Who becomes an entrepreneur?
Labor market prospects and occupational choice*

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Abstract

Why do some people become entrepreneurs (and others don't)? Why are firms so heterogeneous, and many firms so small? To start, the paper briefly documents evidence from the empirical literature that the relationship between entrepreneurship and education is U-shaped; that many entrepreneurs start a firm "out of necessity"; that most firms are small, remain so, yet persist in the market; and that returns to entrepreneurship have a much larger cross-sectional variance than returns to wage work. Popular models of firm heterogeneity cannot easily account for the U-shape or for the persistence of low-productivity firms. The paper shows that these facts can be explained in a dynamic model of occupational choice between wage work and entrepreneurship where agents are heterogeneous in their ability as workers, and starting entrepreneurs face uncertainty about their project's productivity. Then, under weak conditions, the most and the least able individuals choose to become

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entrepreneurs. This sorting is due to heterogeneous outside options in the labor market. Because of their low opportunity cost, low-ability agents optimally spend more time searching for a good project. This also makes them more likely to abandon an unsatisfactory project for a new one. Data from the National Longitudinal Survey of Youth (NLSY79) give support to these two predictions. Individuals with relatively high or low ability are more likely to be entrepreneurs or to become entrepreneurs, and spend more time in entrepreneurship. Low-ability entrepreneurs are more likely to abandon a project after only a year.

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1 Introduction

Why do some people become entrepreneurs, and others don't? Why do so many firms fail so early? Why are firms so heterogeneous? With these questions in mind, this paper explores the occupational choice between wage work and entrepreneurship when people are heterogeneous in their ability as workers, and startups differ in productivity. A substantial number of people choose to become entrepreneurs. In the U.S., for instance, the entrepreneurship rate was 12.2% in 2009 as shown in Hipple (2010, Table 4) using Current Population Survey (CPS) data.[1] This rate is even higher in most other industrialized economies (see Blanchflower 2000).

Understanding this occupational choice is important, as aggregate productivity depends on who becomes an entrepreneur. In addition, many countries have programs promoting entrepreneurship (e.g. from the Small Business Administration in the U.S.) and/or treat small businesses differently. Understanding the effectiveness of these programs also requires understanding who becomes an entrepreneur.

[1]This is the number of incorporated plus unincorporated self-employed divided by total employment (including self-employment), all for persons of 25 years and older. Some words on measurement: In the CPS, respondents are asked "Last week, were you employed by government, by a private company, a nonprofit organization, or were you self-employed?" Respondents who say that they are self-employed are asked, "Is this business incorporated?" Those who answer no are the unincorporated self-employed. Legally, the incorporated self-employed are employees of their own business and therefore not self-employed, but wage and salary workers. For this reason, they are not included in the Bureau of Labor Statistics (BLS) series on self-employment, which are based on the CPS. In the present paper, the key characteristic of the self-employed or entrepreneurs is that they are residual claimants. For this reason, I also consider the incorporated self-employed to be self-employed or entrepreneurs. Definitions in the literature, while not always identical, are similar to the one used here – see the note to Table 1 for details. Finally, note that the self-employed may employ others. Since the word "self-employed" does not convey this at all, the word "entrepreneurs" appears more fitting, and I use it throughout the text.

Before modeling the occupational choice, I assemble and review some relevant facts about entrepreneurship from the empirical literature. First, do entrepreneurs come from the top or from the bottom of the ability distribution? While the answer to this question evidently matters, it is not obvious a priori and depends on what type of firm one thinks of. Lazear (2005, p. 650), for instance, puts it this way:

> It is tempting to argue that the most talented people become entrepreneurs because they have the skills required to engage in creative activity. Perhaps so, but this flies in the face of some facts. The man who opens up a small dry-cleaning shop with two employees might be termed an entrepreneur, whereas the half-million-dollar-per-year executive whose suit he cleans is someone else's employee. It is unlikely that the shop owner is more able than the typical executive.
>
> The reverse might be true. As necessity is the mother of invention, perhaps entrepreneurs are created when a worker has no alternatives. Rather than coming from the top of the ability distribution, they are what is left over. This argument also flies in the face of some facts. Any ability measure that classifies John D. Rockefeller, Andrew Carnegie, or, more recently, Bill Gates near the bottom of the distribution needs to be questioned.

In Section 2, I show that these two types coexist: Entrepreneurship rates are highest for people with high or low levels of education, and lower for those with intermediate levels of education. The relationship between entrepreneurship and ability thus is U-shaped. The empirical literature on education and entrepreneurship has somewhat bypassed this pattern, probably because most authors were looking for a monotonic relationship. Using linear specifications for education, they often obtained inconsistent or insignificant results – as may well occur if the underlying relationship is actually U-shaped, as indicated by the sources I use in this section and by the results I obtain in Section 5 analyzing data from the National Longitudinal Survey of Youth (NLSY79). Even authors who reported evidence of a U-shape either did not comment on it or, in the few cases where they did (e.g. Blanchflower (2000) or Schjerning and Le Maire (2007)), did not explore it any further.[2]

[2]For an overview of the empirical literature, see the references in Section 2. Lazear, following his observation, goes on to focus on heterogeneity in the structure of skills, and not in ability. The potential importance of other dimensions of heterogeneity notwithstanding, the main contribution of the model proposed in this paper is to explain the at first sight puzzling entrepreneurship-ability relationship.

The remainder of Section 2 briefly revisits three better-known facts about entrepreneurship. Firstly, the bulk of firms are small, remain so, and yet persist in the market. Many are smaller than popular macroeconomic models with firm dynamics allow them to be, making structural estimation or calibration of those models to the entire population of firms hard. Secondly, a substantial fraction of entrepreneurs (more than 10% in the U.S.) make their occupational choice not to pursue some golden opportunity, but "out of necessity". Finally, returns to entrepreneurship have a much larger cross-sectional variance than returns to wage or salaried work.

In Section 3, I set out a simple model that can explain all these facts. In particular, it can explain the coexistence of high- and low-ability entrepreneurs in a simple, unified framework. The model describes a world where people differ in both productive ability (efficiency units of labor they can supply as workers) and the productivity of firms they start, and choose the most rewarding occupation. Whereas productive ability is known, the productivity of entrepreneurial projects can only be found out by implementing them, i.e. by becoming an entrepreneur. Average productivity of firms started by a person may however be correlated with his/her productive ability.

Because a project's productivity is not known ex ante, an entrepreneur may happen to start a low-productivity venture and then abandon it in the hope of starting a more productive project next time. The optimal continuation policy hence consists in a reservation productivity, similar to that in McCall (1970) labor market search. Less productive projects are abandoned. The optimal reservation productivity is higher for more able agents. In Section 4, I show that the option to abandon bad projects always attracts low-ability agents into entrepreneurship. If in addition prospective entrepreneurs' expected productivity increases in their ability and this relationship is not too concave (as is likely to be the case empirically; see Section 4.1), the most able people also start firms, and agents of intermediate ability choose to become workers. I also show that not only the optimal reservation productivity, but also the success probability it implies is higher for high-ability agents. This implies that low-ability agents choose to reject more projects and search longer before accepting one.

The pattern of selection into entrepreneurship arises for the following reason: The cost of starting a firm is an opportunity cost in terms of foregone wages. This is higher the more discriminating the reservation productivity policy is. Low-ability agents face low wages and therefore have a low opportunity cost of starting a firm. As long as they have some probability of having a reasonably good idea and if entry costs are not too high, searching for that idea is worthwhile. High-ability agents have particularly high potential benefits. But agents of intermediate ability fall in between, and as a result do not find it optimal to start a firm.

In considering a setting with two dimensions of heterogeneity, the paper goes beyond the classic models of entrepreneurial choice of Lucas (1978) and Kihlstrom and Laffont (1979). With only one dimension of heterogeneity as there, it is obvious who will start a firm: the least risk averse, or the most able entrepreneurs. This however cannot explain the empirical evidence on entrepreneurship and ability, or Lazear's observation. This is also true for Gollin (2007), who introduces self-employment without employees as an additional choice into Lucas (1978). Cagetti and De Nardi (2006) do consider a model of occupational choice with two dimensions of ability. However, their entrepreneurial ability is a binary variable, just indicating whether someone is able to start a firm or not. They then focus on how the possibility of starting a firm shapes the wealth distribution and the distribution of returns to entrepreneurship when there are financial constraints – quite distinct from the role of heterogeneity in this paper.[3]

In featuring two dimensions of heterogeneity, the model is close to the Roy (1951) model of occupational choice.[4] Jovanovic (1994) analyzes such a Roy model with known, heterogeneous managerial and working abilities. The model here extends this by uncertainty about a startup's productivity, and by agents' ability to search for a good project. Section 4.3 shows how two crucial differences, the fact that one of the occupations considered is entrepreneurship and the introduction of search, substantially shape the predictions of the occupational choice model and distinguish it from the Roy model. As a result, the model proposed here matches all the facts presented in Section 2.

The model is also related to the literature that uses heterogeneous-firm models building on Hopenhayn (1992). Recent examples here include Samaniego (2006), Gabler and Licandro (2007), Lee and Mukoyama (2008) and Poschke (2009). While in these models, the occupational choice is not explicit, market selection implies that only firms that are productive enough survive. The models thus implicitly focus on firms started by high-ability entrepreneurs, and cannot account for the small firms operated by low-ability entrepreneurs. As these account for a large fraction of firms but a rather small fraction of employment, this may be the right approach for many purposes, but not for all. For example, an analysis of subsidies to firm creation, a policy in place in many countries, also needs to take into account the effect of the policy on low-ability entrepreneurs. Quantification also needs to be done with care; for example, a model that focuses

[3]Banerjee and Newman (1993) and Lloyd-Ellis and Bernhardt (2000) also study the role of the wealth distribution for occupational choice in the presence of credit constraints.

[4]The Roy model has been significantly refined and extended since then, in particular by Rosen and Willis (1979) and Heckman and Honoré (1990). For an overview, see also Sattinger (1993).

on high-ability entrepreneurs should be calibrated using data that refers to that group only, and not to all entrepreneurs.

The main predictions of the model are that individuals with relatively high or low ability are more likely to become entrepreneurs, and that among these, low-ability agents are more discriminating in their choice of project. The final section of the paper presents new empirical evidence on these predictions, using data from the NLSY79. Here I first confirm that individuals with a high or a low degree are more likely to be or to become entrepreneurs and spend more time in entrepreneurship. An alternative measure of ability that is much closer to the model are wages in previous employment, which are available in the data for almost all entrepreneurs. This measure also reveals a U-shape; individuals with relatively high or low wages in previous employment are more likely to be or to become entrepreneurs and spend more time in entrepreneurship. Finally, among entrepreneurs, more of the firms run by individuals with low wages in previous employment or with a low degree are abandoned after only a year. These new findings give support to both of the main predictions of the model.

The paper thus makes two main contributions. First, it provides evidence that the relationship between the probability of entrepreneurship and different measures of ability is U-shaped. This result has essentially been overlooked by previous literature. Then, it explains this pattern in a simple model of search. The model can account for the coexistence of high- and low-ability entrepreneurs in a unified framework, whereas existing models of entrepreneurship cannot explain the relatively high rate of low-ability entrepreneurship.

These contributions are of practical importance because a lot of public policy discussion on entrepreneurship implicitly or explicitly makes different assumptions, e.g. that many entrants or small firms will grow and create many jobs, if only they have enough financing. (Haltiwanger, Jarmin and Miranda (2010) dissect this particular presumption in detail.) To understand what policy towards entrepreneurship is adequate, it is thus necessary to document actual occupational choice patterns and to understand why they arise. The findings relating to small firms presented here are particularly important given that these firms are the target of a lot of policy intervention. While the model proposed here abstracts from potentially important issues like financial or regulatory frictions, it provides a building block for understanding occupational choice across the entire spectrum of entrepreneurs, which can be used in future quantitative policy analysis.

2 Some facts on entrepreneurship

This section documents several relevant facts about entrepreneurship, some well-known, some new. Firstly, the relationship between entrepreneurship and education is U-shaped. That is, people with very low or high levels of education are more likely to be entrepreneurs than people with intermediate levels of education. Secondly, most firms are small. Most of these firms remain small and are not much more likely to exit than their larger counterparts. This fits with the third fact: there is a substantial fraction of people who become entrepreneurs "out of necessity", and not to pursue an opportunity. Finally, returns to entrepreneurship have a much higher variance than returns to being an employee. This emerges robustly from the recent literature on entrepreneurship and will therefore be reiterated only briefly here.

Are more productive or less productive people more likely to become entrepreneurs? As suggested by the quote from Lazear (2005), either argument might be made, depending on the type of firm one is thinking of. This also suggests that the answer does not have to be either/or. In fact:

Fact 1. *The relationship between entrepreneurship and education is U-shaped, i.e. people with low or high levels of education are more likely to be entrepreneurs than people with intermediate levels of education.*

Whereas there is an abundant literature on the impact of an additional year of schooling on wages or salaries of employees, the relationship between entrepreneurship and schooling has received much less attention, and much less sophisticated econometric treatment. Therefore, in this section, I simply focus on results in the literature on the proportion of entrepreneurs by educational attainment. In Section 5, I supplement this with further, new evidence from the NLSY79. In that section, I also go beyond the focus on schooling in much of the entrepreneurship literature and consider another, potentially more informative proxy for ability: wages in previous employment. Results from the NLSY79 are generally in line with the ones from other countries and data sources reported in this section.

Before proceeding to the results, note that studies that look only for a linear effect, e.g. by regressing the probability of being an entrepreneur on years of schooling, often remain inconclusive. The reason for this is that on closer inspection, as shown below, a U-shape appears: People at the extremes of the education distribution are more likely to be entrepreneurs than people with intermediate levels of education. Looking for a purely linear relationship will hide the U-shape and most likely yield insignificant estimates.

Table 1 summarizes evidence from some recent and some influential papers, and also gives a preview of results in Section 5 of this paper. Note that while the papers cited in the table define entrepreneurs or the self-employed in slightly different ways, their results are comparable because all definitions have one key element in common: entrepreneurs are residual claimants. (See the note to the table for details on definitions.) Moreover, in all sources the self-employed can have employees. Since the term "self-employed" does not convey this well, I refer to them as entrepreneurs throughout the paper.

The table shows entrepreneurship rates by educational category from a variety of sources, covering different countries and time periods. The columns refer to less than high school (<HS), high school (HS), less than college (<C), college (C), Master's degree (M), and professional degrees (essentially MD and LLD) or PhD (P/PhD). Not all sources report data for all of the educational categories.

Table 1: Entrepreneurship rates by education category

		educational attainment					
	data source	<HS	HS	<C	C	M	P/PhD
Borjas and Bronars (1989)	U.S., 1980 Census	4.8	4.2	4.6	———6.5———		
Hamilton (2000)	U.S., 1984 SIPP	12.6	11.1	12.6	———15———		
Hipple (2010)	U.S., 2009 CPS	12.0	11.8	11.8	12.4	13.9	
Lin, Picot and Compton (2000)	Canada, 1994 SLID	17.0	13.1	11.5	12.8	15.0	
Schjerning and Le Maire (2007)	Denmark, 1980-96	10.9	10.9	7.4	3.6	12.9	
This paper (Section 5)	U.S., NLSY79	37.3	30.6	27.3	30.1	21.2	31.3

Sources: Author's computations from: Borjas and Bronars (1989), Table 2 (1980 Census, white men aged 25-64, residing in metropolitan areas, not employed in agriculture; results similar for black and Asian men); Hamilton (2000), Table 1 (1984 Survey of Income and Program Participation (SIPP), male school leavers aged 18-65 working in the nonfarm sector); Hipple (2010), Table 3 (2009 CPS, men and women, aged 16 and older, unincorporated and incorporated); Lin et al. (2000), Table 3 (Statistics Canada 1994 Survey of Labour and Income Dynamics (SLID), men and women aged 15-64); Schjerning and Le Maire (2007), Table A.1 (Statistics Denmark Integrated Database for Labor Market Research (IDA) and Danish Income Registry (IKR), 1980-1996, men and women aged 30-55); Section 5 below (NLSY, 1979-2006, men and women who have completed schooling). In all these data sets except for the Danish register data, respondents self-identify as self-employed or not. Precise sample assignments differ slightly in how they treat respondents who engage in multiple activities: Borjas and Bronars (1989) classify as self-employed those who are self-employed in their main job. Hamilton (2000) those who report "non-casual" self-employment as their main labor market activity for at least three months of a given 12-month period. He also excludes doctors and lawyers. The number reported from Lin et al. (2000) is for a classification that considers only respondents who are either only self-employed or only wage earners. Schjerning and Le Maire (2007) do not report how they classify part-time self-employed. The numbers from the present paper refer to whether a respondent was self-employed at any point of the sample (1979-2006). In all studies, the self-employed may be incorporated or not, and can have employees or not. Because the table includes employers, I refer to "entrepreneurship rates".

The most remarkable feature of the data reported in Table 1 is that entrepreneurship rates are higher for the lowest and highest levels of schooling, and lower for intermediate levels. Hence, the relationship between the entrepreneurship rate and educational attainment is U-shaped. This holds across data sources, time periods, and (some) countries, giving the regularity some support. Using recent data from the new Panel Study of Entrepreneurial Dynamics (PSED), Campbell and De Nardi (2009) also find a U-shape of the probability of being in the process of starting a business with respect to schooling (see their Figure 2).

Econometric exercises show that these differences are not simply due to e.g. cohort effects. The U-shape in education persists when regressing the probability of being an entrepreneur on a set of demographics using discrete choice models. This is found both by Blanchflower (2000) in data across 19 OECD countries, and by Schjerning and Le Maire (2007) in Danish data, using very fine education categories. Combining data from Eurobarometer Surveys and General Social Surveys for 1975 to 1996 for individuals aged 16-64, Blanchflower finds that controlling for age, education, gender, household size, the number of children under the age of 15 in the household and the gender-specific country unemployment rate, "the least educated (age left school $<$ age 15) and the most educated (age left school $>$ 22 years) have the highest probabilities of being self-employed" (p. 488). This pattern is statistically significant.[5] A similar pattern arises in results reported in Section 5 of this paper. Similarly, Schjerning and Le Maire, controlling for age, wealth, number of children by age, marital status, immigrant status and origin, and the spouse's self-employment status still find that the probability of being self-employed is lowest for the intermediate education categories of post secondary education and a short cycle of higher education, and higher at the extremes. A linear specification for education would not be able to pick this up. Evans and Leighton (1989) for instance, using years of schooling as a measure of education, do not find it to be significant when controlling for urban vs rural, experience, unemployment status, father's occupation, and some sectors.

As far as the evidence goes, the U-shaped relationship between entrepreneurship and educational attainment hence emerges robustly. In spite of this, it has received no systematic attention in the previous literature. The lower end of the U carries substantial weight:

Fact 2. *Most firms are small. Most of these firms remain small and, conditional on age, are not much more likely to exit than their larger counterparts.*

[5] Blanchflower considers different specifications, with similar results for education no matter whether the analysis includes only the self-employed and wage and salary earners or also the unemployed or the entire working age (16-65) population.

For instance, in the U.S., 55% of employer firms have less than 5 employees (Census Statistics of U.S. Businesses). Almost 90% of firms have less than 20 employees. In addition, there are around 10 million unincorporated self-employed, of whom only 13.6% have paid employees (Hipple 2010). The U.S. is not an outlier: firms with less than 20 employees account for more than 80% of all firms in the 16 developed, emerging and transition economies analyzed by Bartelsman, Haltiwanger and Scarpetta (2009, Table 6). While small firms are more likely to exit, the difference is small once age is controlled for (Bartelsman, Scarpetta and Schivardi 2003, Figure 6). Among 5-year old firms in the U.S., for example, the yearly exit probability for small firms (fewer than 20 employees) is just under 10%, while it is about 8% for large firms (100 or more employees). Numbers for other countries are similar. Hence, small firms are there to stay. They are not necessarily future large firms (although of course large firms tend to start small), nor are they doomed to disappear quickly. Their presence is not simply due to systematic size differences across industries either, as e.g. Foster, Haltiwanger and Krizan (2001) document that within-industry productivity dispersion dominates the productivity dispersion between industries.

In spite of the prevalence of small firms, most recent research attempting to match the firm size distribution has mainly focussed on the right tail of the distribution (see e.g. Luttmer 2007, Chatterjee and Rossi-Hansberg 2012), not paying much attention to the left tail. Indeed, popular models have problems accounting for just how small and persistent small firms can be. For instance, in settings like that of Hopenhayn (1992) and the many models based on it, a fixed cost or a uniform outside option imply that there is a strictly positive minimum firm size. Similarly, Lucas's (1978) seminal model of entrepreneurial choice predicts that only agents from the upper tail of the entrepreneurial ability distribution will enter the market. In the data, however, minimum firm size (measured in terms of employees) is zero, and not all entrepreneurs have high ability. Hence, estimated versions of such models have trouble accounting for small firms and their persistence. While this may not be a problem for all applications, it certainly should be taken into account in others, e.g. the analysis of entry. It may also affect quantification, as available data and model concepts may refer to different groups of firms. Heterogeneity in outside options could solve that problem, as shown below in the model.

Are all entrepreneurs out to pursue some golden opportunity? Despite the fact that many large firms started small, most firms stay small, and yet they persist. In fact,

Fact 3. *There is a substantial fraction of people who become entrepreneurs "out of necessity", and not to pursue an opportunity.*

This results from data collected through the Global Entrepreneurship Monitor (GEM) project in 47 industrialized and developing countries. Table 2 shows the fraction of people responding to "Are you involved in this start-up to take advantage of a business opportunity or because you have no better choices for work?" as "have no better choice". (For more details on the source, see the notes to the table.) Firms run by these "necessity entrepreneurs" are smaller, and their owners expect them to grow less than other firms (Poschke 2010).[6]

What stands out is that there is a substantial fraction of entrepreneurs "out of necessity" everywhere, even in industrialized countries. In most countries, the number is above 10%. The average for industrialized countries is 14.4%, and it is much higher in poorer countries. Hence, not all entrepreneurs are out to innovate or pursue a golden opportunity.

Table 2: Fraction of entrepreneurs starting a firm "out of necessity" (GEM data)

Western Europe		**other OECD**		**Latin America**	
Belgium	10.8%	Australia	16.7%	Argentina	39.1%
Denmark	6.1%	Canada	16.9%	Brazil	46.7%
Spain	16.4%	Japan	26.3%	*average*	42.9%
Finland	9.7%	New Zealand	13.5%		
France	23.0%	USA	12.3%	**Asia**	
Germany	26.5%	*average*	17.1%	Singapore	15.7%
Iceland	7.1%				
Ireland	16.4%	**Transition Economies**		**Africa**	
Italy	13.5%	Croatia	37.3%	South Africa	39.2%
Netherlands	10.2%	Hungary	33.0%		
Norway	8.0%	Slovenia	19.3%		
Sweden	12.6%	*average*	29.9%		
UK	13.7%				
average	13.4%				

Notes: Tabulated data are from the macro overview data of the GEM, available on `http://www.entrepreneurship-sme.eu/`. The table shows country averages of the "Necessity Entrepreneurial Activity Index" for the period 2001 to 2005 for countries where observations for at least 4 years were available. The GEM is an academic research consortium led by London Business School and Babson College. Its data provide the broadest information on entrepreneurship across countries. The GEM survey targets people aged 18 to 64 years who are involved in some nascent entrepreneurial activity. The relevant group is identified in the context of household surveys.

Finally, it emerges very robustly from the recent literature on entrepreneurship (see e.g.

[6] Nevertheless, as that paper shows, there are "necessity entrepreneurs" in all firm size classes (the largest class in the survey being 20+ employees), and not all entrepreneurs running small firms declare doing so out of necessity. The mapping between small firms and necessity entrepreneurs therefore holds only on average.

Hamilton 2000, Moskowitz and Vissing-Jørgensen 2002) that:

Fact 4. *Returns to entrepreneurship have a much higher cross-sectional variance than wages.*

Whereas measurement issues pose serious problems in comparing the average return to entrepreneurship to that to wage work or to public equity (Hamilton 2000, Moskowitz and Vissing-Jørgensen 2002, Cagetti and De Nardi 2006), the difference in variance is so large, and largely immune to shifts in the mean, that there is no disagreement on it. To illustrate, in an early study, Borjas and Bronars (1989, Table 7) found that the standard deviation of log weekly income for the self-employed is up to twice that of wage-earners. Depending on the measure used for income from self-employment, it is between two and almost four in the sample from the SIPP used by Hamilton (2000, Table 3).

These four facts are related. They suggest that: entrepreneurs have very heterogeneous outside options, so some become entrepreneurs "out of necessity". These may (a conjecture) mainly be people with low levels of education. The firms they run most likely will remain small, if they manage to survive. Suppose that some variance in returns to entrepreneurship also arises from heterogeneous quality of projects. Finally suppose that, while any budding entrepreneur could end up running projects of varying return, those with higher education would on average run their projects better, or run better projects. Then it is clear that the fact that entrepreneurs come from the extremes of the ability distribution implies that the observed post-selection cross-sectional variance in returns will be high relative to the variance in returns any individual might face. Hence, selection from the extremes of the ability distribution, arising from heterogeneous outside options, increases observed variance in returns to entrepreneurship.

The model developed in the next section shows how selection from the extremes can occur naturally in a simple, general setting. It also matches the other facts. Moreover, it suggests that one-sided selection models, as usually employed in empirical work, will only capture part of the selection mechanism.

3 The economy

Time is discrete. The economy consists of a continuum of risk-neutral individuals of measure 1. They derive utility from consumption, and can earn income either as workers or by running their own firm. Every period, they die with probability $\lambda > 0$, and a measure λ of people newly enter the labor market. When an entrepreneur dies, the firm is dissolved. Employees can however immediately find a new job on a competitive labor market. Future utility is discounted at a rate $r > 0$. Combined with the retirement probability, this implies discounting future utility using a discount factor $\beta = (1-\lambda)/(1+r) \in (0,1)$.

Firms produce a homogeneous good, which is used as the numéraire. They produce output with the production function

$$y(s,n) = sn^{\gamma}, \quad 0 < \gamma < 1. \tag{1}$$

This production function combines as inputs one manager/owner, who is essential to operate the firm, with a labor input of n efficiency units. (Any individual can run at most one firm at any moment in time.) Production exhibits decreasing returns to scale in the only variable input, labor, so that optimal firm size is finite.[7] This could be due for instance to limits in managers' span of control (Lucas 1978): as activity expands, it becomes more difficult to control, and the marginal product of the variable factor diminishes. Firms differ in their total factor productivity s, which is constant over time for a given firm. Optimal choice of the labor input n implies that period profits are strictly increasing in s and strictly decreasing in wages.

While firms differ in their productivity, individuals differ in their productive ability a. In the following, this will be referred to as "ability" for short, to distinguish it from productivity, which is a firm-level concept. Ability a is observable. Workers are perfectly substitutable in production; a worker with ability a can provide a efficiency units of labor input. Assume that a is weakly positive and that its distribution in the population can be described by some continuous *pdf* $f(a)$ with finite, strictly positive mean and variance. Let the wage earned by a worker with ability a be $w(a)$. With perfectly substitutable labor inputs and a competitive labor market, the wage $w(a)$ equals ability a times a wage rate w, which is determined endogenously in general equilibrium.

In each period, individuals decide whether to work or to run a firm. If they choose to work, they earn a wage wa. Alternatively, they can start a new firm or continue to run an existing one (if applicable). For simplicity, assume that no entry investment is required.[8] The entry cost thus consists only in foregone wages. A would-be entrepreneur can start a firm by putting into practice some business idea. This implies drawing a level of productivity from some known

[7] The setting is easy to extend to include a variable capital input. As long as the sum of the elasticities of output with respect to capital and labor is strictly below one, the necessity of the fixed managerial input still ensures decreasing returns to variable inputs, guaranteeing finite optimal firm size. See Section 4.2 and Appendix B.3 for a brief exploration.

[8] A case with production with capital and labor and a sunk investment in capital upon entry is analyzed in Section 4.2 and in Appendix B.3, with largely similar results.

distribution that depends on a. Once productivity has been revealed, the entrepreneur decides whether to produce in the following period or to close down the firm.

This formulation allows to incorporate two realistic features: First, it is hard to precisely assess the quality of a project before starting a firm,[9] and second, more able (higher a) individuals may be better at running firms, either because they have better ideas or because there are some general skills which are useful both in employment and for running a firm. Concretely, assume that at startup, entrepreneurs with ability a draw their firm's productivity s from some distribution with continuously differentiable *cdf* $\Phi^a(s)$ with full support in $\mathbb{R}$, where a enters as a parameter. All these distributions are identical up to a translation of location that is given by a monotonic, twice differentiable function $g(a)$. Then $\Phi^a(s) = \Phi^{a'}\{s - [g(a) - g(a')]\}$ for any a and a'. If $g'(a) > 0$, higher-ability entrepreneurs draw from better distributions in a first order stochastic dominance sense. Higher moments are not affected by a. To simplify expressions later on, it is useful to define $H(\cdot) = \Phi^{a_0}(\cdot)$, where a_0 is the a such that $g(a_0) = 0$. Then $\Phi^a(s) = H[s - g(a)]$ for any a and s.[10]

Definition. *A competitive equilibrium in this economy consists of a wage rate w and a distribution of agents over activities such that taking prices and wages as given, agents choose their occupation optimally, firms choose employment to maximize profits, and the labor market clears. The firm productivity distribution is then directly determined by the distribution of agents over activities and their optimal occupational choice.*

4 Occupational choice

The occupational choice problem has the following basic structure. Starting a firm is optimal if it yields higher value than employment. Because both the wage and expected productivity are

[9] Theoretically, this point has been made many times, see for instance Jovanovic (1982). The clearest supporting evidence comes from high failure rates of young firms, which have been amply documented. For instance, Table 3 below shows that in the NLSY79 data used in this paper, almost half the enterprises last only one year. For some recent estimates of survival hazards for incorporated firms in different countries see e.g. Bartelsman et al. (2003).

[10] What are plausible shapes for $g(a)$? To obtain examples, consider some assumptions on the joint distribution of a and s; these imply a shape for g. Two typical assumptions in related settings, bivariate normality or log-normality, suggest linear or weakly convex g: If a and s are jointly normally distributed with correlation ρ, g is linear in a. If $\ln a$ and $\ln s$ are jointly normally distributed with correlation $\rho > 0$ and variance $\tilde{\sigma}_a$ and $\tilde{\sigma}_s$, respectively, g is weakly convex in a if $\tilde{\sigma}_s \rho \geq \tilde{\sigma}_a$. Because of selection, these parameters are not directly observed, but the high pre-entry uncertainty about productivity (even conditional on knowledge about a) suggested by high failure rates of young firms suggests that this condition may well hold. See also Section 4.1 for a discussion of empirical evidence suggesting that $g(a)$ is unlikely to be concave.

functions of a, the value of both choices depends on a. As a consequence, occupational choice also only depends on a and on the aggregate variable w.

Every period, new labor force entrants face their first occupational choice, while the remaining agents decide whether to change activity. For instance, someone who ran a firm in the previous period will pursue that concern further if this yields a higher value than looking for a job or trying out a different project. Switching is never optimal: in the stationary environment considered here, any startup has the same expected value conditional on a, so anyone who once prefers starting a firm to working will do so again, even if the first project turned out to be unsuccessful. The option to start a new project, however, implies that entrants only continue if they are sufficiently productive. For someone who realizes that his business idea was not good, it is preferable to try out a new idea.

A starting entrepreneur's problem is thus analogous to a McCall (1970) search problem in the labor market. Someone who has decided that trying to start a firm is the optimal thing to do also has to decide which level of productivity is good enough to continue operating. The reason is that the entrepreneur can always decide to try a new project next period, at the cost of abandoning the current one. Let the value of running a firm with productivity s forever be $F(s)$. Let expected firm value for a potential entrant with ability a be $V(a)$. An entrepreneur who has just realized that his project has productivity s has two options: pursue it and get $F(s)$ next period, or try another project and get $V(a)$ next period. He is thus indifferent between the two actions if $F(s) = V(a)$. This defines a reservation productivity s_R: for draws of s above s_R it is optimal to continue, and for draws below s_R it is optimal to try a different project. Firm value at the reservation productivity satisfies

$$F(s_R(a)) = V(a) = \beta\mathbb{E}\{\max[F(s), F(s_R(a))]|a\}. \tag{2}$$

The expectation is conditional on a because the entrepreneur's ability determines the distribution from which s is drawn. Because different entrepreneurs face different distributions, the reservation productivity $s_R(a)$ is a function of a. By standard arguments, this equation in $s_R(a)$ has a unique solution.

Each agent's occupational choice problem then consists in comparing the value of starting a firm, $V(a)$, to the value of working. Denote the latter by $W(a)$. As a does not change over an individual's life, agents make the same choice every period, or we can think of them as making an occupational choice when entering the labor market. As the wage wa is linear in a, so is the value $W(a)$ of working forever. The shape of $V(a)$ then determines the pattern of occupational choice.

To derive it, first rewrite the expression for the reservation productivity in a way common in the search literature (see e.g. Ljungqvist and Sargent 2004) as

$$F(s_R(a)) = \frac{\beta}{1-\beta} \int_{s_R(a)}^{\infty} \left[F(s') - F(s_R(a))\right] \, \mathrm{d}\Phi^a(s'). \tag{3}$$

For a detailed derivation, see Appendix A.1. This equation characterizes the reservation productivity as the level of s at which the marginal cost and benefit of searching another period, or trying again, are just equal. A prospective entrepreneur running a project with productivity s who starts a new project foregoes the value of the current one, which is given by $F(s)$ on the left hand side (LHS) of equation (3). In return, the new project may be more productive than the old one. This potential gain is given by the expression on the right hand side (RHS). Therefore, denote the RHS by $MB(s, a)$ (for marginal benefit) for future reference. Figure 1 plots the two sides of equation (3) against the current draw of productivity, s. The cost of searching again increases in the current draw s and is given by the upward-sloping line. The benefit falls in s, as shown for instance in Ljungqvist and Sargent (2004). The reason is that the higher the current draw, the lower the probability that a subsequent draw is better, and the lower the marginal gain from such a better draw. The downward-sloping lines trace out the benefit for three different levels of a for the case of $g'(a) > 0$. At the reservation productivity $s_R(a)$, the marginal cost and benefit are equal; for s below it, continuing to search is optimal, while for s above it, accepting the current draw is optimal.

How do the reservation productivity and entry value vary with a? This clearly depends on $g(a)$. Note first that if all agents, no matter their ability, face the same productivity distribution ($g'(a) = 0$), the marginal benefit of drawing again is independent of a. As a consequence, the reservation productivity s_R is also independent of a, as is the value of trying. This value must be strictly positive for the labor market to clear. Otherwise (if $V \leq 0$), all agents would desire to become workers, but there would not be any firms demanding labor. With $V > 0$ and $W(a)$ increasing monotonically from zero to infinity, there is a unique value of a at which $V = W(a)$. Denote this value by a_L. Agents with $a \leq a_L$ start firms, while agents with $a > a_L$ become workers. If everyone faces the same opportunities as an entrepreneur but opportunities in employment differ, the least able workers choose entrepreneurship.

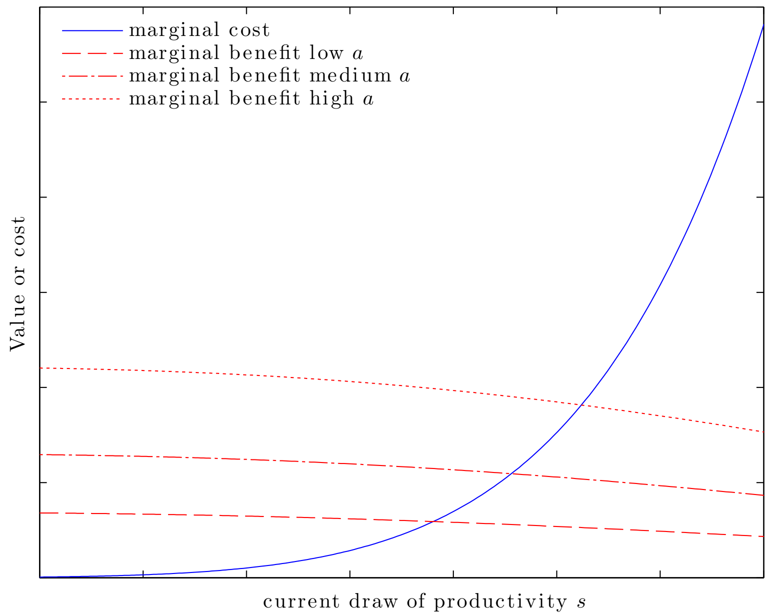

Figure 1: Determination of the reservation productivity: marginal cost and marginal benefit of drawing again if $g'(a) > 0$

Note: The graph is drawn for the following functional forms and parameter values: $\ln a$ is $N(\mu_a, \sigma_a)$ with $\mu_a = 0$ and $\sigma_a = 0.6$. $\ln s$ is $N(g(a), \sigma_\alpha)$ with $g(a) = \rho\sigma_\alpha a$, $\rho = 0.5$ and $\sigma_\alpha = 0.25$. In addition, $\gamma = 0.85$, $\lambda = 1/40$, $r = 0.05$. The three values of a are 0.5, 1 and 1.5.

The more interesting and intuitively appealing case is that in which $g'(a) > 0$, and more able workers on average also are better entrepreneurs. To obtain the shape of $V(a)$ for that case, first rewrite the marginal benefit of trying again, using the properties of Φ^a:

$$MB(s,a) = \frac{\beta}{1-\beta}\int_s^\infty [F(s') - F(s)]\mathrm{d}\Phi^a(s') = \frac{\beta}{1-\beta}\int_{s-g(a)}^\infty \left[F(s'+g(a)) - F(s)\right]\mathrm{d}H(s'), \quad (4)$$

where s is the productivity draw currently in hand, and s' is next period's draw. Written this way, ability a affects the payoff and the cutoff instead of the distribution. By the properties of the production function, g and H, MB is continuously differentiable. By equation (3), this carries over to $F(s_R(a))$ and to $V(a)$. Taking the first derivative of MB with respect to a yields

$$\frac{\partial MB}{\partial a} = \frac{\beta}{1-\beta}\int_{s-g(a)}^\infty F'(s'+g(a))\, g'(a)\, \mathrm{d}H(s'). \quad (5)$$

As firm value increases in productivity ($F' > 0$), this expression has the same sign as $g'(a)$.

Hence, in Figure 1, an increase in a shifts the marginal benefit line up if $g' > 0$. As a result, both the reservation productivity $s_R(a)$ and the value of trying $V(a)$ increase in a. (If $g' < 0$, both fall in a, resulting again in the least able workers becoming entrepreneurs, as in the case with $g' = 0$.)

The second derivative of *MB* with respect to a is

$$\begin{aligned}\frac{\partial^2 MB}{\partial a^2} =& \frac{\beta}{1-\beta}\left\{\int_{s-g(a)}^{\infty}\left[F'(s'+g(a))\; g''(a) + F''(s'+g(a))\; g'(a)^2\right]\, \mathrm{d}H(s')\right. \\ & \left. + F'(s)\; g'(a)^2\; h(s-g(a))\right\}\end{aligned} \tag{6}$$

where $h(s) \equiv H'(s)$, the *pdf* associated to H. The first two terms on the left hand side of (6) give the effect of the shapes of F and g on *MB*, whereas the last one results from the higher probability of exceeding any given threshold that comes with a higher a. Because of this last term, the marginal benefit of trying again is convex in a for any fixed threshold s if g is weakly convex. While the assumptions on technology also imply $F'' > 0$, this is not needed for convexity of *MB*. The driving factor is that drawing from a better distribution not only raises expected productivity, but also raises the probability of exceeding any given threshold.[11]

As *MB* is convex in a for any given threshold s, this is also the case for $F(s_R(a))$ and thus for $V(a)$. The implications for the reservation productivity depend on the shape of F. Note again that convexity of $V(a)$ does not rely on convexity of F or g; it is purely due to the opportunity to search and to reject low draws. (Evidently, convexity of F or g would make V more convex.)[12]

To obtain the main results on occupational choice, some last results on the limits of V are required. First of all, $V(0) > 0$ as long as $\Phi^0(0) < 1$, i.e. there is some probability of drawing an $s > 0$ even if $a = 0$. This is ensured trivially by the assumption that H has full support in $\mathbb{R}$. It carries over to Φ^a $\forall a$, and thus to Φ^0. Hence, $V(0) > W(0)$ because of the ability to search. Agents with very low ability become entrepreneurs.[13] However, for the labor market to clear, not all agents can become entrepreneurs. Together with continuity of V and W, this implies that there is a threshold a_L such that agents with $a \leq a_L$ become entrepreneurs.

[11] The three marginal benefits lines in Figure 1 also display this convexity: for a given current draw s, the marginal benefit increases more when moving from medium to high a than when moving from low to medium a.

[12] Also, by continuity, V still is convex with F linear and g slightly concave; so g linear is a stricter bound than actually required.

[13] Convexity of the return function and ex ante unknown productivity alone also yield $\mathbb{E}F(s) > F(\mathbb{E}s)$ by Jensen's inequality. If for instance $g(0) = 0$, this would also deliver entrepreneurship by low-ability agents. The result in the text does not rely on the shape of F and thus is more general. See also the discussion in Section 4.3.

At the upper end of the ability distribution, a similar threshold a_H such that agents with $a \geq a_H$ become entrepreneurs exists if V is strictly convex in a for all a, including in the limit. This is the case if either F is strictly convex (as it is under very general assumptions on technology, e.g. $\gamma > 0$ in the present context), if g is strictly convex, or if $\lim_{a \to \infty} h(s - g(a)) > 0$.[14]

Figure 2 plots V and W against a. The following proposition summarizes the results.

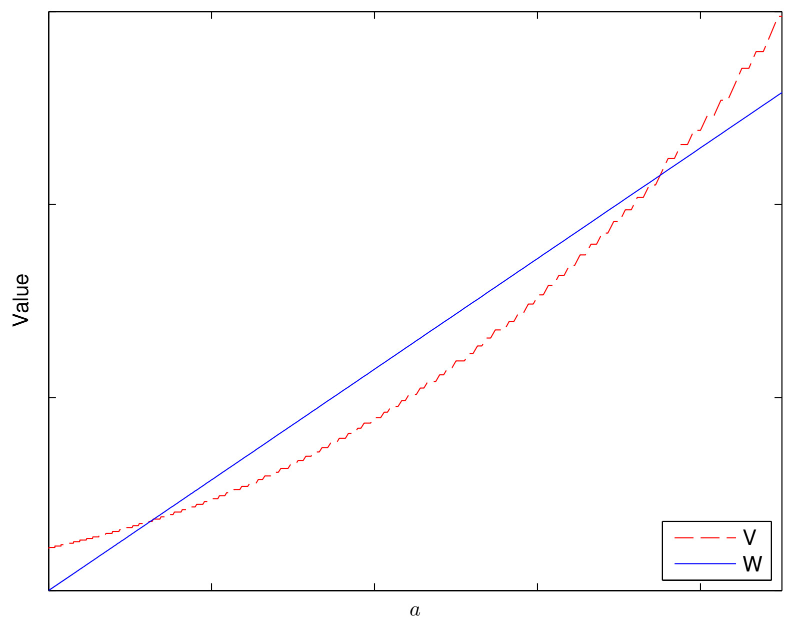

Figure 2: The value of starting a firm ($V(a)$, convex line) and of working ($W(a)$, straight line)

Note: The graph is drawn for the following functional forms and parameter values: $\ln a$ is $N(\mu_a, \sigma_a)$ with $\mu_a = 0$ and $\sigma_a = 0.6$. $\ln s$ is $N(g(a), \sigma_\alpha)$ with $g(a) = \rho\sigma_\alpha a$, $\rho = 0.5$ and $\sigma_\alpha = 0.25$. In addition, $\gamma = 0.85$, $\lambda = 1/40$, $r = 0.05$.

Proposition 1. ***Occupational choice:***

1. *If $g'(a) = 0$, the value of starting a firm is independent of ability. Then there is a threshold a_L such that agents with $a \leq a_L$ start firms and agents with $a > a_L$ become workers.*

2. *If $g'(a) < 0$, the reservation productivity $s_R(a)$ and the value of starting a firm fall in a.*

[14] Given that high-ability entrepreneurs exist, these conditions do not appear restrictive. They are added since if g and F are linear, strict convexity of V depends on $h(s - g(a))$ being strictly positive. If instead $h(s - g(a))$ goes to zero as a approaches infinity, higher ability does not increase success probability at very high levels of a. This implies that MB asymptotes to a linear function, in which case the threshold a_H may not exist. Any one of the three conditions prevents this.

Then there is a threshold a_L such that agents with $a \leq a_L$ start firms and agents with $a > a_L$ become workers.

3. *If $g'(a) > 0$, the reservation productivity $s_R(a)$ and the value of starting a firm, $V(a)$, increase in a. If $F''(s) \geq 0$ ($\gamma \in [0, 1)$) and $g'' \geq 0$, $V(a)$ is convex in a. If in addition either one of the inequalities is strict or $\lim_{a\to\infty} h(s - g(a)) > 0$, then there are thresholds a_L and a_H ($a_L < a_H$) such that agents with $a \leq a_L$ or $a \geq a_H$ start firms and agents with $a_L < a < a_H$ become workers.*

In the following, I focus on the latter, most interesting case. In this case, entrepreneurship by low-ability agents is due to the ability to search for a good project, and to abandon bad ones. Entrepreneurship by high-ability agents is due to entrepreneurs' ability to leverage their productivity by adjusting variable inputs. As a result, more productive entrepreneurs choose to operate larger firms, and firm value increases more than linearly in productivity. Said differently, given sufficient variation in the returns of potential projects, people with very low value of participating in the labor market can always do better by searching for a good project – where "good" is relative to their own alternatives, not to other firms. Search puts a floor under how low the value of running a firm can be. As a result, if their own outside option is sufficiently low, it is optimal for these agents to continue running firms at the bottom of the economy-wide productivity distribution. Note that this holds no matter what the shape of $g(a)$ is. Search matters less at the high end of the ability distribution. More important is the ability to determine the scale of the business as a function of productivity. This possibility distinguishes entrepreneurship from other occupations and changes results compared to the standard Roy (1951) model (more on this below). The crucial economic features driving the result are hence: heterogeneous outside options, a positive relationship between ability and expected productivity, the ability to discard bad projects (for low-ability agents), and the ability to adjust inputs (for high-ability agents). The interaction of heterogeneous benefits with heterogeneous outside options generates selection into entrepreneurship from the extremes of the ability distribution.

Choosing a reservation productivity is equivalent to choosing success and failure probabilities. An additional result can be derived regarding how these vary with ability a. Consider only the case of $g' > 0$, where agents with higher earnings ability also face better productivity distributions. (If $g' = 0$, the reservation productivity is the same for all a.)

Proposition 2. ***Success probability:*** *If $g'(a) > 0$, the optimal success probability $1 - H(s_R(a) - g(a))$ increases in a, and $s'_R(a) < g'(a)$. As a consequence, in the population, entrepreneurs with* *high earnings ability reject fewer projects.*

Proof. The argument is straightforward for the case of linear F. The proof for convex F is more involved and is given in Appendix A.2. Suppose that F is linear. How does the optimal success probability $1-H$ vary with a? To start, suppose that it does not vary with a at all. This means that the change in $s_R(a)$ exactly compensates the change in $g(a)$ induced by a change in a. Now consider equation (3) and note that with linear F, the gain from a new draw depends only on how much this draw exceeds the old one, and does not depend on a, as F has the same slope everywhere. With the same success probability for all a, by the properties of Φ^a, the probability distribution of these gains does not change with a either. Hence, the marginal benefit of drawing again does not vary with a. The marginal cost $F(s_R)$, however, does, as $s_R(a)$ increases with a. As a result, a constant success probability cannot be optimal. Instead, s_R has to be adjusted such that the marginal benefit keeps step with the marginal cost. This can be achieved by raising s_R by less than the increase in g, increasing the success probability, thereby increasing the marginal benefit more and the marginal cost less than in the case with constant $1-H$. $s_R' < g'$ implies that $1-H(s_R-g)$ increases in a. ∎

Given occupational choices, the firm productivity distribution can easily be obtained by equating inflows and outflows of firms. Let $\nu(a,s)$ be the measure of firms of productivity s with an owner of ability a. Let the set of levels of a at which agents choose entrepreneurship be $\mathcal{E} \equiv \{a | a \leq a_L \vee a \geq a_H\}$. The measure of firms $\nu(a,s)$ then is positive only for $a \in \mathcal{E}$ (it is optimal for the owner to start a firm) and for $s \geq s_R(a)$ (the firm is productive enough so that the project is pursued). A fraction λ of these firms exit every period due to retirement. Entry comes from entrants to the labor market who choose to start a firm, or from entrepreneurs who previously attempted entry, but failed to generate a productive enough project. The inflow into $\nu(a,s)$ hence is

$$\begin{aligned} &\lambda f(a)\phi^a(s) + \lambda f(a)\phi^a(s)(1-\lambda)\Phi^a(s_R(a)) + \lambda f(a)\phi^a(s)(1-\lambda)^2\Phi^a(s_R(a))^2 + \dots \\ &= \frac{\lambda f(a)\phi^a(s)}{1-(1-\lambda)\Phi^a(s_R(a))} \end{aligned}$$

where $\phi^a(\cdot)$ is the *pdf* associated to $\Phi^a(\cdot)$. With an outflow of $\lambda\nu(a,s)$, the stock is given by

$$\nu(a,s) = \frac{f(a)\phi^a(s)}{1-(1-\lambda)\Phi^a(s_R(a))} \tag{7}$$

for $a \in \mathcal{E}$ and $s \geq s_R(a)$, and zero otherwise.

Note that while the owner ability distribution features two disjoint parts, this does not have to be the case for the firm productivity distribution. This is of course important, as the empirical distribution of productivity does not have a disjoint support. If a_L and a_H are not too far apart, some (relatively) high-productivity firms operated by low-ability people and borderline firms operated by agents just above a_H may have similar levels of productivity, in particular if the variance of productivity conditional on ability is high relative to the variance of ability in the population. Variation in the taste for running one's own business and in risk aversion, dimensions abstracted from in the model, would also help to smooth the owner ability distribution and, as a consequence, the firm productivity distribution. Note that while they would also help to explain the existence of small firms (some of them persist because some psychological benefits compensate the owner for lower income), they would not on their own explain the U-shaped relationship between education and entrepreneurship, so heterogeneous ability and selection remain crucial.

Aggregate demand for efficiency units of labor follows directly from the firm productivity distribution and the wage rate and is given by

$$\int_{a \in \mathcal{E}} \int_{s \geq s_R(a)} \left(\frac{s\gamma}{w} \right)^{\frac{1}{1-\gamma}} \nu(a,s) \, \mathrm{d}s \mathrm{d}a.$$

It increases in the number of firms and decreases in the wage rate. It goes to infinity as the wage rate goes to zero and goes to zero as the wage rate goes to infinity. Aggregate supply of efficiency units of labor is given by total efficiency units of labor of agents with $a \notin \mathcal{E}$, which is

$$\int_{a \notin \mathcal{E}} a \, f(a) \, \mathrm{d}a.$$

As a higher wage makes $W(a)$ steeper and reduces $V(a)$ for all a, it shifts a_L and a_H outwards, increasing the measure of the complement of $\mathcal{E}$ and thereby labor supply. Aggregate labor supply goes to zero as the wage rate goes to zero (all agents choose entrepreneurship) and goes to $\int_a af(a)\mathrm{d}a > 0$ as the wage rate goes to infinity (all agents choose employment). There thus is a unique value of the wage rate at which the labor market clears, given optimal occupational choice and employment decisions.

4.1 Matching the facts

The model presented here qualitatively matches all the facts on entrepreneurship described in Section 2. In particular, by Proposition 1.3, it matches the fact that entrepreneurs are more likely to come from both extremes of the ability distribution (Fact 1) – in contrast to all other work on firm heterogeneity. As a consequence, it explains the persistence and potentially also the prominence of small, low-profit firms (Facts 2 and 3). These firms continue in the market because their owners' outside options in the labor market are even lower. This effect is particularly strong in industries with low entry costs. Another consequence of selection from the extremes is that the variance of returns to entrepreneurship is higher than that of wages (Fact 4).

For the model to match the facts, the shape of $g(a)$ is central. Unfortunately, it is hard to observe it empirically. The information that exists, however, appears consistent with $g(a)$ being increasing and at least weakly convex. First of all, empirical work shows that more educated individuals on average earn both higher wages and higher profits as entrepreneurs (see e.g. Evans and Leighton (1989), Hamilton (2000)). The positive correlation between payoffs in the two activities suggests that $g'(a) > 0$. Rosen (1982) makes a similar assumption. Secondly, Hamilton (2000, Table 4) shows that "Less educated entrepreneurs generally suffer a smaller earnings penalty than wage workers" (p. 615). More highly educated entrepreneurs, in contrast, earn a premium in many of the specifications he considers. The earnings-education profile for entrepreneurs thus is more convex than that for workers. While this does not constitute conclusive evidence on the shape of $g(a)$, it at least suggests that $g(a)$ is unlikely to be very concave.

At a more fundamental level, the key feature in the present model that allows matching Fact 1 is the heterogeneity of outside options.[15] The existence of small firms also follows from here. Their persistence, in contrast, follows from the stylized assumption of constant s in active firms. This of course also delivers independence of employment growth from size conditional on age as documented by Haltiwanger et al. (2010) and the weak relationship between size and exit probability conditional on age shown in Bartelsman et al. (2003, Figure 6). This is in contrast to the typical pattern often seen in models of firm dynamics, where small firms are more likely to exit because they are closer to the exit threshold, which is common across firms. While constant s of course generates persistence in a quite direct way, it should be noted that even

[15] Cagetti and De Nardi (2006) and Poschke (2011) also allow for heterogeneous outside options. Yet, the former assume that active firms have common productivity (though different size because of financial frictions). As a consequence, there are hardly any small firms. The latter focusses on cross-country patterns and does not consider search.

with constant s, low-productivity firms would not persist if it weren't for the key feature of heterogeneous outside options.[16]

Other explanations can explain some of the four facts, in particular sometimes Facts 2 to 4, but not Fact 1. The basic problem is that in settings like the seminal models by Lucas (1978) or Kihlstrom and Laffont (1979), the presence of a uniform outside option implies selection of entrepreneurs from one side of a distribution only, be it a distribution of entrepreneurial ability or risk aversion. Even in Gollin (2007), who has explicitly incorporated self-employment into Lucas's (1978) model and can thereby explain persistent existence of a potentially large number of small firms, the agents who choose self-employment have higher earnings ability than those choosing employment, in contrast to Fact 1. D'Erasmo and Moscoso Boedo (2012) can generate a "missing middle" of the firm size distribution and thereby get close to Fact 1. Still, in their setting, this arises only in countries with inefficient institutions. Moreover, the minimum firm size in their setting is strictly positive due to the presence of a fixed operating cost.

Moskowitz and Vissing-Jørgensen (2002) discuss some alternative explanations for the fact that a substantial fraction of firms generates low returns on investment, their main candidate being unmeasured returns. Hamilton (2000) and Hurst and Pugsley (forthcoming) also argue that these are important. The presence of unmeasured returns seems plausible and could explain Facts 2 and 3, but does not explain Fact 1.

4.2 Entry Costs

The main text abstracts from entry costs for new businesses.[17] Such costs can be administrative or serve to finance some sunk investment. They add to the entry cost in terms of foregone wages that is always present. In general, additional entry costs reduce the value of entry and thus affect the occupational choice decision. By shifting down the MB line in Figure 1, they lead to both a lower reservation productivity $s_R(a)$ and lower expected value of entry $V(a)$. This shifts the thresholds a_L and a_H outwards. For high enough entry costs, a_L may reach the lower bound of a. Entrepreneurship is attractive to low-ability agents if they can search for a good project. Entry costs can make search prohibitively costly for them.

[16] Hintermaier and Steinberger (2005) argue that low returns in some firms can be interpreted as entrepreneurs' investment into information acquisition about their own entrepreneurial ability. While their argument can explain why low returns occur, it is not sufficient for explaining the persistence of small low-profit firms. Once the information is extracted, only successful firms should continue.

[17] Robustness to the properties of the productivity distribution and to the asymmetry that productivity is ex ante unknown while wages are known is treated in Sections B.1 and B.2 in the Appendix.

The effect of entry costs is weaker in two particular cases of interest: administrative entry costs and sunk investment. First consider administrative entry costs. The effect outlined in the previous paragraph arises if all firms are subject to the same level of entry costs. However, small firms, in particular in poor countries, often operate in the informal sector, thereby dodging administrative costs.[18] If the optimal size of firms around a_L is low enough that these firms find it optimal to operate informally and changes in entry costs thus affect only large firms, entry costs only raise a_H, thereby reducing the fraction of entrepreneurs with high earnings ability. Since poorer countries tend to have higher administrative entry costs and larger informal sectors (Moscoso Boedo and Mukoyama 2012, D'Erasmo and Moscoso Boedo 2012), this is qualitatively in line with the larger share of "necessity entrepreneurs" in poor countries shown in Table 2.

Secondly, suppose that output is produced with capital and labor, and that the capital stock is irreversibly chosen upon entry. Thus, the capital stock cannot be modified, or capital sold, during the life of the firm. Investment then is sunk and constitutes an entry cost.[19] Appendix B.3 gives the details of this scenario and derives results. It shows that the value of entry is still convex in a. In addition, individuals with lower a expect to run smaller businesses and thus invest less, implying a smaller cost of entry for them, endogenously reducing the effect of entry costs on occupational choice. As a consequence, for $g' > 0, g'' > b, b < 0$, it will still be individuals from the extremes of the ability distribution who become entrepreneurs. Individuals with $a = 0$ become entrepreneurs despite the entry cost if

$$\int_0^\infty F(s)\, \mathrm{d}H(s) \geq \beta^{\frac{1-\gamma_2}{-\gamma_1}}, \tag{8}$$

where γ_1 and γ_2 are the elasticities of output with respect to capital and labor, respectively. This condition is more stringent than that of $H(0) < 1$ that holds without entry costs. As the left hand side of (8) depends on both the conditional expectation and the variance of s, low-a individuals still become entrepreneurs if either $g(a)$ is high enough or if the variance of s conditional on a is high enough.

Empirical evidence gives support to these results. Lofstrom and Bates (2011) find that college-educated people are more likely to enter industries with high entry barriers, and that

[18]For instance, the seminal paper on the informal sector by Rauch (1991) models the sectoral choice decision by firms as one where paying the administrative cost allows (legally) operating at a larger scale.

[19]It is crucial here that the capital stock cannot be increased later on either. Otherwise, it would be optimal to invest little upon entry to minimize losses if exit turns out to be optimal once productivity is revealed, while retaining the possibility of topping up the capital stock if continuation turns out to be optimal. If the entry investment can be arbitrarily small, we are essentially back to the model without entry cost.

people with less education are more likely to enter low-barrier industries. Hurst and Lusardi (2004) show that entry investments are very low for most firms. According to data from the 1987 National Survey of Small Business Finances (NSSBF), 25% of new firms were started with less than \$5,000 in capital, and median starting capital was a mere \$22,700. Shane (2008) makes a similar point. These pieces of evidence indicate that choice of industry allows entrepreneurs some control over their entry investment, which is fairly small for most firms. It thus seems likely that the threshold in (8) is not binding. In sum, it appears that in realistic extensions of the basic model, the effect of entry costs on low-earnings ability entrepreneurs may be limited. A quantitative exploration would be an interesting avenue for further work but is beyond the scope of this paper.

4.3 Relationship to the Roy (1951) model of occupational choice

In the Roy (1951) model of occupational choice, the crucial condition governing that choice relates the correlation between agents' abilities in two sectors to the relative variance of those abilities. In that model, workers choose between two sectors of activity. Payoffs are known for each individual. In the population, they are bivariate lognormally distributed, with a correlation of ρ between the logarithms of the payoffs. Let the standard deviations of the logarithm of the random payoffs be σ_s and σ_a, respectively, and assume $\sigma_s > \sigma_a$. Then, if $\rho\sigma_s/\sigma_a \geq 1$, outputs are relatively highly correlated, and relatively productive workers tend to choose the sector with the higher variance.

In the model presented in this paper, the situation is different for two reasons: search, and the fact that one of the occupations is entrepreneurship. The direct counterpart of the Roy model condition would involve $g'(a)$, the variance of a in the population, and the conditional variance of s. However, in the Roy model, payoffs are linear in abilities. Here in contrast, the fact that one of the occupations is entrepreneurship implies that in that occupation, the payoff is convex in productivity. As a result, as long as the conditions in Proposition 1.3 hold, there always is a level of ability above which agents choose entrepreneurship, even if σ_s is very low.

At the lower end, search makes the difference. To see this more clearly, the model could be brought close to the Roy model by eliminating entrepreneurs' capacity to start again with a new project and restricting them to accept their first draw and to stay in business thereafter, thus eliminating the ability to search (certainly a draconian restriction). By Jensen's inequality, expected firm value $\mathbb{E}F(a)$ then is convex in s and bounded below by $F(\mathbb{E}(s|a))$. This implies that $\mathbb{E}F(0) > 0$ if $\mathbb{E}(s|0) = 0$, and low-a agents start firms. However, this is not a very strong result; entrepreneurship by low-a agents disappears if $\mathbb{E}(s|a)$ is sufficiently low. With search, this does not occur, because what matters is not expected firm value but the probability, or *possibility,* of a good draw – bad ones can simply be rejected.

With search and entrepreneurship, as long as there is a positive relationship between ability and expected productivity ($g' > 0$), both the size of g' and the relative variances of the returns lose importance. The partitioning of the population into occupations changes substantially. These simple extensions thus substantially affect the predictions of the model – allowing more complex predictions, in line with the facts.

5 Evidence

The model presented in this paper has two clear, empirically testable predictions. First, Proposition 1.3 states that individuals with relatively high or low potential wages in dependent employment are more likely to become entrepreneurs (under some conditions). Second, Proposition 2 states that among these, individuals with low potential wages are more likely to abandon a project to look for a better one. This section presents evidence on these predictions using data from the NLSY79.

The representative sample of the NLSY79 contains observations on 6111 individuals over the years 1979 to 2006. They are initially between 14 and 22 years old. Being just at the beginning of their labor market experience, all these individuals face occupational choices, making the NLSY79 a particularly suitable data set for analyzing the question at hand. To focus on the occupational choice, only individuals who are not in full-time education are considered for the analysis. Individuals are classified as entrepreneurs if they report being self-employed.[20]

Table 3 presents descriptive statistics. Wages are real hourly wages in 1983 dollars, deflated using the Consumer Price Index published by the Bureau of Labor Statistics. Observations below the 0.5th and above the 99.5th percentile of the real wage distribution are trimmed. This leaves wage data on 5975 individuals. Information on years of schooling is available for 5367 individuals, and information on the highest degree obtained for 5408 individuals.

Individuals who are entrepreneurs at some point in the sample period make up almost a third of the sample. They spend an average of 5 years, or almost 30% of the time they spend

[20] This includes the incorporated self-employed. Alternatives are public and private sector employment, being without pay, and working for a non-profit organization or in a family business. Not all entrepreneurs are incorporated or have employees.

Table 3: Descriptive Statistics

	mean	standard deviation	individuals	observations
average wage	7.56	3.82	5975	
years of schooling	13.43	2.78	5367	
experience	7.85	5.33	5949	113844
ever entrepreneur	0.30	0.46	5949	
duration	4.96	4.65	1807	
relative duration	0.28	0.30	1807	
share of one-year firms	0.45	0.45	1773	
average firm duration	3.34	3.17	1784	
currently entrepreneur	0.057	0.23	5949	113844
entry	0.024	0.15	5949	111990
exit	0.021	0.14	5949	111990
one-year firm	0.012	0.11	5949	106258

Notes: Entrepreneurs are all individuals who ever are self-employed or run a firm. Duration is number of observations of entrepreneurship, conditional on ever being an entrepreneur. Relative duration is duration divided by the total time spent in the labor market. Share of one year firms is share of firms operated by an entrepreneur that last only one year. Entry and exit are the proportion of individuals entering or exiting with a firm in an average year. One-year firms is the proportion of individuals entering with a firm and exiting again within the year. Wages are real hourly wages in 1983 dollars.

in the labor market, as entrepreneurs. While their average firm lasts somewhat longer than 3 years, almost half their firms do not make it past the first year. In an average year, 5.7% of individuals currently are running their own business, 2.4% attempt to enter with a firm, and 2% exit.

Table 4 shows a breakdown of the highest educational degree obtained for the whole sample, for entrepreneurs, and for non-entrepreneurs. In the last column, it also shows entrepreneurship rates for the different education groups. As is evident from the graphical representation of the same data in Figure 3, results from the NLSY79 are consistent with those from other surveys reported in Section 2: entrepreneurship rates are highest among individuals with relatively high or low education.[21]

These groups have very unequal size. The first column of Table 5 shows that the pattern

[21]Figure 5 in Appendix C shows that this also holds within many occupations. Exceptions are those where hardly anyone – employee or entrepreneur – has high education, like “Operatives and kindred” and “Laborers, except farm”.

Table 4: Entrepreneurship by educational attainment

highest degree	entrepreneurs	non-entrepreneurs	population	entrepreneurship rate
<HS	14.4%	10.4%	11.6%	37.3%
HS	55.3%	55.2%	55.2%	30.6%
<C	7.4%	8.6%	8.2%	27.3%
C	17.3%	17.9%	17.7%	30.1%
M	4.0%	6.4%	5.7%	21.2%
P	1.1%	1.2%	1.2%	28.1%
PhD	0.5%	0.3%	0.4%	42.1%

Notes: Degrees are: less than high school (<HS), high school (HS), less than college (<C), college (C), Master's degree (M), professional degree such as MD, LLD, DDS (P), PhD. The first three columns show the distribution of educational attainment within the occupational groups. The last column shows the proportion of entrepreneurs within each educational group.

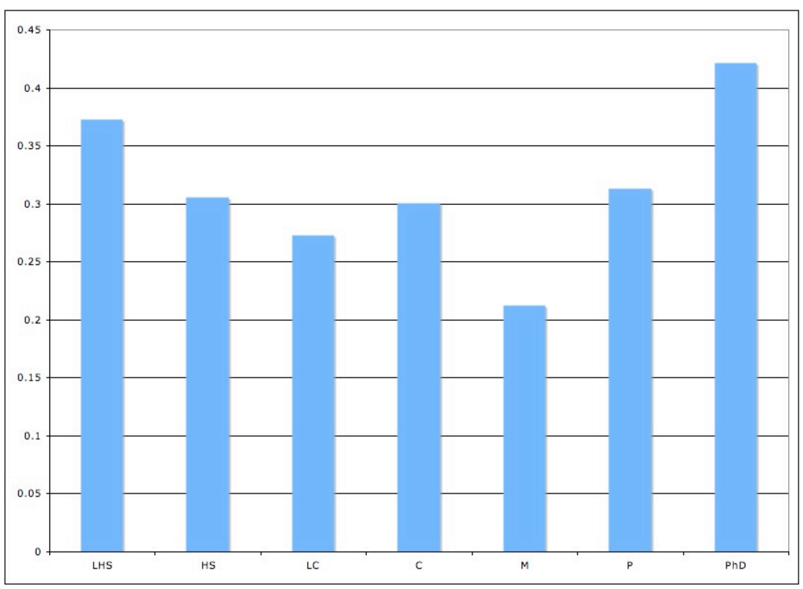

Figure 3: Entrepreneurship rate by educational attainment

Notes: Educational groups are: less than high school (<HS), high school (HS), less than college (<C), college (C), Master's degree (M), professional degree such as MD, LLD, DDS (P), PhD.

Table 5: Entrepreneurship by educational attainment – regression results

dependent variable	individual ever is entrepreneur (1)	time spent as entrepreneur (2)	individual becomes entrepreneur (3)	individual becomes entrepreneur (4)	individual becomes entrepreneur (5)
HS	-0.070 ***	-0.791 **	-0.006 ***	-0.007 ***	-0.004 **
	(0.020)	(0.319)	(0.002)	(0.002)	(0.002)
<C	-0.094 ***	-1.407 ***	-0.009 ***	-0.009 ***	-0.006 ***
	(0.025)	(0.466)	(0.002)	(0.002)	(0.002)
C	-0.074 ***	-1.012 ***	-0.003	-0.004 ***	-0.003
	(0.022)	(0.378)	(0.002)	(0.002)	(0.002)
M	-0.146 ***	-2.707 ***	-0.010 ***	-0.010 ***	-0.011 ***
	(0.025)	(0.554)	(0.002)	(0.002)	(0.002)
P	-0.087	-1.060	-0.005	-0.004	0.001
	(0.052)	(0.989)	(0.005)	(0.005)	(0.007)
PhD	0.040	-0.112	0.004	0.005	-0.005
	(0.108)	(1.645)	(0.010)	(0.010)	(0.009)
experience/100				0.273 ***	0.356 ***
				(0.033)	(0.055)
$(\text{experience}/100)^2$				-1.269 ***	-2.695 ***
				(0.171)	(0.384)
previous entrepreneurship					0.036 ***
					(0.003)
constant		-2.309 ***			
		(0.299)			
observations	5314	5314	100076	100076	64961
groups			5314	5314	5314

Notes: Less than high school (<HS) is the omitted group. Degrees are: high school (HS), less than college (<C), college (C), Master's degree (M), professional degree such as MD, LLD, DDS (P), PhD. Regression by probit in columns 1 and 3 to 5 (marginal effects reported), tobit in column 2. Standard errors in parentheses. Errors clustered at the individual level in columns 3 to 5. Stars indicate statistical significance at the 90% (*), 95 (**) and 99% (***) level, respectively.

persists when taking group sizes into account. It reports marginal effects from a probit regression of entrepreneurship on education group dummies. Individuals with intermediate education are significantly less likely to have tried entrepreneurship over the sample period. In contrast, for individuals with high education, the probability is not statistically significantly different from that for individuals in the lowest education group (the reference group, less than high school (<HS)). Column 2 reports results from a tobit regression showing that individuals with intermediate education also spend significantly less time in entrepreneurship. The pattern is similar for flows: column 3 shows that individuals with relatively high or low education are more likely to enter entrepreneurship. An exception here are college-educated individuals, for whom the entry probability is not statistically significantly different from that of individuals with less than high school. The pattern persists when also controlling for experience, computed as the time spent earning a wage or in entrepreneurship, and for previous entrepreneurship (columns 4 and 5).[22]

While schooling is of course closely related to potential earnings as an employee, the data contain a much better measure of this: wages actually earned. In the model, agents either become workers or attempt entrepreneurship, but never both. However, if for instance it takes time to come up with an entrepreneurial idea, agents may sometimes be workers, and sometimes attempt entrepreneurship. This feature is easy to incorporate into the model; occupational choice follows the same pattern as derived in Section 4, only that agents choosing entrepreneurship have to wait with entry until they come up with an idea, working in the meantime. While they work, their wages reflect their ability. Then the prediction of the model in terms of earnings ability directly translates into one in terms of wages: agents with relatively high or relatively low wages in employment are more likely to become entrepreneurs, while agents with intermediate wages remain workers.

As wages in employment are observable for almost everyone in the sample (only 3 individuals in the sample become entrepreneurs while never working as employees), it is straightforward to test the relationship between wages and entrepreneurship. Crucially, selection is on observables here. This and the fact that the analysis relies on only few, well-measured variables make results very robust. In particular, it is not necessary to use information on income obtained from entrepreneurship, avoiding all the associated measurement difficulties amply discussed in

[22] In a regression of entry on years of schooling (instead of the degree dummies), the coefficient on schooling is not significant. It becomes significantly negative (at the 90% level) when also controlling for a quadratic in experience and for previous entrepreneurship. (Results in Table 8 in Appendix C.) This is in line with the difficulty the empirical literature cited in Section 2 has with finding a stable relationship between education and entrepreneurship, and underlines the shortcomings of the linear specification of schooling.

Hamilton (2000), Moskowitz and Vissing-Jørgensen (2002) and Cagetti and De Nardi (2006).

Results for several ways of exploring the entrepreneurship-wage relationship are shown in Table 6. The first column shows results from a probit regression of ever being an entrepreneur on a quadratic in wages. The wage is the average real hourly wage earned by the individual when not active as an entrepreneur. The quadratic shape is very significant. Fitted values are plotted in Figure 4; it is clear that the probability of ever being an entrepreneur is highest at the extremes of the wage distribution. Individuals at the extremes of the wage distribution also spend significantly more time in entrepreneurship (column 2), and are significantly more likely to enter entrepreneurship in any given period (column 3). This persists when controlling for experience or for previous entrepreneurship. Previous entrepreneurship is strongly associated with renewed entry. Controlling for it weakens the significance level of the wage. This is of course to be expected, as previous entrepreneurship was already driven by ability and therefore soaks up the effect of the wage.[23]

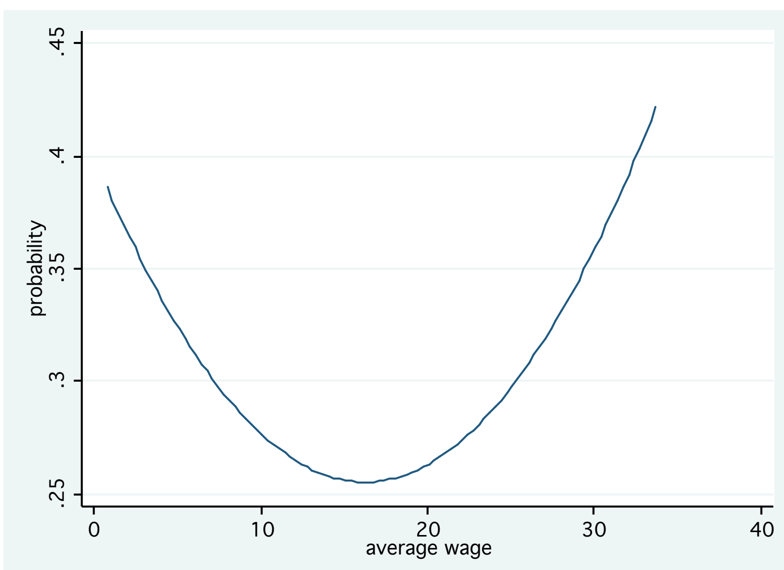

Figure 4: Predicted probability of ever being an entrepreneur as function of the wage

Notes: Fitted from Table 6, column 1. Wage is average real hourly wage of individual when in dependent employment (1983 dollars).

The main prediction of the model is thus borne out very well by the NLSY79 data: individuals

[23]Linear probability models yield similar results. Schooling is not significant if included in the regression. Table 9 in the Appendix shows that results are barely affected by including occupation controls.

Table 6: Entrepreneurship and wages in previous employment – regression results

dependent variable	entrepreneur at least once (1)		time spent as entrepreneur (2)		enter entrepreneurship (3)		enter entrepreneurship (4)		enter entrepreneurship (5)	
wage/10	-0.179	***	-2.238	***	-0.009	**	-0.010	***	-0.005	
	(0.047)		(0.709)		(0.004)		(0.004)		(0.004)	
$(\text{wage}/10)^2$	0.055	***	0.735	**	0.004	***	0.004	***	0.002	*
	(0.020)		(0.297)		(0.001)		(0.001)		(0.001)	
experience/100							0.290	***	0.162	**
							(0.073)		(0.071)	
$(\text{experience}/100)^2$							-1.924	***	-1.437	***
							(0.469)		(0.453)	
previous entrepreneurship									0.034	***
									(0.003)	
constant			-2.001	***						
			(0.362)							
observations	5949		5949		55964		55964		55964	
groups					5898		5898		5898	

Notes: Wage is average real hourly wage of individual when in dependent employment in the first two columns, and lagged real hourly wage in columns 3 to 5 (all in 1983 dollars). Experience are periods spent either earning a wage or in entrepreneurship. Regression by probit in columns 1 and 3 to 5 (marginal effects reported), tobit in column 2. Standard errors in parentheses. Errors clustered at the individual level in columns 3 to 5. Stars indicate statistical significance at the 90% (*), 95 (**) and 99% (***) level, respectively.

with high or low earnings ability are more likely to become entrepreneurs, and those with intermediate earnings ability are more likely to become employees. Let us now turn to the second prediction. Proposition 2 says that conditional on entry, entrepreneurs with low earnings ability are more likely to reject projects. This can be tested using the sample of entrepreneurs only. Table 7 shows that the data support the prediction: the average wage is significantly negatively related to the share of an individual's firms that are active only for a single year (column 1).

The second column shows that firms run by individuals with high earnings ability live longer overall. However, the last column indicates that this effect is strongly related to the probability of surviving the first year: Controlling for the share of an entrepreneur's projects that survive the first year strongly reduces the effect of earnings ability. As predicted by the model, more early rejections are thus an important factor contributing to the shorter life of firms run by low-earnings ability entrepreneurs.[24]

The pattern in the data is exactly the one that obtains in the model, with low-earnings ability entrepreneurs rejecting more projects initially, but sticking to successful ones. Also note that, because the continuation threshold is an entrepreneur's choice, the regression results do not simply indicate that low-a entrepreneurs face worse productivity distributions and therefore exit more frequently but that, given the distributions they face, they set themselves more demanding continuation thresholds.

6 Concluding remarks

Entrepreneurs make up a substantial proportion of the labor force, and an important one to boot, as they employ others. There is substantial evidence, expanded in this paper, that they are more likely to come from the extremes of the schooling or wage distributions. The main contribution of this paper is to explain this by heterogeneity of labor market prospects (the relevant outside option), combined with search for an adequate project. The ability to reject bad projects puts a lower bound under the value of search. This is particularly valuable to low-ability agents. Because of the low value of their alternative option, it makes them more likely to opt for entrepreneurship. High-ability agents benefit from the ability to leverage high productivity by choosing variable inputs accordingly.

[24]Table 10 in Appendix C shows that the pattern also holds when using schooling instead of wages. For both schooling and wages, quadratic terms are not significant; the relationship is monotonic, as predicted by the model.

Table 7: Exit behavior and wages – regression results

dependent variable	share of one-year firms (1)	average firm life (2)	average firm life (3)
wage	-0.022 ***	0.093 ***	0.039 **
	(0.005)	(0.021)	(0.018)
share of one-year firms			-5.746 ***
			(0.181)
constant	0.211 ***	2.540 ***	4.900 ***
	(0.039)	(0.176)	(0.166)
observations	2501	2501	2501

Notes: Sample: individuals who enter entrepreneurship at least once. Wage is average real hourly wage of individual when in dependent employment (1983 dollars). Tobit regressions (censoring at 0 in column 1 and at 1 in columns 2 and 3). Standard errors in parentheses. Stars indicate statistical significance at the 90% (*), 95 (**) and 99% (***) level, respectively.

Selection into entrepreneurship from the extremes of the ability distribution naturally explains why the variance of returns to entrepreneurship is so much higher than the variance in wages. In addition, the model provides a plausible rationale for the existence and persistence of small firms. Its prediction that low-ability entrepreneurs are more selective in their search for a good project is borne out well by the data.

Enlarging the model, there are several promising avenues for further research. Policy makers often have a rosy view of entrepreneurship. Knowing that there is selection into entrepreneurship from the extremes of the ability distribution puts this into perspective. Some new entrepreneurs, but by no means all, may be the next Bill Gates (or, in a less glamorous industry, Sam Walton), creating large enterprises. Many new firms are small, and are going to remain small. (A point also made by Hurst and Pugsley (forthcoming).) To explore for instance the aggregate effect of entry subsidies for small enterprises or for entrepreneurship by the unemployed in such a setting, it is crucial to have a model that is able to explain entry at both ends of the distribution. While it would not be surprising to see that entry subsidies successfully encourage entry, it is not evident that they help productivity or welfare if many new entrants stem from the lower end. Another promising application of the model would be to the analysis of informality, in particular in transition economies and developing countries. (Table 2 shows the staggering extent of entrepreneurship "out of necessity" in some of these countries). As modeling the frictions inherent in these applications would substantially cloud the clarity of the exposition, these applications are left for future research.

Appendix

A Proofs and derivations

A.1 Derivation of equation (3):

Start from equation (2).

$$F(s_R(a)) = V(a) = \beta \left[\int_0^{s_R} F(s_R(a)) \mathrm{d}\Phi^a(s') + \int_{s_R}^{\infty} F(s') \mathrm{d}\Phi^a(s') \right]$$
$$(1-\beta) F(s_R(a)) \int_0^{s_R} \mathrm{d}\Phi^a(s') = \int_{s_R}^{\infty} [\beta F(s') - F(s_R(a))] \mathrm{d}\Phi^a(s')$$
$$F(s_R(a)) = \frac{\beta}{1-\beta} \int_{s_R}^{\infty} [F(s') - F(s_R(a))] \mathrm{d}\Phi^a(s').$$

A.2 Proof of Proposition 2.

Proposition 2 states that if $g' > 0$, entrepreneurs with higher a choose their reservation productivity s_R such that the success probability $\chi(a) \equiv 1 - H(s_R - g)$ is higher. This is shown in the text for linear F. The result relies on the fact that if $\chi(a)$ is kept constant, the marginal benefit from drawing again is the same for all a. With convex F, in contrast, the marginal benefit of drawing again increases with a even for constant χ because higher a moves the productivity distribution the agent faces to a more convex region of F, implying higher value gains for a given improvement in the draw of s. Still, the same result can be derived.

For this, combine equations (2) and (3) to get the following expression for the reservation productivity:

$$\frac{\beta}{1-\beta} \int_{s_R(a)-g(a)}^{\infty} [F(s' + g(a)) - F(s_R(a))] \, \mathrm{d}H(s') = F(s_R(a)).$$

Rearrange to get

$$\beta \int_{s_R - g}^{\infty} F(s' + g) \, \mathrm{d}H(s') = [1 - \beta H(s_R - g)] F(s_R), \tag{9}$$

omitting function arguments wherever this does not risk causing confusion. This relationship holds for all a. All functions involved in equation (9) are continuously differentiable. Then the derivatives of both sides with respect to a also have to be equal:

$$\beta \int_{s_R-g}^{\infty} F'(s'+g)g' \, \mathrm{d}H(s') - \beta h(s_R-g)F(s_R)(s_R'-g')$$
$$= [1-\beta H(s_R-g)]F'(s_R)s_R' - \beta h(s_R-g)(s_R'-g')F(s_R)$$

(where h is the *pdf* associated to H) or

$$\beta \int_{s_R-g}^{\infty} F'(s'+g)g' \, \mathrm{d}H(s') = [1-\beta H(s_R-g)]F'(s_R)s_R'.$$

This equation describes how s_R and the success probability $\chi(a) = 1 - H(s_R - g)$ evolve as a changes. To find how $s_R - g$ changes with a, rearrange and substitute using equation (9) to obtain

$$\int_{s_R-g}^{\infty} \frac{F'(s'+g)}{F'(s_R)} \frac{g'}{s_R'} \, \mathrm{d}H(s') = \int_{s_R-g}^{\infty} \frac{F(s'+g)}{F(s_R)} \, \mathrm{d}H(s').$$

A Taylor series expansion of the numerators around s_R up to the second derivative of F yields an approximation of this as

$$\frac{g'}{s_R'} \int_{s_R-g}^{\infty} \left[1 + (s'-s_R+g)\frac{F''(s_R)}{F'(s_R)}\right] \mathrm{d}H(s')$$
$$= \int_{s_R-g}^{\infty} \left[1 + (s'-s_R+g)\frac{F'(s_R)}{F(s_R)} + (s'-s_R+g)^2 \frac{F''(s_R)}{2F(s_R)}\right] \mathrm{d}H(s')$$

or

$$\left[\frac{g'}{s_R'} - 1\right] \chi(a) =$$
$$\int_{s_R-g}^{\infty} \left[(s'-s_R+g)\left[\frac{F'(s_R)}{F(s_R)} - \frac{g'}{s_R'}\frac{F''(s_R)}{F'(s_R)}\right] + (s'-s_R+g)^2 \frac{F''(s_R)}{2F(s_R)}\right] \mathrm{d}H(s'). \qquad (10)$$

With the production function $y = sn^{\gamma}$, $\gamma \in (0,1)$, this becomes

$$\left[\frac{g'}{s_R'} - 1\right] \chi(a) = \int_{s_R-g}^{\infty} \left[\frac{s'-s_R+g}{(1-\gamma)s_R}\left[1 - \frac{g'}{s_R'}\gamma\right] + \frac{(s'-s_R+g)^2}{2s_R^2}\frac{\gamma}{(1-\gamma)^2}\right] \mathrm{d}H(s').$$

Again, it is immediately clear that g' and s'_R cannot be equal, as otherwise the left hand side would be zero and the right hand side strictly positive. $g' < s'_R$ only worsens this. Hence, it must be that $s'_R < g'$.[25] Agents with higher earnings ability a choose higher success probabilities to compensate the higher cost of drawing again.

B Robustness checks

B.1 Properties of the distribution of s

The domain of s. The proof of Proposition 1.3 relied on H having full support in $\mathbb{R}$. Relaxing this only affects results in very particular cases. First of all, bounding s from below clearly preserves $\Phi^0(0) < 1$ and thus the main result. Bounding the support of H from above may eliminate $\Phi^0(0) < 1$ and thereby entrepreneurship by low-ability agents if $g(0)$ is low enough. However, this requires an upper bound on s at 0 or lower for ability-zero agents – a very restrictive assumption. Any higher bound preserves $\Phi^0(0) < 1$ and entrepreneurship by low-ability agents.

The variance of s. The derivations above have relied on the variance of s being independent of a – differences in a only affected the mean of the distribution of s. Let the standard deviation of s given a be $\sigma_{s|a}$. What if $\sigma_{s|a}$ varies systematically with a? As is typical in search settings, a mean-preserving spread in the search outcome raises the value of search (see e.g. Ljungqvist and Sargent (2004)). As a consequence, $V(a)$ becomes steeper if $\sigma_{s|a}$ increases in a. In this case, the occupational choice pattern is preserved as long as it is still the case that $\Phi^0(0) < 1$. In contrast, $V(a)$ becomes less steep if $\sigma_{s|a}$ decreases in a. This clearly still implies entrepreneurship by low-a agents. Yet, if $\sigma_{s|a}$ falls very strongly with a compared to $g(a)$, $V(a)$ may in principle be locally non-monotonic. In the limit, since $\sigma_{s|a}$ is bounded below by zero, $V(a)$ remains increasing and convex – preserving entrepreneurship by high-a agents – as long as g is strictly convex or, if $g'' = 0$, $\gamma > 0$ (implying that F is strictly convex). The same holds if the limit of $\sigma_{s|a}$ is strictly positive. In all these cases, equation (6) implies that $V(a)$ is strictly convex and low- and high-a agents choose entrepreneurship. Local non-monotonicities can in this case imply that there are some additional ranges of a where agents choose entrepreneurship.

[25] With this production function, a longer expansion yields the same result. Inspection of equation (10) shows that the result may not hold in cases where F''/F' is very large relative to F'/F at s_R, i.e. if the convexity of the value function increases strongly at some s. This cannot occur when the production function has constant elasticity with respect to the variable inputs.

B.2 Job search

If wages in employment are not known in advance, entrepreneurship by low-a agents persists if the variance of the wage distribution is not too high compared to that of the productivity distribution. Suppose that agents who go to the labor market search for jobs, and each period draw a wage offer from a distribution with mean wa and variance σ_a, as in the standard labor market version of McCall (1970) search.[26] By the equivalent of equation (6) for this problem, the value of going to the labor market with ability a, $W(a)$, then is convex in a because low offers can be rejected. In addition, because the value of drawing again increases in the variance of the distribution for any fixed current draw, $W(a)$ increases in σ_a.[27] As a consequence, for any σ_s, γ and w, there is a σ_a such that $W(0) = V(0)$. Let this be $\bar{\sigma}_a$. Then low-a agents become entrepreneurs only if $\sigma_a < \bar{\sigma}_a$, i.e. if the variance of the wage distribution is not too high. If σ_a is higher, low-a agents choose employment. High-a agents still choose entrepreneurship because of the convexity of the underlying return function. What matters for low-a agents is the relative upside potential (conditional on ability) in the two activities. As long as there is not too much (random) upside potential to dependent employment, low-a agents choose entrepreneurship. Empirically, this seems the more plausible scenario, as the variance in returns to entrepreneurship is known to be much larger than that in wages (Fact 4 in Section 2).

B.3 The model with investment upon entry

Suppose that output y is produced with the technology $y = sk^{\gamma_1}n^{\gamma_2}$, where s is TFP, k is capital, n is effective labor, and $\gamma_1, \gamma_2 \in (0,1), \gamma_1 + \gamma_2 < 1$. Entrepreneurs need to make their capital investment upon entry. This investment is sunk, and the capital stock fixed thereafter. Productivity is revealed only after this entry investment. In case of exit, make the extreme assumption that capital has no resale value. With these assumptions, the initial investment is completely sunk and constitutes an entry cost. Maximizing out n, the period profit function is

$$\pi(s,k) = s^{\frac{1}{1-\gamma_2}} k^{\frac{\gamma_1}{1-\gamma_2}} w^{\frac{-\gamma_2}{1-\gamma_2}} \tilde{\gamma},$$

[26] To keep things simple, consider just the partial equilibrium occupational choice decision here, i.e. neglect the determination of the wage distribution. Different wages for given a can arise due to heterogeneous match quality, as in Jovanovic (1979).

[27] This is implicit in the definition of *MB* and discussed in detail by Ljungqvist and Sargent (2004, p. 148).

where $\tilde{\gamma} = \gamma_2^{\frac{\gamma_2}{1-\gamma_2}} - \gamma_2^{\frac{1}{1-\gamma_2}}$. As in the main text, $F(s,k) = \pi(s,k)/(1-\beta)$. The expected value of starting a firm with capital k is

$$V(a,k) = \beta\mathbb{E}\{\max[F(s,k), \bar{V}(a)]|a\} - k,$$

where $\bar{V}$ stands for the expected value of starting a firm with the optimal level of capital. The first order condition for optimal choice of k is

$$\beta \int_{s_R}^{\infty} F_k(s,k)\, \mathrm{d}\Phi^a(s) = 1,$$

where F_k indicates the partial derivative with respect to k. In terms of primitives, this yields

$$k(a) = \left[\tilde{\gamma}\frac{\beta}{1-\beta}\frac{\gamma_1}{1-\gamma_2} w^{\frac{-\gamma_2}{1-\gamma_2}} \int_{s_R-g(a)}^{\infty} (s+g(a))^{\frac{1}{1-\gamma_2}}\, \mathrm{d}H(s)\right]^{\frac{1-\gamma_2}{1-\gamma_1-\gamma_2}} \tag{11}$$

or

$$k(a) = \frac{\beta\gamma_1}{1-\gamma_2}\int_{s_R-g(a)}^{\infty} F(s+g(a), k(a))\, \mathrm{d}H(s) \tag{12}$$

in terms of F.[28] It is clear from (11) that $k'(a) > 0$ if $g'(a) > 0$ and that $k''(a) > 0$ if $g''(a) > b, -\infty < b < 0$. The value of entry then is

$$\bar{V}(a) = \beta\mathbb{E}\{\max[F(s,k(a)), \bar{V}(a)]|a\} - k(a). \tag{13}$$

As in the main text, this is convex in a. The argument proceeds as before, by showing that the marginal benefit of drawing again as a function of a and the current draw s is convex in a at s_R. The expression for the marginal benefit here is

$$MB(s,a) = \frac{\beta}{1-\beta}\int_{s-g(a)}^{\infty} [F(s'+g(a), k(a)) - F(s,k(a))]\, \mathrm{d}H(s') - \frac{k(a)}{1-\beta}.$$

[28] As $F_{kk} < 0$, the second order condition is satisfied.

Its first derivative is

$$
\begin{aligned}
MB'(a) &= \frac{\beta}{1-\beta}\int_{s-g(a)}^{\infty}[F_s g'(a) + F_k k'(a)]\,\mathrm{d}H(s') - \frac{k'(a)}{1-\beta} \\
&= \frac{\beta}{1-\beta}\frac{1-\gamma_1-\gamma_2}{1-\gamma_2}\int_{s-g(a)}^{\infty}[F_s g'(a) + F_k k'(a)]\,\mathrm{d}H(s'),
\end{aligned}
$$

which is strictly positive for $g'(a) > 0$. The second derivative is

$$
\begin{aligned}
MB''(a) = \frac{\beta}{1-\beta}\frac{1-\gamma_1-\gamma_2}{1-\gamma_2}\cdot \\
\int_{s-g(a)}^{\infty}\left[F_s g''(a) + F_{ss}(g'(a))^2 + F_k k''(a) + F_{ks}g'(a)k'(a) + F_{kk}(k'(a))^2\right]\,\mathrm{d}H(s')
\end{aligned}
$$

Although $F_{kk} < 0$, the sum of the last two terms in the integral is zero at $s = s_R$.[29] Hence, if g is not too concave ($g'' > b, -\infty < b < 0$), the second derivative is positive at $s_R(a)$, and $MB(a)$ and hence $V(a)$ are convex in a.

Now consider the occupational choice decision for low a. Individuals with $a = 0$ do not become entrepreneurs if $\bar{V}(0) \leq W(0) = 0$. The equivalent of (3) with irreversible investment upon entry is

$$
\bar{V}(a) = \frac{\beta}{1-\beta}\int_{s_R}^{\infty}[F(s,k(a)) - \bar{V}(a)]\,\mathrm{d}\Phi^a(s) - \frac{k(a)}{1-\beta}
$$

Evaluating this at $\bar{V}(0) = 0$, substituting in k from (12) and realizing that $s_R(0,k(0)) = 0$ (because $\bar{V}(0) = 0$ implies $F(s_R, k(0)) = 0$) implies that entry value for individuals with $a = 0$

[29] The derivation is as follows. Omitting function arguments where this does not cause confusion, using $F_{ks} = \frac{1}{1-\gamma_2}\frac{1}{s}\frac{\gamma_1}{1-\gamma_2}\frac{F}{k}$ and $F_{kk} = \frac{-1+\gamma_1+\gamma+2}{1-\gamma_2}\frac{\gamma_1}{1-\gamma_2}\frac{F}{k^2}$, and taking the derivate of $k(a)$ with respect to a in (11), the last two terms can be rewritten as

$$
\begin{aligned}
&\int_{s-g(a)}[F_{ks}g'(a)k'(a) + F_{kk}(k'(a))^2]\,\mathrm{d}H(s) \\
&= \int_{s-g(a)}\frac{k'}{k}\frac{\gamma_1}{1-\gamma_2}F\cdot\left(\frac{g'}{s}\frac{1}{1-\gamma_2} - \frac{1-\gamma_1-\gamma_2}{1-\gamma_2}\frac{k'}{k}\right)\,\mathrm{d}H(s) \\
&= \frac{k'}{k}\frac{\gamma_1}{1-\gamma_2}\frac{g'}{1-\gamma_2}k^{\frac{\gamma_1}{1-\gamma_2}}w^{\frac{-\gamma_2}{1-\gamma_2}}\frac{\tilde{\gamma}}{1-\beta}\left\{\int_{s-g(a)}\left[s'^{\frac{\gamma_2}{1-\gamma_2}}\,\mathrm{d}H(s') - \frac{\int_{s_R-g(a)}s^{\frac{\gamma_2}{1-\gamma_2}}\,\mathrm{d}H(s)}{\int_{s_R-g(a)}s^{\frac{1}{1-\gamma_2}}\,\mathrm{d}H(s)}\int_{s-g(a)}s'^{\frac{1}{1-\gamma_2}}\right]\,\mathrm{d}H(s')\right\} \\
&= 0 \text{ for } s = s_R.
\end{aligned}
$$

is zero only if

$$\int_0 F(s)\, \mathrm{d}H(s) = \beta^{\frac{1-\gamma_2}{-\gamma_1}}.$$

It is easy to show that higher expected profits increase $\bar{V}(a)$. As a consequence, $\bar{V}(0) > 0$ and individuals with $a = 0$ become entrepreneurs only if the expected operating value F is larger than $\beta^{\frac{1-\gamma_2}{-\gamma_1}}$. This threshold increases in the elasticity of output with respect to capital, γ_1. Without the entry investment ($\gamma_1 = 0$), the threshold is zero.

C Additional tables and figures

Table 8: Entrepreneurial entry and schooling – regression results

	(1)		(2)		(3)	
years of	-0.029		-0.035		-0.041	*
schooling/100	(0.023)		(0.023)		(0.022)	
experience/100			0.301	***	0.353	***
			(0.033)		(0.054)	
$(\text{experience}/100)^2$			-1.416	***	-2.638	***
			(0.171)		(0.373)	
previous					0.037	***
entrepreneurship					(0.003)	
observations	99665		99665		64996	
groups	5275		5275		5275	

Notes: Dependent variable is dummy for entry into entrepreneurship. Regression by probit, marginal effects reported. Standard errors in parentheses. Errors clustered at the individual level. (Groups indicates number of individuals.) Stars indicate statistical significance at the 90% (*), 95 (**) and 99% (***) level, respectively.

Table 9: Entrepreneurial entry and wages – controlling for occupation

	(1)	(2)	(3)
wage/10	-0.008 **	-0.008 **	-0.005
	(0.004)	(0.004)	(0.004)
$(\text{wage}/10)^2$	0.004 ***	0.004 ***	0.002
	(0.001)	(0.001)	(0.001)
experience/100		0.269 ***	0.158 **
		(0.073)	(0.071)
$(\text{experience}/100)^2$		-1.830 ***	-1.408 ***
		(0.463)	(0.450)
previous entrepreneurship			0.029 ***
			(0.003)
occupation dummies	Yes	Yes	Yes
observations	55083	55083	55083
groups	5872	5872	5872

Notes: Wage is lagged real hourly wage when in dependent employment (1983 dollars). Experience are periods spent either earning a wage or in entrepreneurship. 12 occupation dummies are included. (Coefficients omitted. Occupations are: professional, technical and kindred; managers, officials and proprietors; sales workers; clerical and kindred; craftsmen, foremen and kindred; armed forces; operatives and kindred; laborers, except farm; farmers and farm managers; farm laborers and foreman; service workers, except private household; private household.) Regression by probit, marginal effects reported. Standard errors in parentheses. Errors clustered at the individual level. Stars indicate statistical significance at the 90% (*), 95 (**) and 99% (***) level, respectively.

Table 10: Exit behavior and schooling – regression results

dependent variable	share of one-year firms (1)	average firm life (2)	average firm life (3)
schooling	-0.030 ***	0.067 **	-0.003
	(0.007)	(0.032)	(0.028)
share of one-year firms			-5.686 ***
			(0.192)
constant	0.457 ***	2.297 ***	5.201 ***
	(0.090)	(0.429)	(0.383)
observations	2212	2212	2212

Notes: Sample: individuals who enter entrepreneurship at least once. Schooling in years. Tobit regressions (censoring at 0 in column 1, at 1 in columns 2 and 3). Standard errors in parentheses. Stars indicate statistical significance at the 90% (*), 95 (**) and 99% (***) level, respectively.

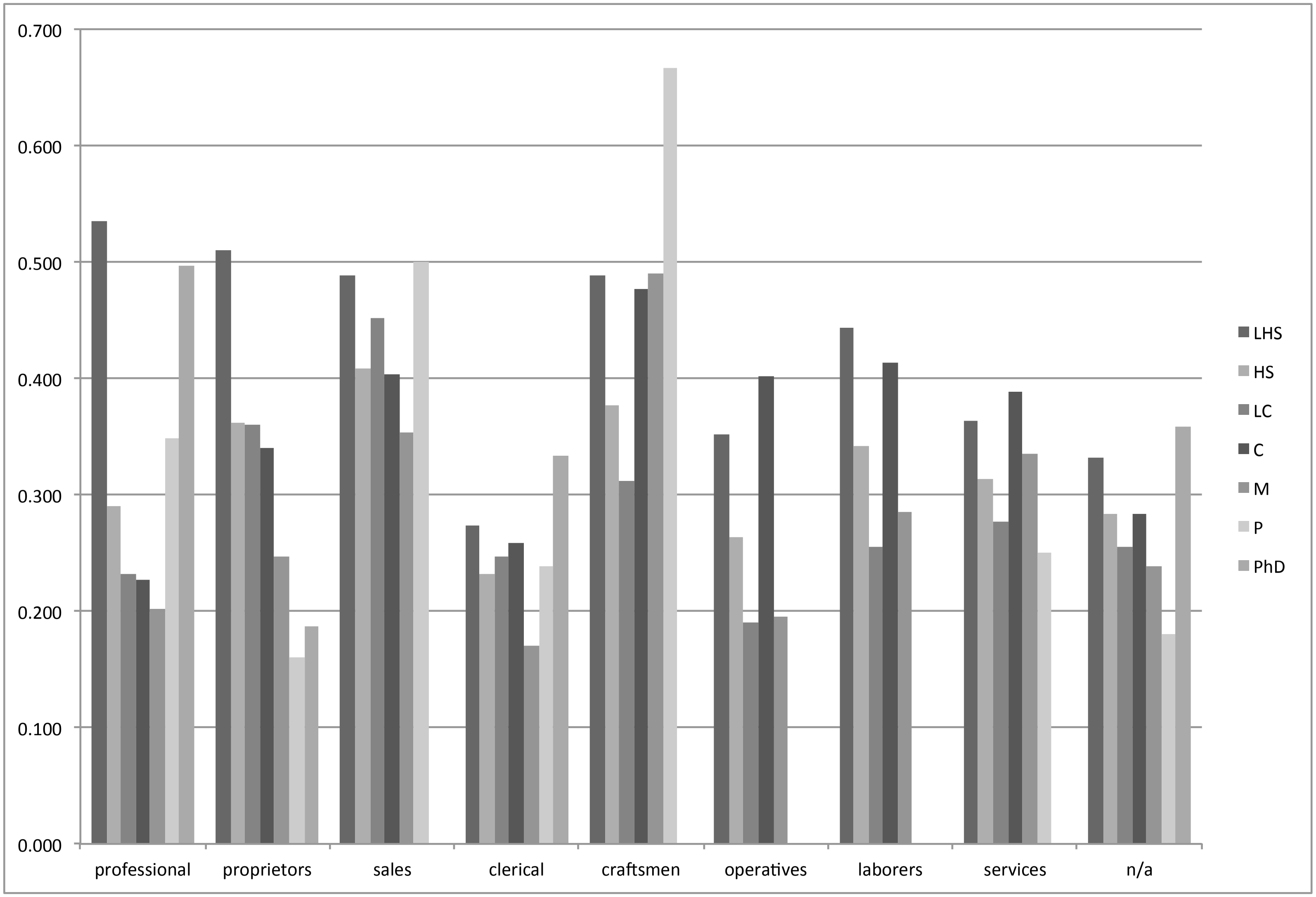

Figure 5: Entrepreneurship rate by educational attainment and by occupation

Notes: Educational groups are: less than high school (<HS), high school (HS), less than college (<C), college (C), Master's degree (M), professional degree such as MD, LLD, DDS (P), PhD. Occupations are Professional, Technical and Kindred (professional), Managers, Officials and Proprietors (proprietors), Sales Workers (sales), Clerical and Kindred (clerical), Craftsmen, Foremen and Kindred (craftsmen), Operatives and Kindred (operatives), Laborers, Except Farm (laborers), Service Workers, Except Private (services) and a residual category where the occupation is not reported (n/a). The private household sector, farmers and farm laborers are omitted because of very small sample sizes. The y-axis shows the fraction of the labor force within the occupation that has ever been an entrepreneur.

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