale, as in Lucas (1978). Specifically, the net profit of the firm is:

$$\Pi_{it} = (1-\tau)\left[e^{z_{it}} K_{it}^{\alpha} - \delta K_{it} - r_D D_{it}\right], \tag{2}$$

where z_{it} measures the log productivity of capital, δ its depreciation rate, and α controls returns to scale. K_{it} is composed of net assets minus current liabilities, that is the assets that need to be financed with equity or bank debt D_{it}. At the beginning of each period, entrepreneurs choose K_{it} before they observe z_{it}, which reflects short-term business uncertainty and capital adjustment costs and makes returns on capital uncertain. The model implicitly assumes that labor is chosen freely after observing the period productivity.

Log TFP is the sum of a permanent random walk component $z_{1,it}$ and a transitory shock $z_{2,it}$. Specifically, the dynamics of z is:

$$\begin{cases} z_{it} = z_{1,it} + z_{2,it} \\ z_{1,it} - z_{1,it-1} \sim \mathcal{N}\left(0, \sigma_{z,1}^2\right) \text{ i.i.d.} \\ z_{2,it} \sim \mathcal{N}\left(0, \sigma_{z,2}^2\right) \text{ i.i.d.} \end{cases} \tag{3}$$

The decision to allow z to follow this path instead of an AR(1) process, as is common in the structural corporate finance literature, is data-driven. The version of the model utilizing an AR(1) generates a decline in within-cohort heterogeneity over time, which is inconsistent with the observed trend. In fact, as reported in Appendix Figure C.5, even under the assumption that some TFP shocks are permanent, the model tends to slightly underestimate the long-run volatility of profit.

Corporate taxes represent a fraction τ of profits and are negative in case of losses, which proxies the firm's ability to carryback and carryforward. Entrepreneurs can borrow without constraint at a rate r_D. In accordance with the data, I assume the cost of corporate debt $(1-\tau)r_D$ to be above the risk-free rate r. Under these assumptions, the dynamics of wealth W is

$$\begin{aligned} W_{it+1} - W_{it} = {} & (1-\tau)\left(e^{z_{it}} K_{it}^{\alpha} - \delta K_{it} - r_D (K_{it} - W_{it})^{+}\right) \\ & + r(W_{it} - K_{it})^{+} - C_{it}. \end{aligned} \tag{4}$$

For simplicity, I assume that entrepreneurs are not protected by limited liability, which is broadly consistent with the reality faced by many French entrepreneurs. Due to the provisions of the French bankruptcy code, banks commonly ask personal guarantees before granting loans to entrepreneurs who often pledge their house as collateral and offer personal guarantees (Schmalz et al., 2017; Davydenko and Franks, 2008).

3.2.2. Beliefs and learning

To start a business, workers need an entrepreneurial idea. Ideas arrive at an annual rate p and can only be realized once in a lifetime. As in Jovanovic (1982), workers do not observe the profitability of their idea and can only learn about it by starting a business, a decision that they can delay. The quality of the project serves as an initial value for permanent productivity z_1. Specifically, the initial value of z_1 is

$$\begin{cases} z_{1,it_0} = \underbrace{\bar{z}}_{\text{industry mean}} + \underbrace{\nu_{1,i}}_{\text{observed}} + \underbrace{\nu_{2,i}}_{\text{unknown}} \\ \nu_{1,i} \sim \mathcal{N}(0, \sigma_{\nu,1}^2) \\ \nu_{2,i} \sim \mathcal{N}(0, \sigma_{\nu,2}^2) \end{cases} \tag{5}$$

where $\bar{z}$ is an observable industry mean, $\nu_{1,i}$ is a component known from the (potential) entrepreneur, and $\nu_{2,i}$ a source of uncertainty. I assume that the entrepreneur updates his beliefs in a Bayesian fashion. His initial prior regarding the permanent component of productivity z_1 and his initial degree of uncertainty σ^2_{μ,t_0} are

$$\begin{cases} \mu_{it_0} &= \bar{z} + \nu_{1,i} \\ \sigma^2_{\mu,t_0} &= \sigma^2_{\nu,2} \end{cases} \tag{6}$$

Conditional on maintaining his business, he observes the realized TFP but not its decomposition between the transitory and permanent components. In this case, the dynamics of his belief is[6]

$$\begin{cases} \mu_{it+1} - \mu_{it} &= \frac{\sigma^2_{\mu,t}+\sigma^2_{z,1}}{\sigma^2_{\mu,t}+\sigma^2_{z,1}+\sigma^2_{z,2}}(z_{it} - \mu_{it}) \\ \sigma^2_{\mu,t+1} &= \frac{(\sigma^2_{\mu,t}+\sigma^2_{z,1})\sigma^2_{z,2}}{\sigma^2_{\mu,t}+\sigma^2_{z,1}+\sigma^2_{z,2}} \end{cases} \tag{7}$$

3.2.3. Investment

In the model, capital investment K is determined by two economic forces. For a risk-neutral entrepreneur, the optimal K is such that the expected return on capital is equal to its opportunity cost. This cost depends on whether the entrepreneur needs external financing. If he does not, then the optimal investment would be $K^*_{it} = (\frac{\alpha(1-\tau)\mathbb{E}_{it}[Z_{it}|\mu_{it}]}{r+(1-\tau)\delta})^{\frac{1}{1-\alpha}}$. Otherwise, the cost of capital is the net interest rate on corporate debt $(1-\tau)r_D$, and the optimal investment is $K^*_{it} = (\frac{\alpha\mathbb{E}_{it}[Z_{it}|\mu_{it}]}{r_D+\delta})^{\frac{1}{1-\alpha}}$.

Because entrepreneurs are risk-averse and risk cannot be diversified, capital investment is also a portfolio choice problem. To some extent, this problem is similar to life-cycle models in which households can invest in a risk-free asset or a portfolio of risky securities. In this class of models, the risky share is determined by the risk premium, the variance of returns, and the risk aversion of the agent (Merton, 1969). There are also important differences with traditional portfolio choice models. First, the curvature of the production function means that the risk premium decreases with firm size. Second, returns are serially correlated: profits above expectations signal higher productivity in the future.

Even though capital investment is not restricted by financing frictions, it is limited by market incompleteness if entrepreneurs are risk-averse. Consequently, entrepreneurs will invest less than K^*_{it}.

3.3. Paid employment

The agent's log wage y has three components: a deterministic function of age $f(t)$, an idiosyncratic persistent element $l_{1,it}$ and a transitory one $l_{2,it}$.

$$y_{it} = f(t) + l_{1,it} + l_{2,it} \tag{8}$$

In accordance with the log wage specification widely used in the life-cycle literature, the transitory component l_2 is normally distributed with variance $\sigma^2_{l,2}$, while the persistent component l_1 follows an AR(1) process

$$l_{1,it+1} = \rho l_{1,it} + \epsilon_{l,it}, \tag{9}$$

where $\epsilon_{l,t}$ is normally distributed with variance $\sigma^2_{l,1}$. Finally, the wealth dynamics of paid employees is

$$W_{it+1} = (1+r)W_{it} + Y_{it} - C_{it}. \tag{10}$$

Importantly, the agent's human capital as a paid employee is not protected during entrepreneurial spells and evolves following the same dynamics. Hence, the value of the fall back option is uncertain.

3.4. Recursive formulation

The problem is solved backward by numerical dynamic programming (see Appendix A.1). Each year is divided into two sub-problems: one for occupation choice and investment and the second for consumption. Apostrophe signs (′) denote evolving state variables.

In the consumption sub-problem, the agent maximizes

$$V_{t+\frac{1}{2}}(W,\mu,\sigma_\mu,l_1) = \max_C \left\{ \frac{(C+\mathbf{1}_{K>0}B)^{1-\gamma}}{1-\gamma} + \beta\mathbb{E}V_{t+1}(W',\mu',\sigma'_\mu,l'_1,l'_2) \right\}, \tag{11}$$

where $W' = W - C$, while l_1 and l_2 evolve as detailed in Section 3.3. Paid employees who have not yet experienced an entrepreneurial idea receive one with probability p. In that case, μ' and σ'_μ are defined by Eqs. (5) and (6). They remain unchanged otherwise.

In the occupation and investment sub-problem, the agent maximizes

$$V_t(W,\mu,\sigma_\mu,l_1,l_2) = \max_K \left\{ \mathbb{E}V_{t+\frac{1}{2}}(W',\mu',\sigma'_\mu,l_1) \right\}. \tag{12}$$

Agents who are not former entrepreneurs and have an idea can choose $K > 0$, in which case W', μ' and σ'_μ evolve as described in Section 3.2. Note that from the agent's point of view, the distribution of $z_{1,it}$ is $\mathcal{N}\left(\mu_{it}, \sigma^2_{\mu,t} + \sigma^2_{z,1}\right)$. If $K = 0$, then μ' and σ'_μ do not change, and W' follows Eq. (10).

Finally, the terminal value V_R only depends on wealth and is approximated using Merton (1969)'s solution, assuming a residual life expectancy of 20 years.[7]

4. Structural estimation

This section details the structural estimation of the model. I preset a number of parameters using key statistics from the firm data and use my benchmark group of paid employees to estimate the dynamics of wages. Finally, I use the simulated method of moments to estimate eight parameters that cannot be directly inferred from the data: unobserved benefits (B), the arrival rate of ideas (p) and their average quality ($\bar{z}$), the dispersion of initial priors ($\sigma_{\nu,1}$), the initial uncertainty over productivity ($\sigma_{\nu,2}$), the standard deviation of permanent ($\sigma_{z,1}$) and transitory ($\sigma_{z,2}$) productivity shocks, and returns to scale (α).

4.1. Labor income process and calibrated parameters

Labor income process I assume that the deterministic component of wages $f(t)$ is a cubic polynomial in age,

[6] See Holmström (1999).

[7] In Merton's model, the agent can also invest in the stock market portfolio. As this is not the case in my model, I use Merton's solution with an equity premium of zero.

Table 2
Labor Income Process and Calibrated Parameters.
This table reports all calibrated parameters. In Panel A, I use the benchmark group to predict log wage as a cubic polynomial in age. In Panel B, I set the parameters governing the stochastic component of wages such that the model matches the empirical standard deviations of log wage growth at the 1, 3 and 5 year horizons among the benchmark group, restricted to males between 25 and 55. Panel C reports the calibration of preference and economic environment parameters. Preferences are based on existing estimates. The corporate tax rate matches the sample empirical mean. The business loan and depreciation rates match the sample medians.

	Panel A: Life-cycle profile of log wage	
f_1	Effect of age on log wage	.3452
f_2	Effect of age^2/10	-.0560
f_3	Effect of age^3/1000	.0321
f_0	Intercept	−6.0085
	Panel B: Estimated labor income process	
Estimated parameters:		
ρ	Persistence	.835
σ_{l_1}	SD of persistent shocks	.345
σ_{l_2}	SD of transitory shocks	.312
Moment conditions:		
	1-Year horizon SD of log wage growth	.570
	3-Year horizon	.724
	5-Year horizon	.814
	Panel C: Preferences & Environment	
γ	Risk aversion	1
β	Discount factor	.96
R	Retirement age	65
τ	Corporate tax rate	.140
r	Risk-free rate	.020
r_D	Business loan rate	.035
δ	Depreciation rate	.065

which I estimate by OLS. Specifically, I normalize wages by the national average and regress the log on age, age^2 and age^3.

The parameters of the AR(1) process (ρ and $\sigma_{l,1}$) and the standard deviation of transitory income shocks ($\sigma_{l,2}$) are set to match the standard deviations of log income growth at the 1, 3 and 5-year horizons, net of life-cycle effects.[8]

To compute these moments, I restrict the employee panel data to males between 25 and 55 years old[9] who have been matched with entrepreneurs and use their entire earnings history between 1992 and 2013. The value of these moments is close to estimates for the general US male population (Guvenen et al., 2014).

Other parameters I set the rate on corporate debt to 3.5% to match the median interest-to-debt ratio of 5.5% minus a 2% inflation rate. Likewise, I set the depreciation rate to $\delta = 6.5\%$ to match the median ratio of depreciation-to-capital employed. I choose the medians of these two ratios because their mean is distorted by outliers. I set $\tau = 0.14$ to match the sample's mean effective corporate tax rate.

Preferences are taken from the literature. I set the discount factor to $\beta = 0.96$, following the structural estimation of the life-cycle consumption model with labor income risk by Gourinchas and Parker (2002). In my baseline scenario, I set relative risk aversion to $\gamma = 1$ but also estimate the model for other values.[10] The agent initial wealth represents 10% of the average net earnings in the economy.

4.2. Moment selection

The choice of targeted moments is guided by two ojectives. The first objective is to estimate eight model parameters. To do so, we need at least eight moments closely tied to these parameters in the model. Second, because the model is used to compute the option value of returning to paid employment, we want it to match key determinants of this value.

The ability to return to paid employment is akin to a put option on the venture. To compute the value of this option over time accurately, the model needs to match key determinants of the price of an American put option. These determinants include the venture's value, its volatility, the option's time to maturity, and the entrepreneurs potential earnings in salaried work: the "strike price" of the put option.

Eight categories of moments Figure 3 illustrates the relationships between the eight moment categories targeted in the estimation and the parameters they identify.

1. *Age of entrepreneurs* – As illustrated by Panel A, the age of entrepreneurs identifies the arrival rates of ideas: If business opportunities appear sooner, entrepreneurs are younger. Matching the age of entrepreneurs is important because the option value of returning to paid employment decreases as they get closer to retirement. The value of experimentation also depends on investment horizon: younger workers are more likely to experiment with less promising ideas since many years of profits would offset the cost of experimentation in case of success.
2. *Entrepreneurial premium* – Panel B shows that unobserved benefits reduce the earnings differential between entrepreneurship and salaried work by encouraging entry and keeping inefficient businesses alive. To compute the simulated earnings differential, I replicate the matching procedure used in Section 2.2 to construct a benchmark group. First, I simulate the income path of 10^5 workers who cannot become entrepreneurs but face the same labor income process. Then, I match each new entrepreneur to one of these paid employees of the same age by minimizing the euclidean distance with respect to their last three years of wages. Importantly, because it is inferred from revealed preference,

[8] The problem can be solved analytically. If v_k denotes the variance of log income growth over k years, $\mathrm{Var}(y_{i,t+k} - y_{i,t})$, then $\rho = \frac{\sqrt{-v_3 + v_5}}{\sqrt{-v_1 + v_3}}$, $\sigma^2_{l,1} = \frac{-(v_1 - v_3)^2\rho}{2(v_3 - v_5)}$ and $\sigma^2_{l,2} = \frac{-(v_3 - v_5)(v_3^2 - v_1 v_5) + (v_1 - v_3)^3\rho}{2(v_3 - v_5)(v_1 - 2v_3 + v_5)}$.

[9] The goal of this restriction is to eliminate as much as possible variations in income caused by voluntary changes in working hours or transitions in and out of the labor force.

[10] Estimates of γ in the laboratory often suggest values slightly below 1 (Holt and Laury, 2002; Harrison and Rutström, 2008; Andersen et al., 2008). Gourinchas and Parker (2002) estimate γ to be between 0.5 and 1.4. Chetty (2006) argues that empirical evidence on the elasticity of labor supply impose a level of γ below 2.

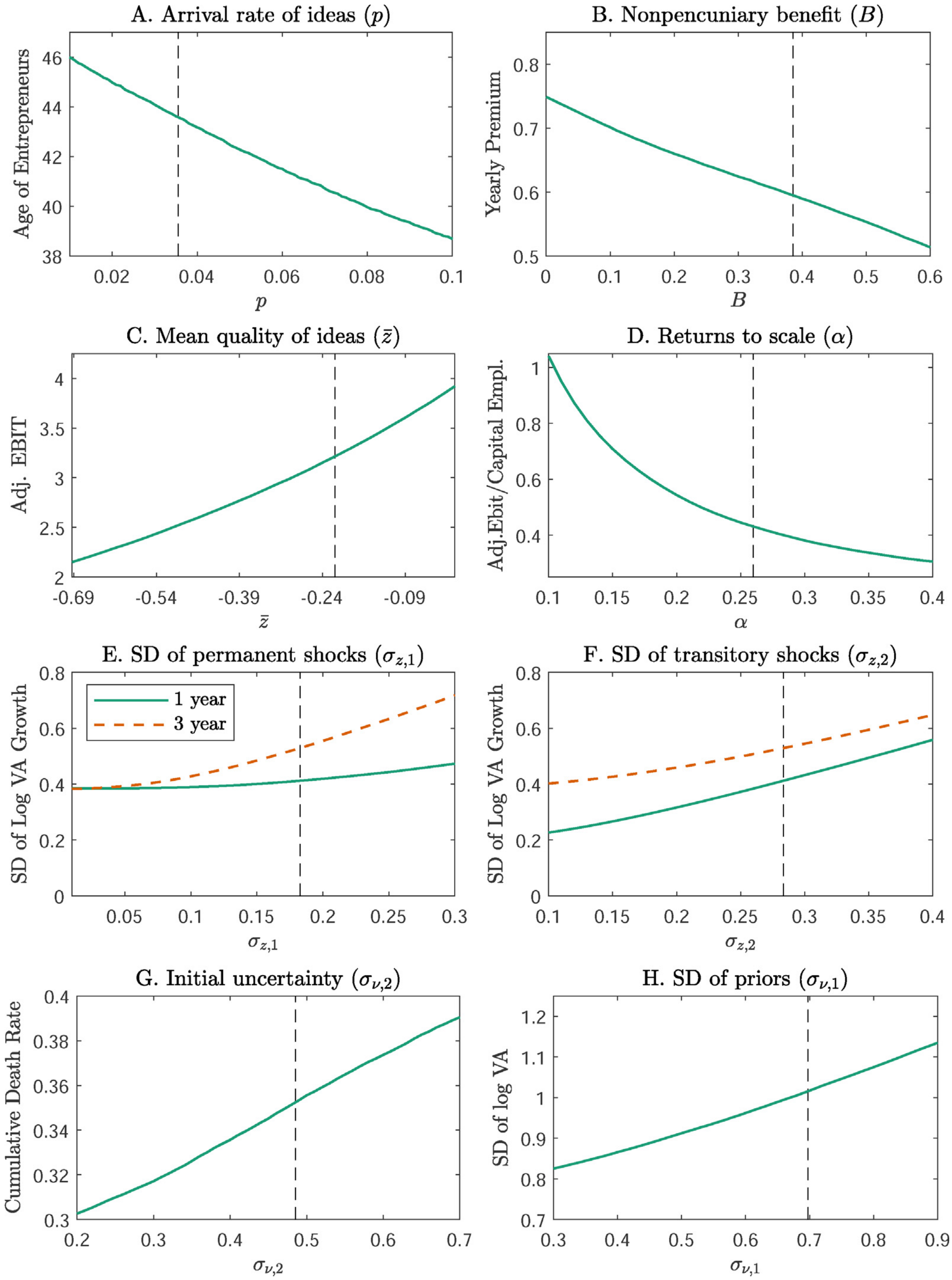


Fig. 3. Elements of Identification. These plots display the relationships between estimated parameters and their primary source of identification. I start by setting all parameters to their baseline estimates, reported in Column (1) of Table 3 and represented by vertical dashed lines. Then, I move each parameter independently around its estimated value and report the evolution of the most informative simulated moment(s). In Panel B, the premium is the mean yearly earnings difference between entrepreneurs and their benchmark group over the first ten years, normalized by the average national wage. In Panels B to H, moments are reported for 5-year old firms, but the SMM targets all of them for each firm age from 1 to 10. In panels E and F, I report the standard deviation of log value added growth at both the 1 and 5-year horizons.

Table 3
Parameters Estimated by SMM.
This table reports the results of my SMM estimations. Column (1) corresponds to the baseline specification in which entrepreneurs can go back to paid employment without frictions. Unobserved benefits are normalized by the mean national wage (net of payroll taxes), which averages 15,800 euros over the sample period (1994–2013). Columns (2)–(5) report estimated parameters for alternative specifications discussed in Section 6. In column (2), I assume that entrepreneurs receive a persistent shock of −.2 to their log labor income when they return to paid employment. In Column (3), entrepreneurs who close their firm must pay a fixed liquidation cost of.5 times the average national wage (≈7,900 euros). In Column (4), agents face a progressive personal income tax (see Section 6.4). In Column (5), the model is estimated with a collateral constraint (see Section 6.1). In Column (6), relative risk aversion γ has a log-normal distribution with mean ln(1) and standard deviation.5, and the discount rate $1-\beta$ has a log-normal distribution with mean ln(.04) and standard deviation.5.

			Alternative Specifications				
		(1) Baseline	(2) Labor Market Friction	(3) Liquidation Cost	(4) Progressive Income Tax	(5) Collateral Constraint	(6) Heterogeneous Preferences
B	Unobserved benefits	.386	.299	.310	.333	.430	.357
		(.002)	(.001)	(.002)	(.002)	(.002)	(.001)
$\sigma_{\nu,1}$	Dispersion of priors	.696	.780	.735	.681	.700	.737
		(.003)	(002)	(.003)	(.003)	(.003)	(.001)
$\sigma_{\nu,2}$	Initial uncertainty	.485	.525	.466	.493	.462	.378
		(.002)	(.001)	(.002)	(.002)	(.002)	(.001)
$\sigma_{z,1}$	SD of permanent shocks	.183	.175	.187	.186	.155	.200
		(.001)	(001)	(.001)	(.000)	(.000)	(.000)
$\sigma_{z,2}$	SD of transitory shocks	.283	.281	.278	.275	.297	.280
		(.001)	(.001)	(.000)	(.001)	(.001)	(.000)
p	Arrival rate of ideas	.036	.051	.046	.022	.022	.010
		(.000)	(.000)	(.000)	(.000)	(.000)	(.000)
$\bar{z}$	Mean quality of ideas	-.217	-.404	-.297	-.216	-.322	-.271
		(.002)	(.002)	(.002)	(.002)	(.002)	(.001)
α	Returns to scale	.260	.255	.259	.271	.318	.261
		(.001)	(.001)	(.001)	(.001)	(.001)	(.001)

my estimate of unobserved benefits is valid for agents whose occupation choice depends on their value. As such, it should be interpreted as the value of unobserved benefits for marginal entrepreneurs. By contrast, the value of unobserved benefits of entrepreneurs running highly profitable businesses is difficult to infer by revealed preference as they play a lesser role in their occupation choice.

3. *Business income* – Better ideas produce more profitable businesses. As illustrated by Panel C, the mean EBIT identifies the average quality of ideas ($\bar{z}$). In the model, there is no difference between retained earnings, dividends, and salaries paid to the entrepreneur. When comparing business earnings in the data and in the model, it is therefore important to use a metric that does not depend on the distribution policy. For this reason, the empirical EBIT is adjusted to reintegrate wages paid to entrepreneurs. When reintegrating wages, one must take into account that they were not subject to corporate taxes in the data but would be in the model. Therefore, in the data, I define adjusted EBIT as $\text{Adj. EBIT}_{it} = \text{EBIT}_{it} + \text{Wage}_{it}/(1-\text{Tax Rate}_{it})$ such that wages have the same purchasing power in the data and in the model. In the model, $\text{EBIT}_{it} = e^{z_{it}}K_{it}^{\alpha} - \delta K_{it}$.
4. *Return on capital* – In a frictionless world, the ratio of Adj. EBITDA to capital employed equals $\frac{\delta+r}{\alpha}$. Hence, as shown in Panel C, this ratio identifies returns to scale α. Capital employed is computed as net assets minus current liabilities. Matching this moment is important because estimated unobserved benefits would be negatively (positively) biased if the model under(over)-estimated how much capital is invested to generate one euro of profit.

5–6. *Volatility of value added* – The standard deviations of permanent and transitory shocks are disentangled by matching the volatility of log value added at different time horizons: one and three years. Panel E shows that volatility is independent of horizon when shocks are purely transitory ($\sigma_{z,1}=0$). Conversely, the greater the variance of permanent shocks, the larger the difference in log value added volatility at the 1- and 3-year horizons. In the model, value added is a constant fraction of EBITDA under the assumption that labor is chosen without constraints. Hence, the volatility and cross-sectional variance of log value added are identical to that of log EBITDA.

7. *Dispersion of value added* – The dispersion in value added unaccounted for by TFP shocks is attributed to variance of permanent productivity at entry. This variance is decomposed into an observed ($\sigma_{\nu,1}^2$) and unobserved ($\sigma_{\nu,2}^2$) component representing initial uncertainty.
8. *Exit rates* – As illustrated by Panel G, initial uncertainty $\sigma_{\nu,2}$ is identified by cumulative exit rates because it encourages experimentation, which in turn increases failure rates. Holding $\sigma_{\nu,2}$, $\sigma_{z,1}$ and $\sigma_{z,2}$ fixed, the residual variance is attributed to $\sigma_{\nu,1}$ as illustrated in Panel H.

Life-cycle patterns The model can be estimated by targeting these moments alone. Despite this, my estimation procedure also targets the evolution of six of these moments over the first ten years of entrepreneurial spells, as illustrated in Fig. 5. There are two reasons to match these life-cycle patterns. First, they are informative about estimated parameters. Second, the dynamic model is used to estimate the option value of returning to salaried employ-

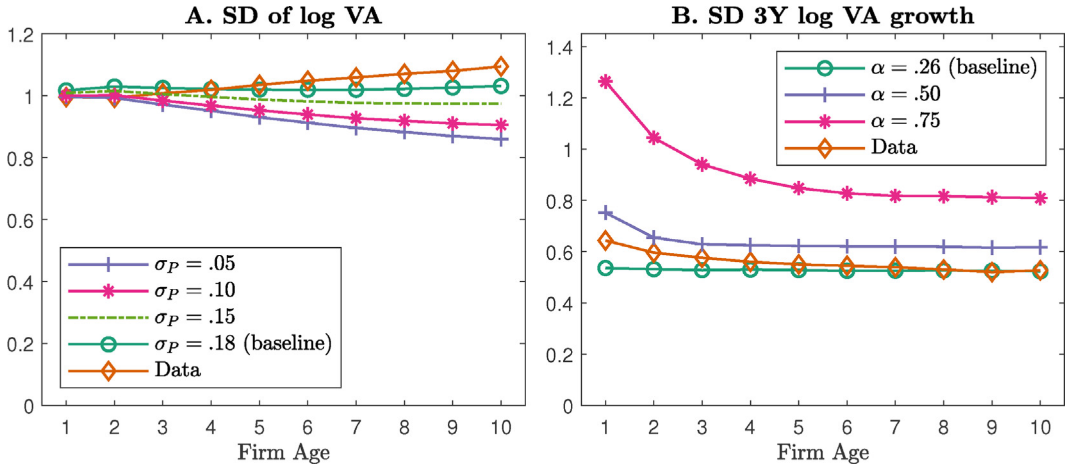


Fig. 4. Elements of Identification - Life-cycle patterns. Panel A reports the evolution of the standard deviation of log value added by firm age for different standard deviations of permanent TFP shocks. Panel B reports the standard deviation of log value-added growth at different firm ages for different levels of return to scales. All other parameters are set to their baseline value reported in column (1) of Table 3.

ment and its evolution over time. Therefore, it is important that the model matches key determinants of this option value, such as cost of exercise, time to maturity, and volatility.

If entrepreneurs returned to paid employment after short periods of experimentation, most exits would occur in early years. On the other hand, if entrepreneurs went out of business because TFP shocks, exit rates would remain high beyond the few years of experimentation. Therefore, the timing of exits reveals the relative importance of these two economic forces.

Together, the life-cycle profiles of exit rates and business earnings determine the expected cash flows from the typical entrepreneurial spell. Matching the life-cycle profiles of these moments guarantees that businesses have similar present values in the model and in the data. This present value represents the observable monetary cost of returning to paid employment. Exit rates also represent the frequency at which the option is exercised at different points in time.

Another important source of option value is the variance of entrepreneurial earnings. Though the within-cohort standard deviation in log value added is high, it appears remarkably stable over the life cycle, growing from 1.00 to 1.09 over the first ten years of the life-cycle. At first glance, the fact that within-cohort inequality does not grow over time suggests that entrepreneurs do not face much risk, and the option value of returning to paid work is low. Nevertheless, Panel A of Fig. 4 shows that matching this modest slope requires a high volatility for the random-walk component of TFP. As a result of selection, without a random-walk component, within-cohort variance declines as the least profitable businesses close.

As Panel B of Fig. 4 illustrates, higher returns to scale increase the variance in value added growth rates among young firms. When new entrants do not know their type, they adjust their stock of capital as they learn: Entrepreneurs who receive positive signals invest more, and those with negative signals do the opposite. As a result, learning creates a source of growth rate heterogeneity that dissipates over time. The strength of this mechanism depends on the curvature of the production function. Indeed, absent any other friction, the optimal capital stock is $K^* = \left(\frac{\alpha \mathbb{E}[Z]}{r+\delta}\right)^{\frac{1}{1-\alpha}}$, where $\mathbb{E}[Z]$ is the entrepreneur's expectation of his productivity. Therefore, the investment response to a change in $\mathbb{E}[Z]$ is an increasing function of α. In the data, this effect appears to be small and short-lived, as the variance of growth rates converges rapidly to its long-run level. This pattern suggests that returns to scale are low or that entrepreneurs do not learn much about their productivity.

SMM With the exception of the mean earnings differential and returns on capital employed, all moments are targeted for each firm age from 1 to 10. The first year (age zero) is not targeted because it does not reflect a complete year of business. For the same reason, I exclude exiting firms when computing simulated and empirical moments. Before computing the moments, I winsorize all variables by industry-year at the 1st and 99th percentiles. The SMM procedure seeks the vector of eight parameters that minimizes:

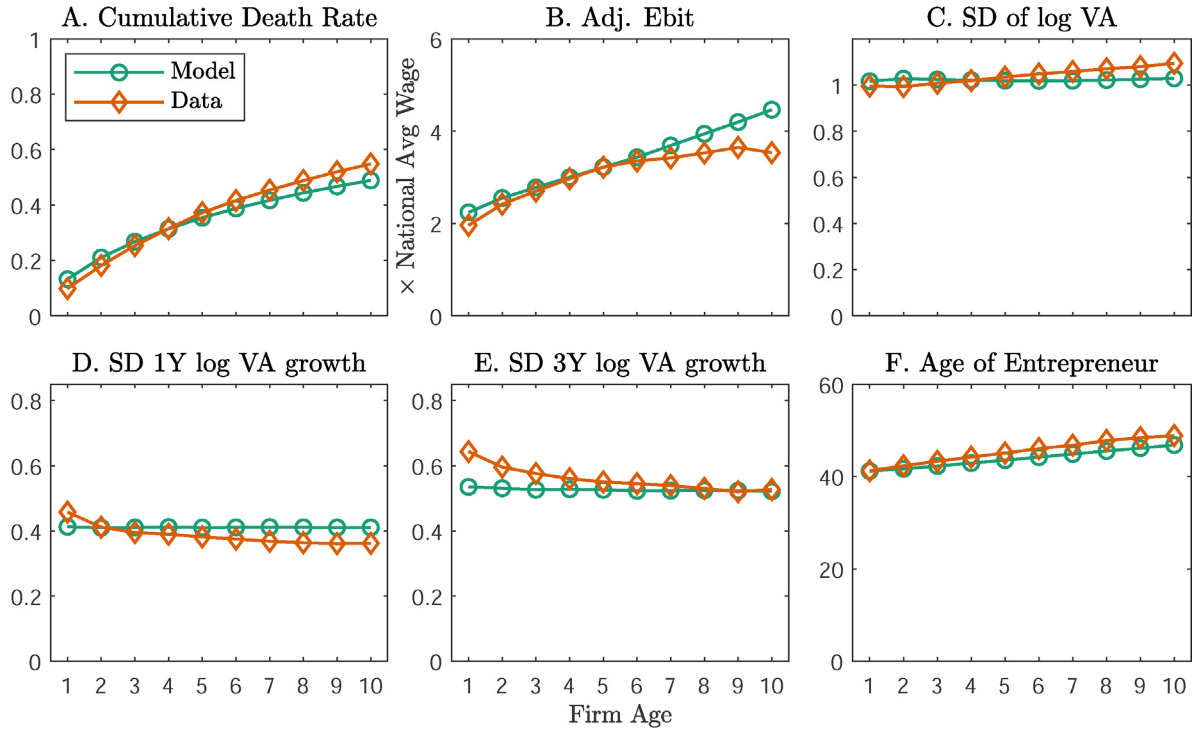
$$(\mathbf{m} - \widehat{\mathbf{m}}(\theta))'\mathbf{W}(\mathbf{m} - \widehat{\mathbf{m}}(\theta)) \tag{13}$$

where $\widehat{\mathbf{m}}(\theta)$ is the vector of 62 simulated moments generated by the model, and $\mathbf{m}$ its empirical counterpart. These moments are reported in Fig. 5. The weighting matrix $\mathbf{W}$ is the inverse of the variance-covariance matrix $\boldsymbol{\Omega}$ of the empirical moments.

4.3. Estimation results

Column (1) of Table 3 reports parameters estimated by SMM in the baseline specification.

Unobserved benefits I estimate that unobserved benefits represent 38.6% of the average national net wage. This represents 8,250€ per year in 2018 and sums up to 90,700€ over the average length of entrepreneurial spells. These estimates of the value of unobserved benefits may



	Data	Model
Adj. Ebitda/Capital Employed	.428	.436
Yearly income premium	.567	.567

Fig. 5. Moments Targeted in the Estimation. These plots report all empirical moments targeted in the structural estimation as well as their simulated counterparts in the baseline estimation. The mean adjusted Ebit includes wages received by the business owner. The yearly income premium is the mean earnings difference between entrepreneurs and their benchmark group over the first ten years. This premium and adjusted Ebit are reported as a fraction of the average wage (net of payroll taxes) in the economy.

appear relatively modest. Since they fall below existing estimates of earnings under-reporting alone, my results seem to imply that non-pecuniary benefits are quite small, which is hard to reconcile with the fact that over 50% of entrepreneurs report non-pecuniary benefits as a key determinant of their occupation choice (Hurst and Pugsley, 2011). However, this is not necessarily the case for two main reasons. First, B should be interpreted as the value of unobserved benefits, net of unobserved costs. There are also disadvantages to being an entrepreneur. For example, independent craftsmen, merchants, and business owners work on 45.8 h per week, which is 22% more than the national average (37.4) and 10% more than white collar professionals (41.5).[11] It is also possible that unreported earnings are lower in my sample of job-creating entrepreneurs than in previous studies that consider the entire self-employed population, which largely consists of smaller and more informal businesses where underreporting might be more pervasive.[12]

Another element captured by the parameter B is the difference in the tax treatment of dividends and wage income, as well as the value of Social Security made on gross wage. Since entrepreneurs have the ability to decide what portion of their earnings is reported as dividends and wage income for tax purposes, they are at least as well off as salaried workers whose earnings are restricted to the tax structure imposed on wages.[13] Overall, it is difficult to determine an entrepreneur's optimal mix between wages and dividends for tax, as it depends on each individual tax bracket, Social Security record, and trust in the pay-as-you-go retirement system. Note however that en-

[11] Source: *France, portrait social*, Insee, 2020, page 245

[12] Schuetze (2002) documents that entrepreneurs receiving more payments in cash are more likely to underreport their income and Hurst et al. (2014) report some weak evidence that underreporting decreases with education.

[13] For a numerical example, consider the case of an entrepreneur with a taxable income above 71,000e in 2011. His marginal income tax rate was 41%. His dividends are subject to a 13.5% Social Security tax and an income tax. However, to avoid double taxation with corporate taxes, only 60% of dividends are subject to income tax. Moreover, the entrepreneur has the option to pay an income tax rate of 19%, which he should take given his tax bracket. Overall, his marginal tax rate on dividends would be 13.5%+0.6*19%=25%, or 16.5% lower the marginal tax rate. This makes each euro of dividend roughly 20% more valuable than one euro of net wage. On the other hand, a 20.3% retirement contribution have been paid on net wage. If the value of accrued benefits is similar to their cost (contributions are fairly priced), the difference in value between a euro of dividend and a euro of net wage would be small.

trepreneurs should optimize this mix such that dividends and wages are, at the margin, equally valuable.[14]

Other parameters Overall, entrepreneurs face a substantial amount of risk. First, productivity shocks are fairly large, with a standard deviation of $\sqrt{\sigma_{z,1}^2+\sigma_{z,2}^2}\approx 0.34$. Hence, even if entrepreneurs observed their permanent productivity and had no debt, the standard deviation of returns to capital would be twice that of the S&P500. While these shocks are mostly transitory, a one standard deviation shock to the permanent component would raise EBITDA by roughly 20%.

Moreover, new entrants face substantial uncertainty regarding their initial permanent log productivity ($\sigma_{\nu,2}=0.485$). This initial uncertainty produces as much dispersion as seven years of permanent shocks. However, since the average new entrepreneur is twenty years from retirement, permanent shocks generate more risk and option value than initial uncertainty

Finally, the estimated value of α is consistent with previous estimates by Evans and Jovanovic (1989).

4.4. Model fitness

As reported in Fig. 5, the model matches the data well. One weakness, however, is that average EBIT grows at a 7.9% rate in simulated data but only 6.8% in the empirical data. As a result, simulated EBIT is slightly below its empirical target in the first six years and above it thereafter. One possible set of explanations lie in institutional frictions overlooked by the model, such as more stringent labor regulation above 49 employees or progressive corporate taxes.[15] Capital adjustment costs, financial constraints and imperfect bayesian updating could also slow down the growth of EBIT by delaying exits of unsuccessful firms and investment in the successful ones. Panel A does suggest that entrepreneurs exit slightly later than the model's bayesian agent.

Another potential concern regarding the model's fit is its apparent overestimation of earnings towards the end of business' first ten years of existence. The effect of this overestimation on my results, however, are largely mitigated by the discount and survival rates. Its impact is further reduced by the fact that risk averse agents put less weight on these late earnings, as they occur in good states of the world.

To better understand the model and the identification of key parameters, I also estimate it under the assumptions that *(i)* there are no unobserved benefits ($B=0$), *(ii)* no permanent productivity shocks ($\sigma_{z,1}=0$), or *(iii)* no initial uncertainty ($\sigma_{\nu,2}=0$). The model fitness under these assumptions is reported in Appendix Figure C.1. Of particular interest are the moments that cannot be matched when a parameter is set to zero. For example, without unobserved benefits, the model fails to match the dispersion of log value-added because small and inefficient firms cease to exist or are very rare. The only way to increase the dispersion is to extend the right tail of the distribution by increasing $\sigma_{\nu,1}$, but this cannot be done without massively inflating the mean EBIT. This result indicates that the dispersion of value added is a source of identification for B.[16] Without permanent productivity shocks, the model cannot simultaneously match the volatility of log value added at the one-year and three-year horizons. More interestingly, without permanent productivity shocks, the model predicts that the dispersion of log value-added should decrease sharply with firm age because selection by learning eliminates the least productive firms. This causes heterogeneity among survivors to decrease. On the other hand, the model can match the data relatively well when initial uncertainty is set to zero, which suggests that learning does not play a large role in explaining the data.

5. Discussion

This section discusses my main results. First, I show that the model correctly predicts the income trajectories of entrepreneurs and their benchmark group before and after the creation of their firm. Second, I compute the certainty equivalent of the option to return to paid employment. Finally, I run counterfactual experiments to quantify the importance of key model ingredients.

5.1. Simulated income trajectories

Figure 6 reports the income trajectories of new entrepreneurs and their benchmark group, in the model and in the data. Earnings include wages of entrepreneurs who returned to paid employment. Overall, the model captures relatively well *(i)* who become entrepreneurs and *(ii)* the subsequent earnings differential.

With regards to selection into entrepreneurship, simulated data replicate the decline in labor income that leads to entrepreneurial entry as well as the average income of new entrants. In the model, the decline of wages in the years leading to the entrepreneurial spell triggers the decision to start a firm by lowering the opportunity cost. In a way, entrepreneurial entry is also a fall back option when labor earnings are low.

There is no ex-ante guarantee that the model would reproduce these patterns. First, the deterministic component of wages, $f(t)$, is increasing at an age of around $t=40$ years. Second, labor income inequalities are substantial in the model: the within-cohort standard deviation of log persistent income is $\sqrt{\sigma_{l,1}^2/(1-\rho^2)}=0.63$. Entrepreneurs could therefore be drawn from a pool with a different level of income.

5.2. Selection issues

In the data, the entrepreneurial premium is measured as the earnings differential between entrepreneurs and

[14] For a more in-depth discussion of legal tax avoidance by French entrepreneurs, see Bach (2017) and Bach et al. (2019a)

[15] In the sample, the average corporate tax rate is 14%, but the marginal rate reaches 33% above 75,000 euros of profits. Firms with more than 7.6M euros in sales cannot benefit from reduced tax rates at all.

[16] This also explains why the standard error for my estimate of B is very small, as the empirical dispersion of firm size is precisely estimated.

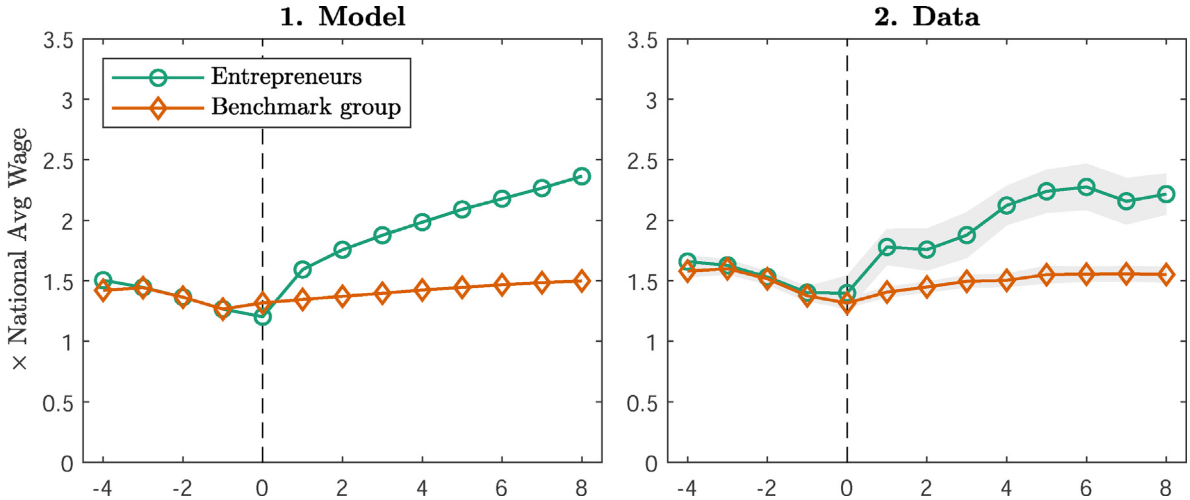


Fig. 6. Predicted and Observed Income Trajectories. This graph reports the mean income of individuals becoming entrepreneurs at time 0 and that of a benchmark group of paid employees constructed by matching. The income of entrepreneurs is defined as the sum of wages (net of payroll taxes) and firm net income. It includes entrepreneurs who returned to paid employment. The left plot reports simulated data from the baseline model using estimated parameters reported in Column (1) of Table 3. The right plot reports the empirical counterpart. For empirical data, the matching algorithm takes into account sex, last occupation, age and earnings received over each of the three years preceding the entrepreneurial spell. For simulated data, the matching procedure is only based on age and the last three years of earnings. Shaded areas represent 95% confidence intervals estimated by bootstrap.

workers with similar characteristics and salaries before the entrepreneurial spell. However, it is possible that two workers, even though they are identical in the data, have different expected earnings as salaried employees going forward. In that case, workers with lower salary expectations would be more likely to become entrepreneurs. As a consequence, the econometrician would overestimate the counterfactual salary of entrepreneurs and underestimate the entrepreneurial premium.

If entrepreneurs had lower long-run earnings potentials, those who return to paid work should earn significantly less than their benchmark group. As show in Appendix Figure C.3, they earn −20% in their first year back on the labor market, but this difference becomes statistically insignificant four years later. Given that a loss of income can be expected after a failed entrepreneurial spell, it does not appear as though workers in the benchmark group had much better prospects on the labor market at time $t = 0$.

It is also possible that workers become entrepreneurs when they lose their jobs. Even if losing their job did not affect their earnings over the long run, it could reduce the opportunity cost of starting a business. This is an issue for the econometrician who observes that entrepreneurs do not hold their previous salaried job, but ignores whether it is the consequence or the cause of the entrepreneurial spell. If the loss of employment triggered the entrepreneurial spell, then the benchmark group overestimates how much entrepreneurs would have earned if they had remained on the labor market. However, the structural model incorporates this source of selection and allows me to quantify the bias it generates. In Appendix Figure C.2, I report the simulated income paths of entrepreneurs and their benchmark group, as well as the actual wage entrepreneurs could earn as salaried workers, which is only observable in simulated data. I find that the latter is, on average, 12% lower than that of the benchmark group over the first ten years. Therefore, the model suggests that the matching procedures underestimate the premium among new entrepreneurs. Importantly, this bias does not affect the structural estimation as long as the entrepreneurial premium is measured in the same way in the actual and simulated data.

5.3. Option value of exit

In this section, I define the option value of returning to paid employment as the amount of money required to keep entrepreneurs' expected utility unchanged when removing this option, that is, its certainty equivalent. Dropping indexes to simplify the notation, the option value is the solution to the equation

$$V_t(W + \text{Option Value}, \mu, \sigma_\mu, l_1 - \infty) = V_t(W, \mu, \sigma_\mu, l_1). \tag{14}$$

in which the entrepreneur is prevented from finding a paid job by imposing an infinite stigma on the persistent component of labor income. Because expected utility is strictly increasing in W and l_1, this equation has a unique solution and can be solved numerically. As reported in Fig. 7, the mean option value of new entrants exceeds five times the average national wage, representing 82,000€ or 12 years of unobserved benefits. Though the option's value significantly decreases over time, it remains sizable among older firms because of permanent productivity shocks.

5.4. Counterfactual experiments

To further understand the model, I run counterfactual experiments in which I remove certain mechanisms and

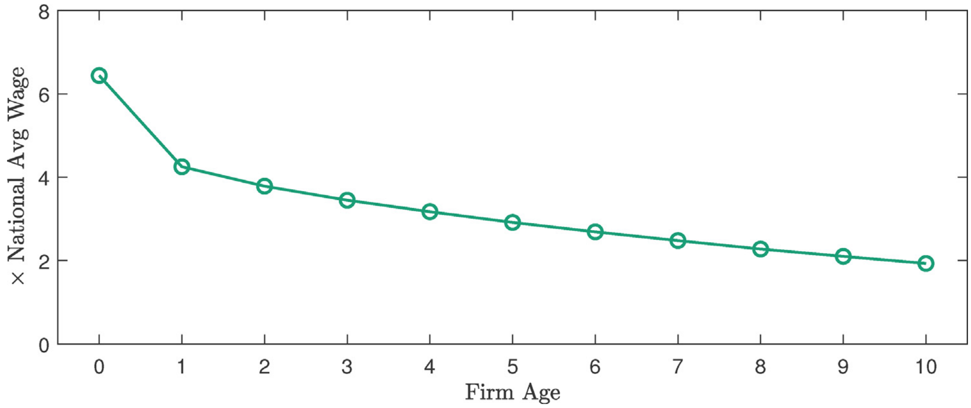


Fig. 7. Option value. This figure reports the certainty equivalent of the option of returning to paid employment. The certainty equivalent is estimated numerically by solving Eq. (14) and is normalized by the average national wage (net of payroll taxes). I simulate the baseline model using estimated parameters reported in Column (1) of Table 3, compute the option value for each entrepreneur, and report its mean by firm age.

Table 4
Counterfactual Experiments.
This table reports the effects of removing key model ingredients. In each counterfactual experiment, I simulate the model using estimated parameters reported in Column (1) of Table 3. Panel A reports the relative changes on the number of firm creations, the number of firms, and their mean and total value-added. Panel B reports the average percentage earnings differential between entrepreneurs and a benchmark group of paid employees. This benchmark group is built by matching using age wages over the three years preceding the entrepreneurial spell. The line "All entrepreneurs" takes into account those who returned to paid employment, whereas "Active entrepreneurs" ignores entrepreneurs after their return to paid employment. In Column (2), permanent productivity shocks are set to zero. In Column (3), I assume that entrepreneurs perfectly know their abilities before starting their firm. In Column (4), unobserved benefits are set to zero. In Column (5), I assume that entrepreneurs cannot return to paid employment. Finally, Column (6) combines the assumptions of Columns (4) and (5).

		Removed Element				
	(1) Baseline	(2) Permanent Shocks	(3) Initial Uncertainty	(4) Unobserved Benefits	(5) Exit Option	(6) (4) & (5) Combined
Panel A: Changes in Entrepreneurial Sector						
Firm creations		−1.5%	−6.0%	−9.9%	−18.2%	−39.5%
Firms		−6.9%	+0.0%	−26.4%	+8.9%	−34.9%
Mean Value Added		−39.0%	+1.3%	+23.8%	−14.9%	+10.9%
Total Value Added		−43.2%	+1.4%	−8.9%	−7.4%	−27.8%
Panel B: Premium over first 10 years						
All entrepreneurs	36.0%	26.3%	44.0%	46.5%	53.6%	99.8%
Active entrepreneurs	49.4%	35.7%	53.8%	84.3%	53.6%	99.8%

study how they affect the entrepreneurial sector and premium. Panel A of Table 4 reports the change in the number of entries, firms and their value added relative to the baseline model. Panel B reports the premium received by entrepreneurs over the first 10 years following the creation of their firm, including and excluding entrepreneurs after they returned to paid employment.

Permanent TFP shocks In Column (2), I eliminate permanent productivity shocks by setting $\sigma_{z,1} = 0$. The potential growth of successful firms is considerably reduced, making the mean value added fall by 39.6% and reducing the earnings differential between entrepreneurs and paid employees.

Initial uncertainty In Column (3), I assume that individuals perfectly observe the initial heterogeneity in permanent productivity. Specifically, I set initial uncertainty to zero ($\sigma^2_{\nu,2} \leftarrow 0$) but keep the total initial variance of productivity constant ($\sigma^2_{\nu,1} \leftarrow \sigma^2_{\nu,1} + \sigma^2_{\nu,2}$). In this counterfactual experiment, individuals have less incentive to experiment with entrepreneurship, but this reduces the number of new firms by only 5%. Moreover, lower exit rates offset this effect such that the number of firms does not change. The mean value added is barely affected.

Unobserved benefits As shown in Column (4), removing unobserved benefits reduces the number of firm creations by 12.3% and the total number of firms by 27%. The average firm is substantially better, and the earnings differential between active entrepreneurs and their benchmark group nearly doubles, jumping from 50.7% to 87.4%. These findings illustrate the importance of unobserved benefits in explaining the entry and persistence of apparently inefficient entrepreneurs.

Exit option In Column (5), I assume that entrepreneurs cannot return to paid employment when they fail. As a result, entries are reduced by 16%. Interestingly, the earnings differential between active entrepreneurs and their benchmark group barely changes because two opposing effects offset each other. On the one hand, new entrepreneurs are

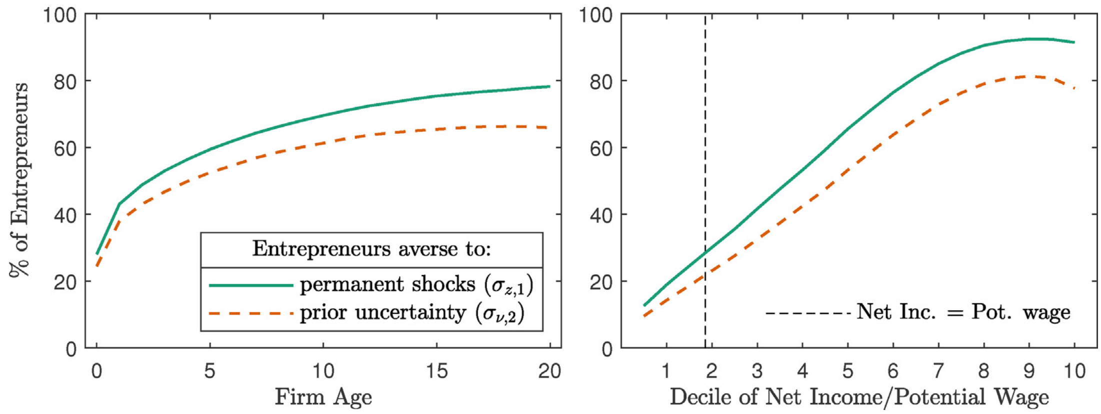


Fig. 8. Attitude towards risk. These plots report the share of entrepreneurs who would have lower expected utility if *(i)* the variance of permanent productivity shocks ($\sigma^2_{z,1}$) or *(ii)* the uncertainty over their current productivity level (σ^2_{μ}) were higher. For each of these three sources of risk, I compute what the expected utility of each entrepreneur would be after an unexpected $\Delta = 0.01$ increase in either $\sigma^2_{z,1}$ or σ^2_{μ} for one year. In each case, I adjust the current expectation of profitability μ such that the path of Z remains the same in expectation. I say that entrepreneurs are averse to permanent shocks or prior uncertainty when increasing it reduces their expected utility. The left panel reports the shares of risk-averse entrepreneurs by firm age. The right panel reports these shares for each decile of firm net income, divided by potential earnings in paid employment.

of better quality. On the other hand, unlucky entrepreneurs experiencing large negative productivity shocks have to keep running their firms.

Unobserved benefits & Exit option Finally, Column (6) combines the assumptions of Columns (5) and (6). Removing unobserved benefits and the option to return to paid employment at the same time reduces the number of firm creations by 42%. The combined effect is stronger than the sum of individual effects because initial expectations regarding permanent productivity are normally distributed. Removing unobserved benefits *or* the option to return to paid employment only discourages individuals to become entrepreneurs if their beliefs fall in the left tail of the distribution, where density is low. Removing both moves the threshold further right, where density is much higher, and therefore discourages many more individuals to become entrepreneurs.

5.5. Attitude towards entrepreneurial risk

This section shows that, in simulated data, a large fraction of entrepreneurs would be better off with higher uncertainty over productivity or larger permanent shocks. This is especially the case for new entrants and entrepreneurs about to close their firm, that is marginal entrepreneurs. Because of the option to return to paid employment, marginal entrepreneurs are protected against downside risk, which implies that uncertainty and permanent productivity shocks only bring upside potential. These findings nuance the notion that entrepreneurs need to be rewarded for bearing idiosyncratic risk, which in turn explains why the model can match the data with relatively small unobserved benefits.

From the entrepreneur's point of view, the variance of next year's log productivity can be decomposed into three components: prior uncertainty ($\sigma^2_{\mu,t}$) and permanent ($\sigma^2_{z,1}$) and transitory shocks ($\sigma^2_{z,2}$). To test whether entrepreneurs are averse to the first two components, I compute the change in expected utility that would follow an increase of the associated component of variance by $\Delta = 0.01$. I assume this change to be unexpected and to last only one year. I also reduce z by $\frac{\Delta}{2}$ to keep expected productivity $\mathbb{E}[e^z]$ unchanged. This adjustment is permanent and known from entrepreneurs who correct their priors (μ) accordingly. Entrepreneurs are averse to a component of variance if it reduces their expected utility.

As reported in Fig. 8, most of entrepreneurs who run young firms or whose firm's net income does not largely exceed what they would make on the labor market are not averse to either source of risk. In particular, 80% of entrepreneurs making less than they would in paid employment actually like entrepreneurial risk and do not need to be compensated for it. The right panel also supports the mechanism described in Choi (2018): during recessions, potential wages go down and entrepreneurs become more risk averse.

Vereshchagina and Hopenhayn (2009) also propose a model in which marginal entrepreneurs are risk loving, but the mechanism is clearly different as it relies on financial constraints. In their model, entrepreneurship is more attractive than paid employment conditional on running a large business. If his own resources are barely sufficient to finance his business, the entrepreneur's utility function is locally convex in wealth, which encourages him to take on risky projects.

6. Model extensions

This section reports how my structural estimates change when the model is enriched to take into account collateral constraints, labor market frictions, liquidation costs and personal income taxes. I also discuss how my results vary when I assume different levels of relative risk aversion or when agents have heteroegenous preferences. The option value in these different specifications are reported in Fig. 9.

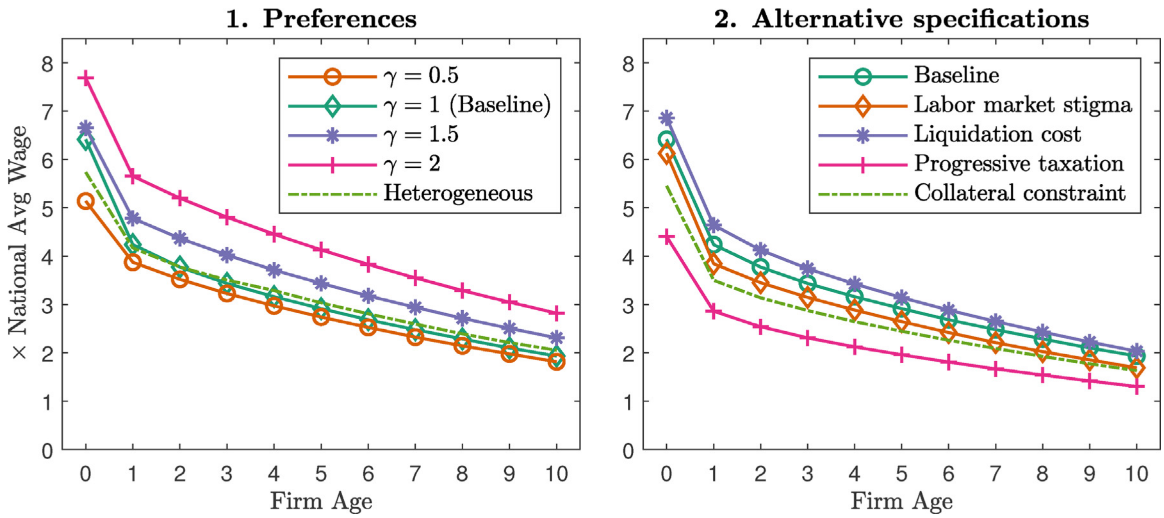


Fig. 9. Option Value – Robustness Tests. This figure reports the option value of returning to paid employment under different model assumptions. The option value is estimated numerically by solving Equation (14) and normalized by the average national wage. I simulate the baseline model using parameters estimated by SMM, compute the option value for each entrepreneur, and report the mean by firm age. Panel A reports mean option values for different levels of relative risk aversion using parameters reported in Table B.3. Panel B uses parameters reported in Table 3.

6.1. Collateral constraint

I start by introducing a collateral constraint in the model by imposing

$$D_{it} \leq \vartheta K_{it}, \tag{15}$$

which follows the modeling of many papers (Evans and Jovanovic, 1989; Hennessy and Whited, 2005; Liu et al., 2013; Midrigan and Xu, 2014). A simple way to calibrate ϑ is to match the mean (median) debt-to-capital employed ratio which Davydenko and Franks (2008) estimate at 0.65 (0.63) for small and medium French firms and is consistent with my own findings. Because matching this moment would require $\vartheta > .65$, estimating the model with $\vartheta = .65$ will give us an upper bound on how much our estimates could be affected by collateral constraints. Moreover, this value of ϑ is in the range of the calibrated/estimated values of previous papers. For example, Evans and Jovanovic (1989) estimate $\vartheta = .72$ for US entrepreneurs, Midrigan and Xu (2014) find $\vartheta = .86$ in South Korea, and Hennessy and Whited (2005) find $\vartheta = .59$ for compustat firms.

As reported in column (5) of Table 3, estimated parameters do not change much relative to the baseline model. In the model, low returns to scale explain the high Ebitda-to-capital employed ratio. Because this ratio is also an increasing function of financial constraints, introducing the latter increases my estimate of α. The standard deviation of permanent shocks is adjusted such that $\sigma_{z,1}/(1-\alpha)$ does not change much. Interestingly, matching the average age of entrepreneurs now requires a lower p, which is not consistent with collateral constraints explaining why individuals wait until their 40's to start businesses.

Finally, I find that introducing a collateral constraint does not appreciably change the estimated value of the fall back option.

6.2. Labor market stigma

Difficulties finding a new job when returning to the labor market should theoretically reduce both entry and exit rates. In Column (2) of Table 3, I assume that entrepreneurs receive an additional shock of −0.2 to the persistent component of their wage l_1 when they exit. This shock dissipates as in Eq. (9). To support this calibration of the labor market stigma, Appendix Figure C.3 reports the income trajectories of entrepreneurs who close their firm within three years. Upon returning to paid employment, these entrepreneurs earn 21% less than their benchmark group, a difference which becomes statistically insignificant five years later. As this friction makes it costly to exit, matching empirical exit rates requires a higher level of initial uncertainty. For the same reason, the model requires slightly smaller unobserved benefits to explain the persistence of inefficient businesses. Because initial uncertainty and unobserved benefits have opposite effects, the option value does not change significantly.

6.3. Irreversibility of investment

Another cost of returning to paid employment may arise from the inability to recover the full value of capital. As reported in Column (3), I find that introducing a fixed liquidation cost equal to half of the national average wage affects my results in the same way as the labor market stigma does.[17] I calibrate this transaction cost such that it represents 20% of the average capital of firms in their penultimate year in my baseline specification. There is substantial disagreement regarding the value of resale losses in the literature: Cooper and Haltiwanger (2006) estimate

[17] Ideally, the liquidation cost should be a fraction of the firm's capital but this would reduce the tractability of the model since capital would become a state variable.

that liquidated assets are sold at a discount of only 2.5% whereas Bloom (2009)'s estimate is 34%.

6.4. Personal income tax

Because it is akin to change of scale, a proportional income tax has no effect in a model with CRRA utility. On the other hand, progressive taxes increase incentives to undertake risky projects by providing insurance (Domar and Musgrave, 1944) but can also discourage individuals motivated by the option value of experimentation and unwilling to share upside risk with the government. Column (4) of Table 3 reports how structurally estimated parameters change when progressive income taxes are introduced in the model. I use the following tax schedule, which seeks to replicate French personal taxes in 2017. Marginal tax rates are:

$$\text{Marginal Tax Rate}_{it} = \begin{cases} 0\% & \text{if} \quad \text{Income}_{it} < 0.36 \\ 14\% & \text{if } 0.36 \leq \text{Income}_{it} < 1.00 \\ 30\% & \text{if } 1.00 \leq \text{Income}_{it} < 2.69 \\ 41\% & \text{if } 2.69 \leq \text{Income}_{it} < 5.70 \\ 45\% & \text{if } 5.70 \leq \text{Income}_{it} \end{cases} \tag{16}$$

I find that estimated unobserved benefits are now one fourth smaller but must be interpreted in post-tax income equivalent. Similarly, I also find the option value drops by one fourth in the presence of progressive taxation.

6.5. Risk aversion

I also reestimate all parameters for different coefficients of relative risk aversion, specifically $\gamma = 0.5$, $\gamma = 1.5$ and $\gamma = 2$. Appendix Table B.3 shows that parameter estimates are not overly sensitive to my calibration of γ. The estimated value of unobserved benefits is increasing in risk aversion whereas estimated initial uncertainty decreases with γ. While economic theory predicts that the option value should go up with risk-aversion, the change in these two parameters is sufficient to offset that expectation.

6.6. Heterogeneous preferences

Finally, I reestimate the model assuming that agents have different levels of relative risk aversion ($\ln(\gamma) \sim \mathcal{N}(0, .5)$) and patience ($\ln(1-\beta) \sim \mathcal{N}(\ln(.04), .5)$). Estimated unobserved benefits and the option value of returning to paid employment remain close to their baseline values.

6.7. Counterfactual experiments

In appendix Table B.4, I replicate the counterfactual experiments reported in Table 4 for the different model specifications dissed in Sections 5.1-5.6. Most of my conclusions are robust across specifications and for different levels of relative risk aversion between 0.5 and 2. Unobserved benefits are slightly less important when the model assumes that entrepreneurs face frictions when they return to paid employment, but my conclusion that the entrepreneurial premium would be much larger without unobserved benefits still holds. When entrepreneurs have difficulties returning to paid employment, the model requires higher initial uncertainty to explain empirical exit rates, which slightly reinforces the role of initial uncertainty in explaining entrepreneurial entry.

7. Policy experiments

In this section, I use the model to investigate how policy makers can promote entrepreneurship. Specifically, I look at the partial equilibrium effect of policies seeking to *(i)* facilitate returns to the labor market, *(ii)* reduce liquidation costs and *(iii)* change the personal income tax schedule. To evaluate the effects of removing the labor market stigma, I use parameters estimated under the assumption that such stigma exists and reported in Column (3) of Table 3. Similarly, I use parameters reported in Columns (4) and (5) to evaluate the effect of removing liquidation costs and changing the tax schedule, respectively. Table 5 reports the effects of these policies. Overall, my policy experiments suggest that promoting entrepreneurship is difficult.

Removing labor market friction Facilitating returns to paid employment increases the number of entrepreneurial entries by 12.4% but reduces the total number of firms by 0.2% because entrepreneurs can now return to paid employment more easily. The mean value added of firms barely moves (+0.6%), which is consistent with Hombert et al. (2020)'s study of a 2002 French reform providing generous downside insurance for unemployed individuals starting businesses. These authors find a very large effect on firm creation (25%), but this effect is entirely confined to firms without employees at creation.

Removing liquidation costs Countries with faster and cheaper bankruptcy procedures have higher rates of entrepreneurial entry (Lee et al., 2011). Similarly, column (2) of Table 5 shows that, in the model, eliminating liquidation costs increase entrepreneurial entry by 5%. However, the effect on the total number of firms or their quality is small because the new firms are of lesser quality, and lower liquidation costs make exits more attractive. Overall, eliminating liquidation costs has a similar effect as removing labor market friction but smaller because the labor market friction is slightly more expensive than the liquidation cost in my calibration.

Capping marginal tax rate at 30% for entrepreneurs A 2018 reform introduced the option for entrepreneurs to have their dividends taxed at an overall rate of 30%, rather than to pay the income tax rate implied by their income bracket. I simulate a similar policy by capping the marginal tax rate of entrepreneurs to 30%.[18] This policy has very little effect on entries, exits or the quality of firms. It only reduces taxes for income above 2.7 times the national average wage, which is slightly more than the earnings of entrepreneurs running 10 year old businesses. Hence, the policy focuses on successful entrepreneurs and states of the world in which the marginal utility of money is small due to risk aversion. This result could change if some en-

[18] See Bach et al. (2019b) for a detailed discussion of this reform.

Table 5
Policy Experiments.
This table reports how policy experiments affect the entrepreneurial sector in simulated data. In Columns (1) and (2), I report the effect of eliminating labor market frictions and liquidation costs faced by entrepreneurs when they close their firms. I use parameters reported in Columns (3) and (4) of Table 3 and estimated while taking these frictions into account. In Columns (3) and (4), I report the effect capping the marginal income tax rate at 30% for entrepreneurs or moving to a proportional income tax of 27.24%. The initial income tax schedule is detailed in Eq. (16). In both cases, I use parameter reported in Column (5) of Table 3 and estimated while taking into account progressive income taxes.

	(1) Removing Labor Market Friction	(2) Removing Liquidation Costs	(3) Capping Marginal Tax Rate at 30%	(4) Moving to a Proportional Income Tax
Number of entries	+12.4%	+5.0%	+0.1%	+1.3%
Number of firms	−0.2%	−0.1%	+0.7%	+3.7%
– VA <.1M€	+1.1%	−0.1%	+0.6%	+14.4%
–.1M€ < VA <.5M€	−1.3%	−0.2%	+0.7%	+1.4%
–.5M€ < VA < 1M€	+0.8%	−0.0%	+0.9%	+0.7%
– VA > 1M€	+0.9%	+0.1%	+1.0%	+0.8%
Mean Value Added	+0.6%	+0.1%	+0.0%	−2.7%
Total Value Added	+0.4%	−0.0%	+0.8%	+0.9%

trepreneurs were risk neutral or if the distribution of TFP was highly skewed.

Moving to a proportional income tax In principle, progressive taxation can encourage risk-taking by providing insurance. Ex-post, successful risk-takers bear a greater share of the tax burden than the less successful ones, which reduces risk ex-ante. Yet, Gentry and Hubbard (2000) find a significant increase in entrepreneurial entry when tax rates are less progressive. In the last policy experiment, I assume that the progressive system is replaced by a proportional income tax. I set the tax rate to 27.24%, which matches the weighted average rate in the progressive system. I find that moving to a proportional income tax increases the number of firm entries, but by only 1.3%. In the model, potential entrepreneurs do not value the downside insurance offered by progressive taxation because they are already protected by the option of returning to the labor market. In effect, progressive taxation only reduces the upside potential of entrepreneurship, and therefore does not encourage risk-taking. The number of firms grows by 3.7%, but most of this increase comes from small firms with value added below 100 thousand euros. Moving to a proportional income tax makes entrepreneurship more attractive to workers who fell in the lower income tax brackets under the progressive schedule. The increase in their marginal tax rate makes unobserved (and untaxable) benefits more valuable, relative to wage earnings, encouraging entrepreneurship among low earners.

8. Conclusion

In this paper, I study whether job-creating entrepreneurs are motivated by unobserved benefits or the option value of experimentation. I find both to be equally important in explaining why individuals become entrepreneurs and that removing both would reduce the number of firm creations by half. Unobserved benefits are also crucial in explaining the cross-sectional difference in earnings between entrepreneurs and paid employees. An important byproduct of my structural estimation is that entrepreneurs experience large permanent productivity shocks which generate a lot of option value if entrepreneurs can return to paid employment and are important in explaining the evolution of the firm size distribution.

My model focuses on two trade-offs faced by potential entrepreneurs: whether to work as paid employees or strike out on their own, and, conditional on going it alone, whether to invest in their own firm or in the risk-free asset. In reality, however, entrepreneurs have several other alternatives to entrepreneurial investment, including the option to invest in public equity. Though entrepreneurial investment generates higher returns than public equity, it is unclear whether that premium is large enough to compensate entrepreneurs for bearing more idiosyncratic risk (Kartashova, 2014). Future research could answer this question by expanding the model to allow stock market participation.

One interesting side result of my paper is that entrepreneurs face large permanent productivity shocks, which means that entrepreneurial success is not only determined by personal skills and project quality. Luck plays an important role.".

Supplementary material

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.jfineco.2022.01.001.

References

Andersen, S., Harrison, G.W., Lau, M.I., Rutström, E.E., 2008. Eliciting risk and time preferences. Econometrica 76 (3), 583–618.
Bach, L., 2017. Do Sophisticated Entrepreneurs Avoid More Taxes? Unpublished working paper 1517.
Bach, L., Bozio, A., Fabre, B., Guillouzouic, A., Leroy, C., Malgouyres, C., 2019. Follow the Money! Combining Household and Firm-Level Evidence to Unravel the Tax Elasticity of Dividends. Unpublished working paper.
Bach, L., Bozio, A., Fabre, B., Guillouzouic, A., Leroy, C., Malgouyres, C., 2019. Évaluation d'impact de la fiscalité des dividendes. PSE-Ecole d'économie de Paris (Postprint). HAL.
Bhandari, A., Birinci, S., McGrattan, E.R., See, K., 2020. What do survey data tell us about US businesses? Am. Econ. Rev. 2 (4), 443–458.
Bloom, N., 2009. The impact of uncertainty shocks. Econometrica 77 (3), 623–685.
Cabral, L.M.B., Mata, J., 2003. On the evolution of the firm size distribution: facts and theory. Am. Econ. Rev. 93 (4), 1075–1090.

Chetty, R., 2006. A new method of estimating risk aversion. Am. Econ. Rev. 96 (5), 1821–1834.
Choi, J., 2018. Entrepreneurial Risk-Taking, Young Firm Dynamics, and Aggregate Implications. Unpublished working paper.
Cooper, R.W., Haltiwanger, J.C., 2006. On the nature of capital adjustment costs. Rev. Econ. Stud. 73 (3), 611–633.
Davydenko, S.A., Franks, J.R., 2008. Do bankruptcy codes matter? A study of defaults in France, Germany, and the U.K. J. Finance 63 (2), 565–608.
Dillon, E.W., Stanton, C.T., 2018. Self-Employment Dynamics and the Returns to Entrepreneurship. Unpublished working paper.
Domar, E.D., Musgrave, R.A., 1944. Proportional income taxation and risk–taking. Q. J. Econ. 58 (3), 388–422.
Evans, D.S., Jovanovic, B., 1989. An estimated model of entrepreneurial choice under liquidity constraints. J. Polit. Economy 97 (4), 808–827.
Gentry, W.M., Hubbard, R.G., 2000. Tax policy and entrepreneurial entry. Am. Econ. Rev. 90 (2), 283–287.
Gottlieb, J.D., Townsend, R.R., Xu, T., 2021. Does career risk deter potential entrepreneurs? Rev. Financ. Stud.. forthcoming
Gourinchas, P.-O., Parker, J.A., 2002. Consumption over the life-cycle. Econometrica 70 (1), 47–89.
Guvenen, F., Ozkan, S., Song, J., 2014. The nature of countercyclical income risk. J. Polit. Economy 122 (3), 621–660.
Haltiwanger, J., Jarmin, R.S., Miranda, J., 2013. Who creates jobs? Small versus large versus young. Rev. Econ. Stat. 95 (2), 347–361.
Hamilton, B.H., 2000. Does entrepreneurship pay? An empirical analysis of the returns to self-employment. J. Polit. Economy 108 (3), 604–631.
Harrison, G., Rutström, E.E., 2008. Risk aversion in the laboratory. Res. Exp. Econ. 12, 41–196.
Hennessy, C.A., Whited, T., 2005. Debt dynamics. J. Finance 60 (3), 1129–1165.
Henrekson, M., Sanandaji, T., 2014. Small business activity does not measure entrepreneurship. Proc. Natl. Acad. Sci. 111 (5), 1760–1765.
Holmström, B., 1999. Managerial incentive problems: a dynamic perspective. Rev. Econ. Stud. 66 (1), 169–182.
Holt, C.A., Laury, S.K., 2002. Risk aversion and incentive effects. Am. Econ. Rev. 92 (5), 1644–1655.
Hombert, J., Shoar, A., Sraer, D.A., Thesmar, D., 2020. Can unemployment insurance spur entrepreneurial activity? Evidence from France. J. Finance 75 (3), 1247–1285.
Humphries, J.E., 2021. The Causes and Consequences of Self-Employment over the Life Cycle. Unpublished working paper.
Hurst, E., Li, G., Pugsley, B., 2014. Are household surveys like tax forms? evidence from income underreporting of the self-employed. Rev. Econ. Stat. 96 (1), 19–33.
Hurst, E., Pugsley, B.W., 2011. What do small businesses do? Brookings Pap. Econ. Act. 42 (2 (Fall)), 73–142.
Jones, J.B., Pratap, S., 2020. An estimated structural model of entrepreneurial behavior. Am. Econ. Rev. 110 (9), 2859–2898.
Jovanovic, B., 1982. Selection and the evolution of industry. Econometrica 50 (3), 649–670.
Kartashova, K., 2014. Private equity premium puzzle revisited. Am. Econ. Rev. 104 (10), 3297–3334.
Lee, S.-H., Yamakawa, Y., Peng, M.W., Barney, J.B., 2011. How do bankruptcy laws affect entrepreneurship development around the world? J. Bus. Venturing 26 (5), 505–520.
Levine, R., Rubinstein, Y., 2017. Smart and illicit: who becomes an entrepreneur and do they earn more?*. Q. J. Econ. 132 (2), 963–1018.
Liu, Z., Wang, P., Zha, T., 2013. Land-price dynamics and macroeconomic fluctuations. Econometrica 81 (3), 1147–1184.
Lucas, R.E., 1978. On the size distribution of business firms. Bell J. Econ. 9 (2), 508–523.
Manso, G., 2016. Experimentation and the returns to entrepreneurship. Rev. Financ. Stud. 29 (9), 2319.
Merton, R.C., 1969. Lifetime portfolio selection under uncertainty: the continuous-time case. Rev. Econ. Stat. 51 (3), 247–257.
Midrigan, V., Xu, Y., 2014. Finance and misallocation: evidence from plant-level data. Am. Econ. Rev. 104 (2), 422–458.
Moskowitz, T.J., Vissing-Jorgensen, A., 2002. The returns to entrepreneurial investment: a private equity premium puzzle? Am. Econ. Rev. 92 (4), 745–778.
Pissarides, C.A., Weber, G., 1989. An expenditure-based estimate of Britain's black economy. J. Public Econ. 39 (1), 17–32.
Schmalz, M.C., Sraer, D.A., Thesmar, D., 2017. Housing collateral and entrepreneurship. J. Finance 72 (1), 99–132.
Schoar, A., 2010. The divide between subsistence and transformational entrepreneurship. Innov. Policy Economy 10 (1), 57–81.
Schuetze, H.J., 2002. Profiles of tax non-compliance among the self-employed in Canada: 1969 to 1992. Can. Public Policy 28 (2), 219–237.
van Praag, M., Raknerud, A., 2017. The Returns to Entrepreneurship: Evidence from Matched Person-Firm Data. Unpublished working paper.
Vereshchagina, G., Hopenhayn, H.A., 2009. Risk taking by entrepreneurs. Am. Econ. Rev. 99 (5), 1808–1830.