Credit Constraints and Delayed Entrepreneurship*

Pierre Nguimkeu†

Georgia State University

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Abstract

How much do financial constraints delay entrepreneurship and how much do they cost households in terms of foregone welfare and implied inequality in countries with large informal sectors and poorly developed financial markets? I use a dynamic occupational choice model with credit constraints to empirically study the role of financial frictions in delaying micro-entrepreneurship in such countries. The main prediction of the model is that individuals with low entrepreneurial talent remain in subsistence work whereas those with higher entrepreneurial talent and low collateral have to delay their entry decision, but may eventually become entrepreneurs if their initial wealth and future savings allow them to escape from poverty traps. The model is estimated and tested using both reduced-form survival analysis and structural maximum likelihood methods with data from Cameroon. I find that prospective entrepreneurs would need to work for an average of 7.1 years as subsisters to accumulate the minimum savings required to start their micro-enterprise. Among the potential entrepreneurs about 53% are subsisters implying a missing proportion of entrepreneurs of 10.9% of households among which more than 32% have wealth below their estimated poverty traps. Counterfactual simulations of a credit access policy using the estimated model show that a high-talent median-wealth household's permanent consumption would increase by 30% should credit constraints be removed completely. Relaxing the collateral constraint can eliminate delays to entry, double the fraction of entrepreneurs while reducing inequality by at least 6.4 percentage points in the Cameroon's Gini index.

Keywords: Entrepreneurship, Credit constraints, Welfare, Inequality, Cameroon.

JEL Classification: C51, D91, J24.

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†Department of Economics, Andrew Young School of Policy Studies, Georgia State University, 55 Park Place NE, Suite 600, Atlanta, GA 30303, USA; Email: nnguimkeu@gsu.edu.

1 Introduction

Empirical studies on occupational choice in developing countries find that a major barrier to entrepreneurship is the inability to borrow against future entrepreneurial earnings (Blattman, Fiala and Martinez 2014, Karlan, Knight and Udry 2015). Many talented individuals, for whom entrepreneurship may be a better occupation have insufficient collateral to secure a loan to create a business. They may then choose to work as non-entrepreneurs for several years in order to accumulate enough wealth required to eventually start their business. Such delay has consequences on the economy in terms of misallocation of skills, poverty traps inequality and welfare. While these consequences have been extensively studied for labor markets in industrialized economies and formal labor markets in developing countries, they are still understudied for informal sector workers in developing countries, especially in Africa where they represent the majority of the labor force (Benjamin and Mbaye 2012) Informal activities are synonym to small scale activities, and in most African countries informal sector workers represent more than 90% of the workforce and have less access to credit than their formal sector counterparts (Maimbo et al. 2011, Nguimkeu 2022). This paper uses a simple dynamic model of entrepreneurial choice with credits constraints under partial equilibrium to analyze the role of financial frictions in delaying microentrepreneurship among households in an economy with a large informal sector and poor financial markets. It structurally estimates parameter values of the model in order to: 1) assess the length of the time to entry into entrepreneurship for sufficiently talented households, 2) estimate the associated poverty traps and implied inequality, and 3) evaluate the counterfactual gains in entrepreneurship, income distribution and welfare to be expected from policies that alleviate financial constraints.

The model adopted is an extension of the static occupational choice model in Nguimkeu (2014) to a dynamic framework. It provides a theoretical characterization of a model initially due to Buera (2008, 2009) who analyzed interactions between borrowing constraints and poverty traps in the US. I present it from a perspective that allows to explicitly derive the optimal entry time to entrepreneurship, track the individual income-skill gap, and empirically identify the model's structural parameters using cross-sectional data. I apply the model to a new context, that of a sub-Saharan african country, with the aim of understanding the implications of borrowing constraints on entrepreneurship, welfare, inequality and poverty traps in a predominantly informal economy with high rates of subsistence work and highly deficient formal credit markets. The model assumes agents with standard intertemporal preferences, who are heterogeneous in their entrepreneurial skills and initial wealth, and who choose informal entrepreneurship versus subsistence work in each period. Subsisters receive a talent-inelastic earning whereas microentrepreneurs rent capital subject to a collateral constraint that limits the amount of capital input to a proportion of their current financial wealth. While a static snapshot allows to uncover the role of initial wealth in excluding talented individuals from entrepreneurship through high collateral requirements (as found, e.g., by Evans and Jovanovic 1989, Ghatak and Jiang 2002, Paulson et al. 2006, Nguimkeu 2014), the dynamic outlook considered here allows to predict that individuals with high talent might eventually become entrepreneurs in spite of their low initial collateral if they escape from poverty traps. The minimum delay that their entry decision will take if they save (time to entry) is derived, as well as the minimum wealth at which they may find it beneficial to save (poverty trap). Both the time to entry and poverty traps increase with tighter borrowing constraints and decrease with higher entrepreneurial ability and initial wealth. It is only under perfect credit markets that initially poor but talented individuals may become entrepreneurs right away. While there are competing theories that may also explain the delay to entry into entrepreneurship in the informal economy (e.g. on-the-job-learning), the present paper focuses on understanding and identifying the role of credit constraints.

Data from the Cameroon informal sector are used to assess these theoretical characterizations and to quantify their effects. I first provide reduced form estimation results by evaluating the relationship between initial wealth (a proxy for collateral), and the duration in subsistence prior to starting a micro-enterprise, while controlling for a myriad of other factors that may affect the timing of business ownership such as schooling, parents occupation, apprenticeship, etc. Evidence suggests that credit constraints may bind since the delay to entrepreneurship entry is negatively correlated with initial wealth and is longer in high starting capital industries. I also provide structural estimates of the model by matching the probability of becoming a microentrepreneur and the associated income generated by the theoretical model with the corresponding occupational status and income observed in the data. This allows to structurally compute the proportion of missing entrepreneurs, the expected delay to entry and the poverty trap for each household, expressed as a function of initial wealth and other individual and market characteristics. I find that average delay to entry to microentrepreneurship among high-skills is around 7.1 years, and is longer for individuals at the median and lower percentiles of the initial wealth distribution. The proportion of missing microentrepreneurs due to credit constraints is about 10.9% of households, among which 32% have wealth below their estimated poverty traps. The estimated model is also used to analyze the counterfactual impacts of a credit access policy on the time to entry, the fraction of entrepreneurs, welfare and inequality. This delay to entry implies significant welfare losses for talented people. High-ability individuals who could otherwise earn up to 25% higher lifetime income as microentrepreneurs remain subsisters for about seven years. Similarly, the lifetime consumption of the high-talent median-wealth worker in the data must be increased permanently by 30% to make them indifferent between living in the Cameroon economy and in a similar economy with perfect credit markets. Counterfactual simulations also show that allowing people to borrow up to two times the mean household wealth can reduce the average delay to zero and nearly double the fraction of entrepreneurs. Likewise, relaxing borrowing constraints allows highly talented individuals to close their income-skill gap sooner, and reduce wealth inequality among them by 6.4 percentage points in the country's Gini index under perfect credit markets. Only people above the 90th percentile of the initial wealth distribution are financially unconstrained and therefore unaffected by any policy aiming at improving access to credit.

These results complement recent studies documenting the importance of credit access for entrepreneurship in developing countries (Paulson et al 2006; Karaivanov 2012, Karaivanov and Townsend 2014, Karaivanov and Yindok 2022, Yindok 2021), the persistence of poverty traps and the role of microfinance, cash transfers or social capital (Balboni et al 2022, Banerjee et al 2019, Barrett and Carter 2013, Ghatak 2015, Bauernschuster et al. 2010). Most of existing papers studying the interaction between borrowing constraints and entrepreneurship have been largely based on the US economy (e.g., Evans and Jovanovic 1989, Blanchflower and Oswald 1998, Hurst and Lusardi 2004, Cagetti and De Nardi 2006, Buera et al 2015). The evidence found in this work most directly complement those of Buera (2008, 2009), by providing a formal empirical basis for a comparison between the US, a formal economy with a well developed financial market and a sub-Saharan African country whose economy is predominantly informal with a poorly developed financial market.

The rest of the paper is organized as follows. Section 2 presents a simple theoretical framework for the household's dynamic occupational choice problem and illustrates how wealth and talent disparities translate into poverty traps and different timing of microentrepreneurship entry in the presence of credit constraints. Section 3 describes the data and reduced form results. Section 4 provides the structural estimates as well as counterfactual simulations based on the estimated model. Section 5 evaluates the findings and draws conclusions. Proofs and other technical material are gathered in the Appendix.

2 Model

In this section, I present a simple dynamic occupational choice model with credit constraints that delivers a relationship between wealth, entrepreneurial skills, financial frictions, poverty traps and the time to entry into entrepreneurship, which forms the basis of my empirical assessment. This framework is useful to understand the broad context of small scale activities that overlook formal regulation issues, given that the data I am using are from the informal sector of a sub-Sahara African country.

2.1 Occupational Choice and Earnings

The economy is populated by a continuum of individuals who are heterogeneous with respect to their wealth and their entrepreneurial talent. An agent enters the workforce in the informal sector with an initial wealth a_0 and entrepreneurial ability θ_0. At the beginning of each period, the agent decides between subsistence activity and entrepreneurship, and inelastically supplies their entire labor endowment to this occupation.[1] Examples of subsistence activities include street-vending (e.g., a peanuts stand or a fruit stand),

[1]Given that these are small scale activities from the outset, I use the terms entrepreneur and microentrepreneur interchangeably.

unpaid family labor, unskilled labor with non-specific work relations, etc. The subsistence income is given by w which does not depend on entrepreneurial talent. An entrepreneur with talent θ uses k units of capital to produce goods or services according to the technology:

$$f(\theta, k) = \theta k^{\alpha}, \tag{1}$$

where $\alpha \in (0, 1)$ is the elasticity of output with respect to capital. An entrepreneur can operate only one production unit in a given period. Access to capital is determined by wealth through a simple collateral constraint, motivated by the imperfect enforceability of capital rental contracts. The entrepreneur's capital rental k is assumed to be limited by a collateral constraint, $k \leq \lambda a$, where $a \geq 0$ is the entrepreneur's financial wealth at the time he is seeking credit, and $\lambda \in [1, \infty)$ measures the degree of financial friction in the economy. Financial autarky corresponds to $\lambda = 1$ which means that all capital has to be self-financed, whereas $\lambda = +\infty$ corresponds to perfect credit markets where the amount of capital rented to the entrepreneur does not depend on their wealth. This specification captures the common prediction from models of limited liability where the amount of credit is limited by an individual's wealth (Evans and Jovanovic 1989, Paulson et al 2006). Denoting by r the exogenous interest rate, the expected profit for an entrepreneur with talent θ_t and wealth a_t at period t is given by:

$$\pi(\theta_t, \lambda, a_t) = \max_{k_t} \{\theta_t k_t^{\alpha} - r k_t \quad \text{s.t.} \quad 0 \leq k_t \leq \lambda a_t\} \tag{2}$$

The optimization constraint on capital then gives rise to two types of microentrepreneurs. Those who are financially unconstrained, i.e., their optimal investment capital is an interior solution of the above optimization problem, and those who are financially constrained, i.e., their capital constraint is binding. The interior solution of the entrepreneur's maximization problem is

$$k_t^* = \left(\frac{\theta_t \alpha}{r}\right)^{\frac{1}{1-\alpha}}. \tag{3}$$

This solution is feasible only if k_t^* is lower than λa_t, which means

$$a_t > \frac{1}{\lambda}\left(\frac{\theta_t \alpha}{r}\right)^{1/(1-\alpha)} \equiv \bar{a}(\theta_t, \lambda). \tag{4}$$

The amount $\bar{a}(\theta_t, \lambda)$ is then the minimum collateral that an entrepreneur with talent θ_t needs at time t in order to fully express their potential in an economy with financial frictions λ. However, when the constraint is binding the investment capital is given by

$$k_t^* = \lambda a_t$$

Hence, the optimal microentrepreneur's profit at time t is defined as follows:

$$\pi(\theta_t, \lambda, a_t) = \begin{cases} (1-\alpha)\theta_t^{\frac{1}{1-\alpha}} \left(\frac{\alpha}{r}\right)^{\frac{\alpha}{1-\alpha}} & \text{if } a_t > \bar{a}(\theta_t, \lambda) \\ \\ \theta_t(\lambda a_t)^{\alpha} - r\lambda a_t & \text{otherwise.} \end{cases} \tag{5}$$

The entrepreneur's profit takes two possible values according to whether they are unconstrained, that is, $a_t > \bar{a}(\theta_t, \lambda)$ or constrained, that is, $a \leq \bar{a}(\theta_t, \lambda)$. An agent with current talent θ_t and wealth a_t will choose to become an entrepreneur in period t if his expected profit as an entrepreneur, $\pi(\theta_t, \lambda, a_t)$, exceeds their expected subsistence earning w, and will prefer to remain a subsister otherwise. In each period, the agent's potential earning from his occupation is therefore given by

$$y_t = \max\{w, \pi(\theta_t, \lambda, a_t)\}. \tag{6}$$

Define the critical ability level

$$\theta^* = \left(\frac{r}{\alpha}\right)^{\alpha} \left(\frac{w}{1-\alpha}\right)^{1-\alpha}. \tag{7}$$

This is a cutoff talent level that determines whether a financially unconstrained agent has the ability to successfully run a firm. Notice that this cutoff does not depend on wealth, but only on technology parameters and market characteristics. In principle, with no financial frictions, any individual who starts their work life with entrepreneurial talent above this threshold should choose entrepreneurship right away. However, with borrowing constraints only sufficiently wealthy people among them can do so. We thus have the following result, which is illustrated in Figure 1.

Proposition 1. *Consider an agent with ability θ_t and wealth a_t in period t.*

(i) If $\theta_t \leq \theta^*$, then $y_t = w$.

(ii) If $\theta_t > \theta^*$, then there exists a wealth threshold $\underline{a}(\theta_t, \lambda) \in (0, \bar{a}(\theta_t, \lambda))$ such that

$$y_t = y_t(\theta_t, \lambda, a_t) = \begin{cases} w & \text{for } a_t < \underline{a}(\theta_t, \lambda) \\ \pi(\theta_t, \lambda, a_t) & \text{otherwise} \end{cases}$$

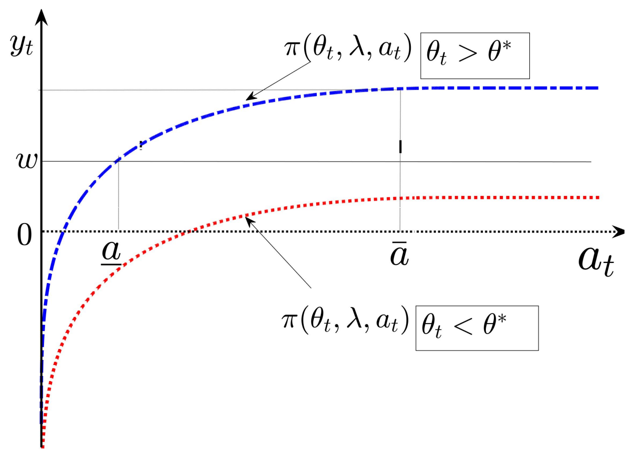
(iii) The wealth threshold $\underline{a}(\theta_t, \lambda)$ is decreasing in θ_t and λ, and vanishes with large values of λ, that is,

$$\forall(\theta_t, \lambda, a_t), \qquad \frac{\partial \underline{a}(\theta_t, \lambda)}{\partial \theta_t} < 0, \qquad \frac{\partial \underline{a}(\theta_t, \lambda)}{\partial \lambda} < 0, \quad \text{and} \quad \lim_{\lambda \to +\infty} \underline{a}(\theta_t, \lambda) = 0.$$

Proof. See Appendix A.1. □

Proposition 1 is the usual occupational choice result in this type of models, which says that, given a minimally required level of talent, there is a wealth threshold above which the agent becomes an entrepreneur. While this wealth threshold decreases with entrepreneurial talent and better access to credit, it is not needed in a perfect credit market economy so that talented individuals always become entrepreneurs, regardless of their wealth. This result is standard and well established in the literature (see, e.g. Evans and Jovanovic 1989, Nguimkeu 2014, Paulson et al. 2006). Also notice that for highly talented and unconstrained households, log income is just a linear function of log talent so that the standardized difference between these two quantities - which can be thought of as income-skill gap - would be zero for this type of households but not for the remaining types (i.e. those that are constrained in credit and/or skills). Hence larger income-skill gaps can be regarded as evidence of credit and/or skill constraints.

Figure 1: Occupational Earnings



I now look at the dynamics of wealth accumulation that precedes the eventual entry to microentrepreneurship for talented people.

2.2 Wealth Accumulation and Time to Entry

As discussed above, the prospective entrepreneur whose initial wealth does not meet the collateral requirement would have to save in hope to eventually make up for this amount. I assume that each period, agents accumulate wealth from their earnings and assets as follows

$$a_{t+1} = y_t - c_t + (1+r)a_t, \quad t = 0, 1, \ldots, \tag{8}$$

where c_t represents consumption in period t. I also assume that entrepreneurial talent increases with the time spent in the labor market, such that $\partial\theta_t/\partial t > 0$ and $\partial\theta_t/\partial\theta_0 > 0$. If agents live infinite periods and discount the future at rate $\frac{1}{1+r}$, their preference over a sequence of consumption $\{c_t\}_{t=0}^{\infty}$ is given by the utility function[2]

$$U(c) = \sum_{t=0}^{\infty} \left(\frac{1}{1+r}\right)^t u(c_t), \tag{9}$$

where $u(\cdot)$ is increasing, continuously differentiable and concave. Each period, a worker has to decide whether to run a business or to remain in subsistence and how much to save

[2] This means that I am setting the psychological discount factor to equal the financial discount factor.

for the following period. More formally, the problem of the agent is to choose the vector of current consumption and next period's wealth $\{c_t, a_{t+1}\}_{t=0}^{\infty}$ and the entrepreneurship entry date T^* to maximize their lifetime utility function. Assuming that an agent chooses the entry date T^*, then their earning function can be rewritten as

$$y_t = w\mathbf{1}[t < T^*] + \pi(\theta_t, \lambda, a_t)\left(1 - \mathbf{1}[t < T^*]\right), \tag{10}$$

where $\mathbf{1}[\cdot]$ is a binary indicator function which takes the value 1 if the statement in brackets is true and 0 otherwise. The agent's maximization problem can therefore be written as[3]

$$\begin{aligned} &\max_{\{c_t, a_{t+1}\}, T^*} \sum_{t=0}^{\infty} \left(\frac{1}{1+r}\right)^t u(c_t) \\ &\text{s.t.} \quad c_t + a_{t+1} = w\mathbf{1}[t < T^*] + \pi(\theta_t, \lambda, a_t)\left(1 - \mathbf{1}[t < T^*]\right) + (1+r)a_t \qquad \forall t \geq 0 \\ &\qquad a_{t+1} \geq 0, \quad a_0 \text{ given.} \end{aligned} \tag{11}$$

Denoting by $u_c(\cdot)$ the first derivative of $u(\cdot)$, the Euler equation of the agent's maximization problem for periods prior to the entry date is

$$u_c(c_t) = u_c(c_{t+1}), \qquad \forall t < T^*. \tag{12}$$

This implies an optimal decision where the agent consumes a fixed amount c_0 in each of these periods and therefore saves from his subsistence income at a fixed rate $s_t = w - c_0 = s$ for all $t < T^*$.[4] Plugging this result in the agent's intertemporal budget constraint, the wealth accumulated as a wageworker at the beginning of any period $t < T^*$ is given by

$$a_t = (1+r)^t a_0 + \sum_{j=1}^{t} (1+r)^{t-j} s_j = (1+r)^t \left(a_0 + \frac{s}{r}\right) - \frac{s}{r}.$$

By Proposition 1(ii), an agent with ability $\theta_t > \theta^*$ would start a business only if $a_t \geq \underline{a}(\theta_t, \lambda)$. Assuming that θ_t is an increasing function of t, we then have the following result.

Proposition 2 (Main)**.** *Consider an agent with initial wealth a_0 and talent θ_0.*

(i) If $\theta_t < \theta^*$, $\forall t \geq 0$, then the agent is a lifetime subsister, regardless of a_0.

(ii) If $\theta_t \geq \theta^*$ for some $t \geq 0$, then

(a) There exists a critical wealth threshold $a^*(\theta_0, \lambda) < \underline{a}(\theta_0, \lambda)$, above which households can save to become entrepreneurs in the future. Households whose initial wealth is below this threshold do not save and remain subsisters forever, regardless of their entrepreneurial talent.

[3] Notice that $w = \lim_{T^* \to \infty} y_t(T^*)$. Then, by Proposition 1, the time to entry would be infinite for less talented workers (i.e. $\theta_t \leq \theta^*$) and would be finite only for prospective entrepreneurs (i.e. $\theta > \theta^*$).

[4] With linear utility, the optimal consumption is $c_0 = 0$, $\forall t < T^*$; that is, it is always better to save the entirety of subsistence earnings until the collateral requirement is met. With CRRA utility, c_0 would take its minimum possible value, i.e. minimum subsistence consumption.

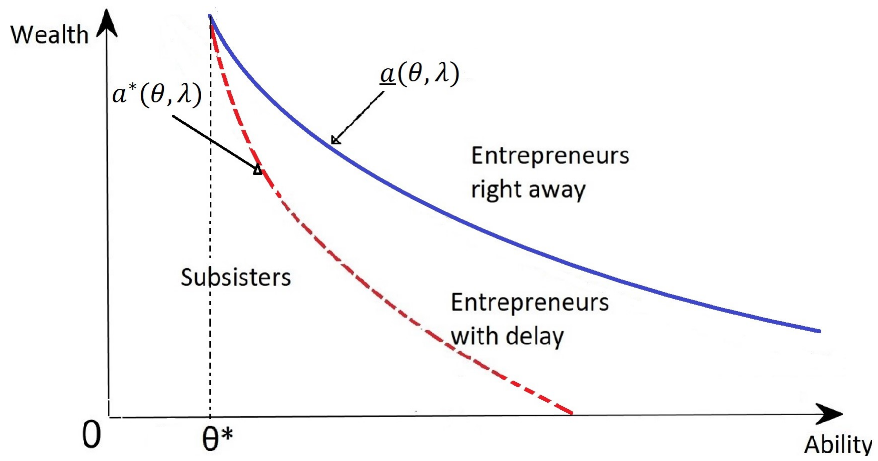
(b) *For households that save, there exists an optimal finite entry date* $T^* = T^*(\theta_0, \lambda, a_0) > 0$ *at which they become entrepreneurs.*

(c) *The "poverty trap" threshold,* $a^*(\theta_0, \lambda)$, *and the time to entry* $T^* = T^*(\theta_0, \lambda, a_0)$ *are both decreasing in* θ_0 *and* λ, *and go to* 0 *for large values of* λ. *In addition,* T^* *is decreasing in* a_0.

Proof. See Appendix A.2. □

Figure 2 illustrates the result given in Proposition 2 for a fixed λ. Agents with low entrepreneurial talent remain subsisters whereas more talented and wealthier agents enter entrepreneurship right away. The main theoretical result of the paper is given in

Figure 2: Selection to Occupations



Part (ii) (b) of this proposition: For talented but initially poor individuals i.e. $\theta_0 > \theta^*$ and $a_0 < \underline{a}(\theta_0, \lambda)$, we have $T^* = T^*(a_0, \theta_0, \lambda) > 0$, that is, the entrepreneurship entry time is delayed, and depends on initial wealth, entrepreneurial talent and the degree of financial frictions. Specifically, Part (iii) states that it is decreasing in talent and wealth, and goes down to zero with large values of the collateral multiplier λ, so that in a perfect credit market there is no delay to entry for talented individuals. Interestingly, by differentiating the optimal entry time T^* with respect to other factors such as the interest rate, r, and the subsistence earning w, it is possible to see how they would affect the time to entry. In particular, the higher the subsistence income, the sooner the time to entry T^* as it makes it easier for talented individuals to save the collateral needed to start a profitable business. In contrast, higher interest rates have an ambiguous effect on the time to entry. On the one hand they are positively related to wealth accumulation, but on the other hand they are negatively related to borrowing incentives.

2.3 Welfare Costs for High Talents

In order to fully understand the welfare costs of borrowing constraints on high talents, it is important to characterize the possible consumption paths and the associated lifetime utilities of agents. So far, I described the consumption path of prospective entrepreneurs until the entrepreneurship switch. However, since less talented individuals (i.e. $\theta_0 < \theta^*$) remain subsisters indefinitely, the Euler equation (12) with $t = 0, 1 \ldots, \infty$ implies that the consumption of those agents is $c_t = c_l = w + ra_0, \quad t = 0, 1 \ldots, \infty$. As for more talented individuals (i.e. $\theta_0 \geq \theta^*$), recall that the optimal entry date T^* derived in the previous sections is only the earliest time where the prospective entrepreneur can start a constrained firm. To start an unconstrained firm, an agent with ability θ_t should have accumulated at least $\bar{a}(\theta_t, \lambda)$ amount of wealth. Denote by $T^{**}(\theta_0, \lambda, a_0)$ the earliest date where an agent with initial ability $\theta_0 \geq \theta^*$ and initial wealth a_0 can start an unconstrained firm. Then

$$T^{**}(\theta_0, \lambda, a_0) = \inf \{t : a_t > \bar{a}(\theta_t, \lambda)\}.$$

The entry time $T^{**}(\theta_0, \lambda, a_0)$ has similar properties as $T^*(\theta_0, \lambda, a_0)$, that is, decreases with θ_0, λ and a_0, and goes down to 0 when λ is sufficiently large. This means that in a perfect credit market, highly talented individuals could start an unconstrained firm right away. The Euler equation of the agent's maximization problem for periods above T^* is given by

$$\frac{u_c(c_t)}{u_c(c_{t+1})} = \begin{cases} 1 + \dfrac{1}{1+r} \dfrac{\partial \pi(\theta, \lambda, a_{t+1})}{\partial a_{t+1}} & \text{for } t \in [T^*, \quad T^{**}) \\ 1 & \text{for } t \in [T^{**}, \quad \infty) \end{cases} \tag{13}$$

The following corollary has important consequences for welfare.

Corollary 1. *(i) The consumption of prospective entrepreneurs is lower than the consumption of individuals who remain subsisters.*

(ii) Consumption increases after individuals become constrained entrepreneurs and reaches a maximum when they become unconstrained.

Proof. See Appendix A.3. □

Figure 3 presents the consumption paths of both subsisters and prospective entrepreneurs, and illustrates Parts (i) and (ii) of Corollary 1 (in the figure, c_h is the early consumption of high entrepreneurial skills, whereas c_l is the lifetime consumption of low entrepreneurial skills). This result shows that prospective entrepreneurs save at a higher rate than both existing entrepreneurs and individuals who have no intention to become entrepreneurs. Entrepreneurship provides higher levels of consumption, and consumption is the highest for financially unconstrained entrepreneurs with similar skills. As a consequence, higher financial frictions imply higher welfare losses for talented people. The welfare cost of financial frictions can be computed in units of permanent consumption compensation necessary to make an individual indifferent between the status quo, that is the economy with λ, and an economy with better capital markets indexed by λ' such that $\lambda' > \lambda$. Simulation results performed in Section 4.3 allow to

Figure 3: Consumption Paths for Subsisters and Prospective Entrepreneurs

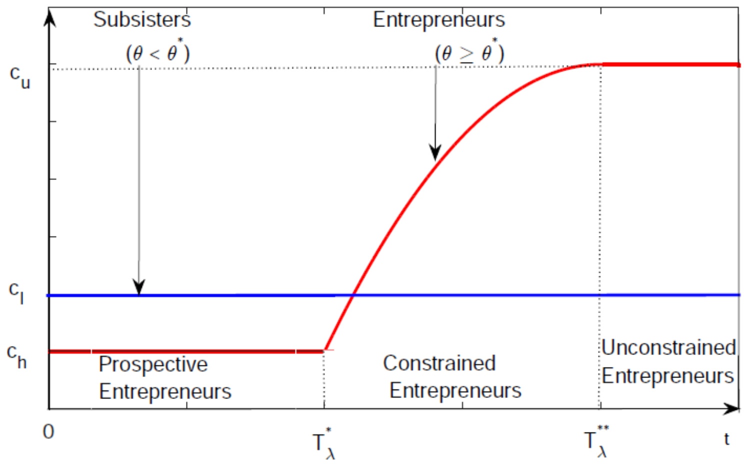
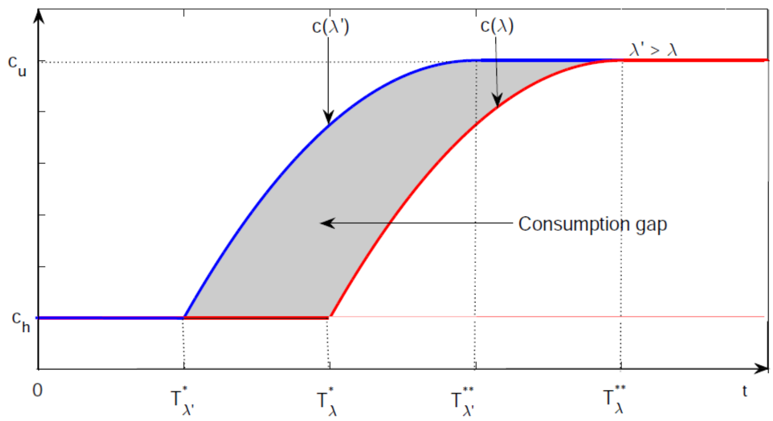


Figure 4: Consumption of High Entrepreneurial Talents for Different Levels of Constraint



quantify these losses in the Cameroon data. The change in the share of consumption for an agent with ability θ and initial wealth a_0 when the economy moves from λ to λ' is $\Delta c(\lambda', \lambda) = c(\theta, \lambda', a_0) - c(\theta, \lambda, a_0)$, where

$$c(\theta, \lambda, a_0) = \sum_{t=0}^{\infty} \frac{\max\{\pi(\theta, \lambda, a_t(\theta, a_0)) + ra_0, w + ra_0\}}{(1+r)^t}.$$

The lifetime consumption gap for talented agents resulting from the improvement of credit markets is illustrated in Figure 4. With better credit markets (indexed by λ') talented individuals become entrepreneurs sooner than they would in a worse credit market state (indexed by λ) and their consumption quickly reaches the highest unconstrained level c_u. Their lifetime consumption therefore increases with increasing levels of λ, inducing welfare gains (or welfare losses otherwise).[5]

[5]Note that these welfare gains do not account for supplementary non-monetary returns associated

2.4 Income Inequality for High Talents

The model allows to explore the dynamics of income inequality in this economy. We examine how changes in the degree of credit constraints may affect the distribution of income and inequality among agents with similar levels of talent.

Denote by $G_\lambda(\theta_t, a_t)$, $(\theta_t, a_t) \in (0, \infty) \times [0, \infty)$, the joint CDF of talent and wealth when the level of credit constraint is λ. For a given $y \geq 0$, denote $R_t^\lambda(y) = \{(a_t, \theta_t) : y_t(\theta_t, \lambda, a_t) \leq y\}$, where $y_t(\theta_t, \lambda, a_t)$ is the high talent income as defined in Proposition 1(ii). This the region of all configurations of talent and wealth for which the associated income is less than y. The cumulative distribution function (CDF) of income for the high talents is given by

$$F_t(y, \lambda) = \int_{R_t^\lambda(y)} \mathrm{d}G_\lambda(\theta_t, a_t).$$

The corresponding Lorenz curve is given by

$$L(F_t(y, \lambda)) = \int_0^y u\mathrm{d}F_t(u, \lambda) \Big/ \int_0^\infty u\mathrm{d}F_t(u, \lambda)$$

and the Gini coefficient at time t for an economy with level of borrowing constraints indexed by λ is given by

$$\mathcal{G}_t(\lambda) = \int_0^\infty F_t(u, \lambda)\,(1 - F_t(u, \lambda))\,\mathrm{d}u \Big/ \int_0^\infty u\mathrm{d}F_t(u, \lambda).$$

The left inverse cumulative distribution function is defined by

$$F_t^{-1}(u, \lambda) = \inf\{y : F_t(y, \lambda) \geq u\}$$

The following result establishes the existence of a stochastic dominance between the distributions of income under two different regimes λ and λ'.

Proposition 3. *Consider the economy under regimes λ' and λ such that $\lambda' > \lambda$. Then we must have*

$$F_t^{-1}(u, \lambda') \leq F_t^{-1}(u, \lambda), \quad \forall u \in [0,\, 1] \tag{14}$$

Hence, the economy with the higher regime has less inequality, i.e.

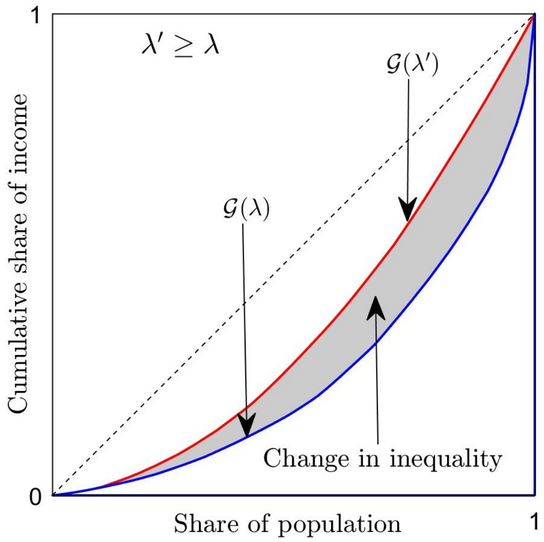
$$\Delta\mathcal{G}_t(\lambda', \lambda) = \mathcal{G}_t(\lambda') - \mathcal{G}_t(\lambda) \leq 0.$$

Proof. See Appendix A.4. □

with entrepreneurship, which Bianchi (2012) has found to be significant.

This result shows that in this economy the degree of inequality measured by the Gini index decreases with higher values of λ, implying that greater access to credit is associated with better equity. This result is not only confined to the Gini index. As shown by Muliere and Scarsini (1989) and more recently by Aaberge et al. (2021), the second degree stochastic dominance given by Equation (14) implies that a wider range of inequality indices based on various types of social preferences will preserve this ranking. Figure 5 illustrates the income inequality change in the economy resulting from a

Figure 5: Lorenz Curves of High Talents for Different Levels of Constraint



variation in the degree of credit constraints given the same initial distribution of talent and wealth. A higher λ is associated with a reduction of inequality, which implies that improved access to credit benefits the talented poor more than proportionally.

The model discussed above is not new, but only the perspective from which I am using it for this empirical analysis is new to the best of my knowledge. I provide another theoretical characterization of a model originally due to Buera (2008, 2009), which also bears similarities with Buera and Shin (2013). Beside the predictions already found in these earlier works, such as the characterization of savings behavior and the poverty trap threshold $a^*(\theta, \lambda)$, I use the model to explicitly characterize the entry dates into constrained entrepreneurship and unconstrained entrepreneurship, T^* and T^{**}, and to analyze the role of credit constraints in shaping income inequality in a developing country context with a heavily deficient financial market. While Buera (2009) interest lies on understanding the dynamic interaction between savings and entrepreneurial choice among wage-workers in the US, I use it to study how credit constraints affect households prospects to escape from subsistence informal activities into microentrepreneurship in an economy where financial frictions are much more substantial and poverty traps more prevalent.

The model is also theoretically limited because of the simplifying assumptions that are made to obtain tractable analytical results. First, entrepreneurial ability is assumed to be monotonically increasing throughout the agent's work life. This is to capture the entrepreneurial effect of human capital accumulation through labor market experience. However, one may allow entrepreneurial talent to possibly depreciate over time, for example if θ_t captures entrepreneurial ideas or investment opportunities that could become obsolete or less profitable after some time (e.g., Bassetto et al. 2015, Buera and Shin 2013). In those cases, individuals with initially insufficient entrepreneurial talent will still never become entrepreneurs, but the time to entry derived above would be similar for high talents. The case where entrepreneurial talent receives stochastic positive or negative shocks over time would affect the probability of having sufficient talent or keeping it, but given that high ability alone is not enough to become or remain entrepreneur (as shown in Proposition 1 (ii)), the time to entry derived in Proposition 2 will also be similar for high talents. In the context of this paper, the simplistic assumption used can be supported by the less competitive business environment of developing countries and the extremely low exit rate (see summary statistics and discussion in Section 3.1). Second, I assumed that subsistence earnings are not directly affected by entrepreneurial skills. Although this is a common assumption made for wage earnings in several related studies (e.g. Lloyd-Ellis and Bernhardt 2000, Jeong and Townsend 2007, Paulson et al. 2006), allowing for subsistence earnings to vary with entrepreneurial talent would raise the critical ability threshold, θ^*, required to become entrepreneur for high talents, but the predictions in Propositions 1-3 would remain unchanged.[6] Finally, the entrepreneur's production function overlooked paid labor in its specification. Since, in the data, very few informal enterprises hired and paid any labor outside their family (less than 5% of enterprises), adding labor would bring a complication that does not improve the empirical results, especially as only a partial equilibrium is analyzed.

3 Data and Reduced-form results

This section describes important features of the Cameroon informal sector data and examines the empirical relevance of some of the model predictions. The choice of Cameroon for the empirical analysis is largely driven by the availability of the data to the author, but also for the purpose of empirically exploring the informal sector constraints in an African country with one of the lowest levels of financial inclusion (World bank 2014). I give the background and provide descriptive statistics of these data and then test some implications of the model through reduced-form regressions.

[6] In the structural estimation I allow subsistence earnings to vary with education to capture some of the heterogeneity observed in subsistence income.

3.1 Data and preliminary analysis

The data used to empirically test the model and provide structural estimates come from the Cameroon National Survey on Employment and Informal Sector (EESI) conducted in 2005 by the National Institute of Statistics of Cameroon in partnership with the World Bank.[7] It is a nationwide cross-sectional and representative survey that collects a comprehensive set of information about households characteristics and the characteristics of their economic activities. The survey identified a total of 4337 active individuals heads of households aged 15 and above operating in the informal sector defined as "activities and production units that do not have written formal accounts and/or are not registered with the tax authorities." This sector covers the vast majority of activities and employs about 90% of the Cameroon workforce. Households heads are either informal wage earners, purely self-employed or employers, and less than 5% of informal businesses hire and pay anyone from outside their family. Non-agricultural activities account for 40% of the informal workforce and are distributed across manufacturing and services.

Table 1: Household Characteristics by occupation

	Whole	Entrepreneurs	Subsisters
Num. of obs.	4337	424	3913
% of sample	100%	9.8%	90.2%
% of women	54.3%	6.4%	93.6%
Avg. household size	6.0	6.1	5.8
Avg. age of head	34.6	37.3	35.2
Avg. entry age of head	26.4	29.8	23.1
Years of schooling			
0-5 years	43.7%	30.3%	45.1%
6-10 years	45.2%	49.4%	44.7%
11+ years	11.1%	20.3%	10.2%
Avg. annual income*	703.32	862.6	421.9
Avg. wealth*	2,380.2	4,569.7	2,143.0

*In thousands of local currency (CFA); 1,000 CFA $\sim$ \$2 US

While the distinction between entrepreneurs and non-entrepreneurs is clearer for developed countries or for the formal sector of developing countries, it is not so obvious in the informal sector. For the formal sector the usual approach is to consider self-employment or business-ownership as entrepreneurship (e.g., Evans and Jovanovic 1989; Holtz-Eakin et al. 1994). However, in the informal sector where the majority of people are self-employed, using the same definition would be seriously misleading in this context. In fact, self-employment in the informal sector includes both the actual informal entrepreneurs as well as a wide category of subsisters (street-vendors, etc.). To

[7]These data are thoroughly described in Nguimkeu (2014), and are available from www.statistics-cameroon.org

distinguish between these activities, I follow Nguimkeu (2014) and define as informal entrepreneur an individual who owns a business, uses a technology and employs others, albeit mostly family members (see also Mondragón-Vélez and Peña 2010, for a similar definition). This definition particularly excludes purely self-employed (i.e. those who work just by themselves) who do not use a technology, most of which are subsisters (e.g., taxi-drivers who own their cars are not excluded). Examples of informal entrepreneurs include grocers, tailors, carpenters, car mechanics who own shops, taxi-drivers who own cars, etc. Subsisters are all other types of workers including people working for households or informal firms as well as all the pure self-employed. With this definition, the data consists of 9.8% entrepreneurs and 90.2% subsisters, and Table 1 shows that women are underrepresented in entrepreneurship in Cameroon as also found in industrialized countries (e.g., Markussen and Røed, 2017)

Although the EESI survey is not a dynamic panel data survey, there are many retrospective questions that can be used to evaluate the length of time a household head has been staying in a house/location, employed/unemployed, running a business, using some consumer durables, etc. As we describe below, this information allows to identify key transitions in our model and helps overcome some of the difficulties related to the unavailability of a panel data, which would be ideal for this type of analysis.

Figure 6: Distribution of Education and Initial Wealth

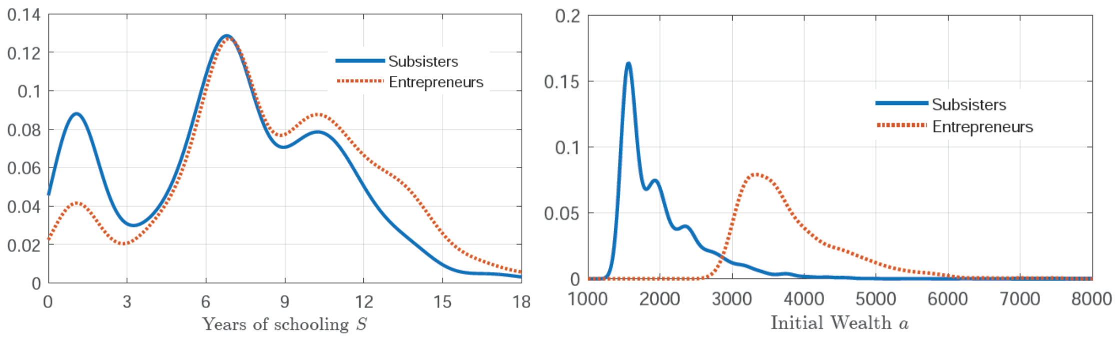
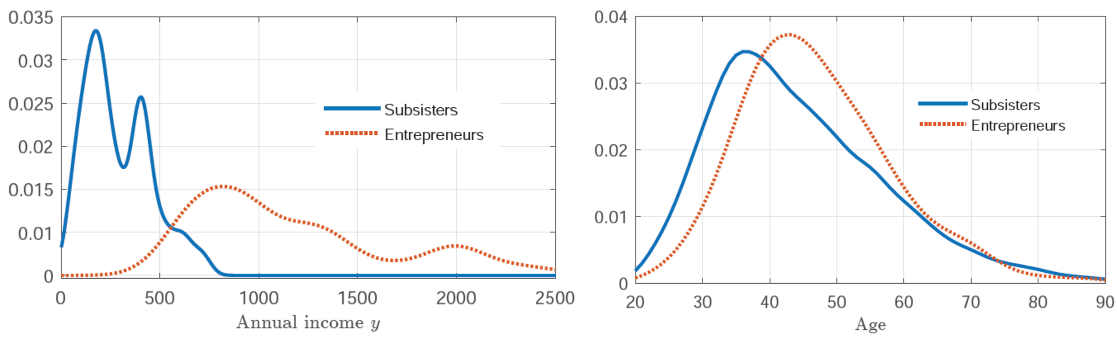


Table 1 generally presents the characteristics of individuals by occupation. A comparison between current and previous occupations shows that about 1% of subsisters were previously entrepreneurs, and about 20% of entrepreneurs were previously subsisters. The left panel of Figure 6 shows the distribution of education by occupations. While entrepreneurs and subsisters are similar in terms of average education (49.4% vs. 44.7%), the former has the lowest proportion of workers in the category of $0-5$ years of education (30.3% vs. 45.1%) and the highest proportion among those in the 11+ years of education (20.3% vs. 10.2%). In general, entrepreneurs are slightly more educated than subsisters. The striking difference between the two groups, though, is in their initial wealth distribution. This distribution is pictured in the right panel of Figure 6 and shows that entrepreneurs are substantially wealthier than subsisters. The wealth variable was built by computing the market value of households belongings reported in the questionnaires. Because the analysis requires that this variable be representative of the initial wealth of the household, only items that were acquired prior to starting their activity are accounted for in the computation.[8] This measure of wealth is positively correlated with various measures of the quality of habitat such as the type of housing, the type of walls, roof and floor material of the house, and access to clean water, indicating its validity.

Figure 7: Distribution of Earning and Age



The earning distribution of subsistence households is highly skewed to the right with the highest proportion of the group showing earnings below the sample mean (left panel of Figure 7). On the other hand, the earning distribution of entrepreneurs is seemingly bimodal with both modes situated at the middle and top percentiles of the distribution. This may reflect the presence of both constrained and unconstrained entrepreneurs as predicted by the theory. Consistent with the distributions of wealth and the model predictions, entrepreneurs earn substantially more than subsisters in general.

The average age gap between entrepreneurs and subsisters is 2.1 years, whereas the average entry age gap between the two categories into the workforce is 6.7 years. The age distribution by occupation suggests that younger people are less likely to become entrepreneurs compared to older ones. Only people around the middle-age of 37 years are equally likely to be entrepreneurs (right panel of Figure 7). These statistics are consistent with the hypothesis of a delayed entry to entrepreneurship. The large gap in initial wealth between entrepreneurs and subsisters, compared to a relatively smaller gap in education reinforces the intuition that a significant portion of this delay may be explained by credit constraints, as discussed in the analysis below. Finally, since the

[8] The households durable goods that enter the measure of wealth include vehicles, TVs, radios, DVD/Video-CD players, fridges/freezers, gas cookers, fans, sewing machines, air conditioning system, mobile phones, computers, electric irons, and houses owned by the household. I considered only items that were acquired by the household prior entering their activity, and computed their wealth as the weighted sum of the number of these items, where the weights are the real market prices of the corresponding items (in 2005 values, that is, adjusted to inflation).

aim is to assess the role of credit constraints, I also distinguish, among occupations, industries that require high starting capital (such as transportation, telecommunication, healthcare, hospitality, etc.) versus those that require relatively less (e.g., commerce, small-scale manufacturing, catering, etc.). A similar distinction is used by Hurst and Lusardi (2004) for the same purpose. In the Cameroon informal sector data, 17.8% of households operate in the former type whereas 82.2% of them operate in the latter.

3.2 Reduced-form analysis

Before estimating the structural parameters, I use the Cameroon data to perform some basic tests of the theory. In particular, the theoretical model predicts that financial constraints increase the waiting time to entry in entrepreneurship. To test this result, I examine how the timing of entrepreneurship entry varies with initial wealth (a proxy for collateral in the data), and how it differs across high starting capital versus low starting capital industries. I also examine how this relationship varies with years of schooling or apprenticeship. A natural alternative explanation for the observed delay to entrepreneurship entry could be that of generational transmission. Since many entrepreneurs are children of entrepreneurs, individuals may become entrepreneurs only when parents end their careers, therefore generating a delay pattern quite independent of collateral requirements. In the analysis performed, I therefore also control for this confounding factor.

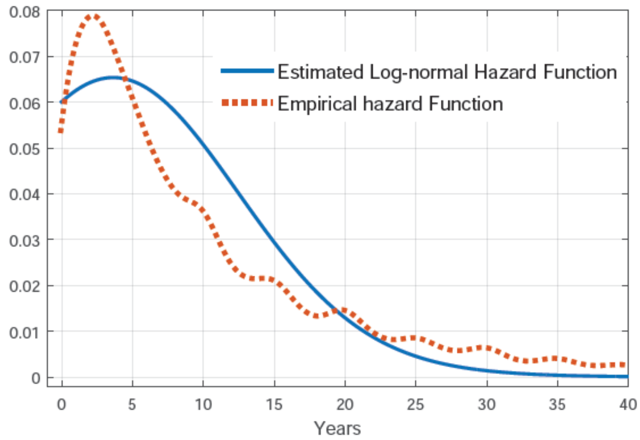
One approach to perform reduced-form analysis in this setting, with the data I have, is to use a duration model to estimate hazard functions of the transition to entrepreneurship while accounting for the possible censoring in the observed timing. To summarize, let T_i be the duration in subsistence activity for respondent i prior to starting a microenterprise. We either observe T_i up to the exact number of years, or a censored interval of time. If t_i is the observed duration in subsistence for respondent i, then for censored observations, we only know that $T_i > t_i$. The likelihood function is defined in terms of the hazard function, which is conditioned on the set of covariates, $\mathbf{x}_i$. For a particular value t_i if T_i, the hasard function $h(t_i|\mathbf{x}_i)$ is related to the survival function $\mathcal{S}(t_i|\mathbf{x}_i)$ by $\mathcal{S}(t_i|\mathbf{x}_i) = \exp\{\int_0^{t_i} h(u|\mathbf{x}_i)du\}$. The probability density function of T_i is then defined by $f(t_i|\mathbf{x}_i) = h(t_i|\mathbf{x}_i)\mathcal{S}(t_i|\mathbf{x}_i)$ for observed durations, and the contribution of a right-censored observation to the likelihood is $\Pr[T_i > t_i|\mathbf{x}_i] = \mathcal{S}(t_i|\mathbf{x}_i)$.

Hence, the log-likelihood function can be written as

$$l = \sum_{\substack{\text{uncensored}\\\text{observations}}} \ln f(t_i|\mathbf{x}_i) + \sum_{\substack{\text{censored}\\\text{observations}}} \ln \mathcal{S}(t_i|\mathbf{x}_i).$$

Note that the uncensored observations are observations about entrepreneurs (since their total duration in subsistence/non-entrepreneurial work is known), whereas the censored observations are observations about subsisters (since their total duration before they transit to entrepreneurship is still unknown). For the hazard specification, I use the log-normal distribution which, unlike other commonly used distributions, is flexible

Figure 8: Empirical and Estimated Hazard Functions



enough to allow the possibility that the hazard may first increase and then decrease over time as suggested by the empirical hazard from the data depicted in Figure 8. For the lognormal model, the density function and the survival function are defined by

$$f(\ln t_i|\mathbf{x}_i) = \frac{1}{\sigma t_i}\phi\left(\frac{\ln t_i - \mathbf{x}_i'\beta}{\sigma}\right), \quad \mathcal{S}(\ln t_i|\mathbf{x}_i) = \Phi\left(-\frac{\ln t_i - \mathbf{x}_i'\beta}{\sigma}\right)$$

where $\phi(\cdot)$ and $\Phi(\cdot)$ are the pdf and cdf of the standard normal, respectively. The log-likelihood function for the observed data is therefore given by

$$l(\beta,\sigma) = \sum_{i=1}^{n}\left[E_i \ln \frac{1}{\sigma t_i}\phi\left(\frac{\ln t_i - \mathbf{x}_i'\beta}{\sigma}\right) + (1-E_i)\ln\Phi\left(-\frac{\ln t_i - \mathbf{x}_i'\beta}{\sigma}\right)\right],$$

where $E_i = 1$ for entrepreneurs (i.e. the spell is completed) and $E_i = 0$ for non-entrepreneurs (the spell is censored). Because some individuals become entrepreneurs immediately as they enter work life, I normalize the time origin to 1, so that the likelihood is well defined when the failure time is at the origin.[9] For the estimation, I consider the following set of covariates for $\mathbf{x}_i$:

$$\mathbf{x}_i' = [1,\ Industry_i,\ Wealth_i,\ Industry_i \times Wealth_i,\ Schooling_i,\ Parent_i,\ Control_i],$$

where $Industry_i = 1$ for relatively high starting capital industries and $Industry_i = 0$ for relatively low ones, and $Control_i$ gathers a set of other personal and geographical characteristics. Notice that for the lognormal duration model, we have $\mathbf{E}[\ln t_i|\mathbf{x}_i] = \mathbf{x}_i'\beta$, so that the estimated coefficients have a regression-like interpretation.

[9]This means that the duration is shifted one period so that a duration of zero corresponds to $t_i = 1$.

Table 2: Duration in subsistence: Reduce-form results

	Regression Estimates	
	(1)	(2)
Industry	–	0.4849**
		(0.2197)
Initial Wealth	-0.0319***	-0.0357***
	(0.0085)	(0.0091)
Wealth× Industry	–	-0.0280
		(0.0253)
Schooling	-0.1425***	-0.1402***
	(0.0205)	(0.0205)
Parent	-0.9498**	-0.9381**
	(0.4640)	(0.1629)
Female	0.5356***	0.6023***
	(0.1591)	(0.1614)
Married	-0.4495***	-0.4644***
	(0.1613)	(0.1614)
Urban	0.5272***	0.5333***
	(0.1776)	(0.1773)
Constant	7.3661***	7.4382***
	(0.3087)	(0.3102)
Log likelihood	-1854.96	-1852.49
Number of Obs	4337	4337

Standard errors in paranthesis
Significance code: 1% ‘ ** ’, 5% ‘ ** ’, 10% ‘ * ’

Table 2 reports the estimates of the reduced-form survival model. The estimates of the wealth coefficient show that household initial wealth is negatively associated with the duration in subsistence, and this association is statistically significant at the 1% level. This means that conditional on other observable characteristics, wealthier individuals start their firm sooner, as predicted by the theory. This suggests that the existence of credit constraints delays the timing of entrepreneurship. When the high starting capital industries dummy is included (Column 2), the coefficient of this dummy variable is positive and significant whereas its cross product with wealth is negative and insignificant. This means that the delay is longer in industries that require higher levels of starting capital, as expected. However, this gap tends to disappear as the level of initial wealth increases. The results also show negative and significant coefficients for schooling/apprenticeship and parent entrepreneurial status. Individuals with more years of schooling or apprenticeship tend to spend less time in subsistence. Similarly, people whose parents were entrepreneurs tend to become entrepreneurs sooner. This suggests that generational transmission is not acting as a serious constraint, but rather that informal business skills received at home as well as parents business network or externalities may contribute to catalyze the entry decision of entrepreneurs' offspring. As discussed in the following section, these two variables are assumed to be correlated with entrepreneurial talent, and the results in Table 2 confirm that they are negatively associated with the delay to entry, as predicted by the theory. Perhaps surprisingly, I find that people living in rural areas start their firm sooner than those living in urban areas. This result, however, is consistent with the significant role played by extended family and kinship networks in alleviating investment constraints and risk in rural Africa (Cox and Fafchamps 2007, Udry 1994) or the role of social capital generally plays in overcoming resource constraints in small communities (Bauernschuster et al. 2010).

4 Structural Estimation and Policy Simulations

Although the theoretical model is dynamic, the structural parameters can be identified with a single cross-section, as we discuss below. This is partly because we assumed that entrepreneurial talent does not change over time during work life except through human capital accumulated with experience, and because retrospective questions in the survey allow to measure key transition variables such as the amount of wealth prior to starting occupation, the time elapsed since entry to the workforce, duration in the current occupation, prior and current earnings, etc. Following standard practice, log-utility preferences are assumed.

4.1 Estimation, Identification and Testing

To structurally estimate the model, a distribution for entrepreneurial talent, θ, needs to be specified. This talent is known by households in the model, but is unobserved by the econometrician. I follow the literature by assuming a log normal distribution for θ, and I allow it to be correlated with education/apprenticeship, parent entrepreneurial status and industry work experience. That is,

$$\ln\theta = \delta_0 + \delta_1 \ln(1+S) + \delta_2 P + \delta_3 t + \varepsilon, \qquad \varepsilon|S,P \sim N(0,\sigma^2),$$

where S are years of schooling and/or apprenticeship, P is a dummy indicating whether at least one parent was an entrepreneur, and t is the time spent in the labor market.[10] I also assume a log linear specification for the subsistence income, defined by

$$w = \mu(1+S)^{\gamma}\xi,$$

where $\mu > 0$ is the minimum subsistence earning, and $\gamma > 0$ is the elasticity of subsistence earning to schooling. The random shock ξ is such that $\ln\xi$ is normally distributed with mean 0 and variance σ_ξ^2.

[10] This baseline specification assumes that entrepreneurial ability is uncorrelated with initial wealth as found in Nguimkeu (2014); But I relax this assumption later to allow correlation with wealth as a robustness check.

Denote $Z = [y,\ E,\ X']'$, where $X = [1\ S\ P\ t\ a]'$ is the vector of observable household characteristics, E the indicator of household entrepreneurial status, y the household income and a the household initial wealth. Setting the gross interest rate r to be exogenously fixed at 1.42, representing the observed average interest rate in microfinance institutions in the country (see IDLO 2011), the vector of model structural parameters is then $\psi = [\delta_0, \delta_1, \delta_2, \delta_3, \mu, \gamma, \sigma, \alpha, \lambda]$. With the distributional assumption on θ and on income shocks, the joint probability of income and occupational choice can be derived for each household, conditional on observing household characteristics. The expressions that follow will be simplified if we define

$$\bar{\theta} = \delta_0 + \delta_1 S + \delta_2 P + \delta_3 t, \quad \theta^I = (\lambda a)^{1-\alpha}\frac{r}{\alpha}, \text{ and } \quad \theta^{II}(w) = (\lambda a)^{-\alpha}[w + \lambda r a].$$

The model's joint predicted probabilities of income and occupations are then given in the following result.

Proposition 4 (Model Predicted Probabilities)**.** *Denote by $\phi(\cdot)$ and $\Phi(\cdot)$ the standard normal pdf and cdf, respectively. Conditional on observables X and parameters ψ,*

$$f(y, E = 0|X, \psi) = \phi\left(\frac{\ln y - \ln \mu - \gamma \ln(1 + S)}{\sigma_\xi}\right)(1 - \Gamma(X, \psi)),$$

$$f(y, E = 1|X, \psi) = \left[\phi\left(\frac{\ln \theta^{II}(y) - \bar{\theta}}{\sigma}\right)\Phi\left(-\theta^I\right) + \phi\left(\frac{\ln \theta^*(y) - \bar{\theta}}{\sigma}\right)\Phi(\theta^I)\right]\Gamma(X, \psi),$$

where $\Gamma(X, \psi)$ is the predicted probability of entrepreneurship given by

$$\Gamma(Z, \psi) = \Phi\left(\frac{\bar{\theta} - \ln \theta^*(y)}{\sigma}\right)\Phi\left(\frac{\ln \theta^I - \bar{\theta}}{\sigma}\right) + \Phi\left(\frac{\bar{\theta} - \ln \theta^{II}(y)}{\sigma}\right)\Phi\left(\frac{\bar{\theta} - \ln \theta^I}{\sigma}\right) \tag{15}$$

and the function $\theta^*(w)$ is given by Equation (7).

Proof. See Appendix A.5. □

For a sample of independent observations of size n, $\{Z_i = [y_i, E_i, X_i],\ i = 1, \ldots, n\}$, the log-likelihood function of the structural econometric model can be written, using the functions specified in Propositon 4, as

$$L_n(\psi) = \sum_{i=1}^{n} L(Z_i, \psi), \tag{16}$$

where

$$L(Z_i, \psi) = E_i \ln f(y_i, E_i = 1|X_i, \psi) + (1 - E_i) \ln f(y_i, E_i = 0|X_i, \psi). \tag{17}$$

The structural parameters $\psi = [\delta_0, \delta_1, \delta_2, \mu, \gamma, \sigma, \sigma_\xi, \alpha, \lambda]$ are estimated by maximizing the likelihood function $L_n(\psi)$. These parameters correspond respectively to the constant term of the ability distribution, δ_0; the correlation between education and ability, δ_1; the correlation between parents occupation and ability, δ_2; the associattion with work experience, δ_3, the minimum subsistence income μ, the elasticity of subsistence income to schooling γ, the standard deviation of the ability distribution, σ; the standard deviation of the subsistence earning distribution, σ_ξ; the elasticity of capital, α; and the magnitude of borrowing constraints, λ.

To understand the identification of the model parameters, notice that without the borrowing constraints the model would be a standard Roy model that belongs to the general framework discussed by Heckman and Honoré (1990). They showed that in the log-normal Roy model (that is, the Roy model with log-normal talent) the coefficients of nondegenerate covariates that shift the mean log talent distribution and the variance of log-talent can be identified from a single cross-section, provided data on income in each sector and occupational choices are known (Theorem 4 in Heckman and Honoré). This result guarantees that in our context, data on schooling, parents, occupational status and their corresponding earnings are able to identify the talent and income parameters δ_0, δ_1, δ_2, μ, γ, σ^2, σ_ξ^2, and α through the first-order conditions of the likelihood maximization. The additional heterogeneity that the initial wealth brings in these data is then what allows to pin down the parameter λ in the structural estimation of the model.

Denoting by $\widehat{\psi}$ the maximum likelihood estimator of the model parameters, the formula for the covariance matrix estimator is given by $\text{Var}[\widehat{\psi}] = \mathbf{I}^{-1}(\widehat{\psi})$, where

$$\mathbf{I}(\psi) = \sum_{i=1}^{n} \frac{\partial L(Z_i,\psi)}{\partial \psi} \frac{\partial L(Z_i,\psi)}{\partial \psi'} = \sum_{i=1}^{n} h(Z_i,\psi) h(Z_i,\psi)'$$

is the information matrix, and $h(Z_i,\psi) = \dfrac{\partial L(Z_i,\psi)}{\partial \psi}$ is the individual score.

To evaluate the model fit, a diagnostic test for maximum likelihood models using the Tauchen (1985) conditional moment (CM) test is used. I consider the auxilliary criterion function defined by

$$m(Z_i,\psi) = E_i - \Gamma(X,\psi), \tag{18}$$

where $\Gamma(X,\psi)$ is the model predicted probability of entrepreneurship given by (15). Hence, the function defined by Equation (18) above should satisfy the moment restriction $\mathbf{E}[m(Z,\psi)] = 0$, if the model is correctly specified. The model specification test then consists in performing a classical t-test on the intercept coefficient β_0 in the linear regression model defined by

$$\widehat{m}_i = \beta_0 + \widehat{h}_i' \boldsymbol{\beta} + \epsilon_i, \qquad i = 1, \ldots, n,$$

where $\widehat{m}_i = m(Z_i,\widehat{\psi})$ and $\widehat{h}_i = h(Z_i,\widehat{\psi})$ are respectively the moment function and the score of household i evaluated at the structural maximum likelihood estimate $\widehat{\psi}$. This test provides a statistical assessment of whether the moment function (18) is equal to zero on average over the sample (i.e. $\beta_0 = 0$), and thus whether the empirical model is correctly specified. A thorough discussion of this testing procedure can be found in Tauchen (1985). As a supplement to the CM test, I compare the estimated probability of each occupation with their sample analogs. I also compare the delay to entrepreneurship entry predicted by the model with the actual delay incurred by entrepreneurs in the data. Since the predicted delay was not specifically targeted in the structural estimation, this comparison constitutes a useful robustness check.

4.2 Structural Results, Robustness and Model Fit

The first column of Table 3 reports the parameter estimates and standard errors of the baseline specification. In a nutshell, the estimated economy is one where entrepreneurs get high returns to capital, $\alpha = 0.51$, but face tight borrowing constraints, $\lambda = 1.10$. The distribution of entrepreneurial ability shows a strong and positive elasticity of talent to education, $\delta_1 = 0.11$. It also confirms that children of entrepreneurs may benefit from informal business training at home since they are on average significantly more productive than children of non-entrepreneurs, $\delta_2 = 0.07$. The parameters related to non-entrepreneurial activities show that subsistence households expect to earn a minimum annual income of $\mu = 300.67$ (i.e. $300,670$ CFA) in the informal sector. This income varies significantly with education, with an elasticity of $\gamma = 0.2$, implying that a 10% increase in schooling is associated with an increased subsistence income of about 2%.

These results are in general similar in sign and magnitude to those obtained in Nguimkeu (2014) except for the borrowing constraint λ and the additional subsistence income elasticity parameter γ. The specification considered here allows for heterogeneity in education (captured by γ) in the outside option of the entrepreneur, as found in the data. The parameter estimate of λ obtained here is not directly comparable with the one in Nguimkeu (2014) because the latter used a unitless index of household wealth whereas this estimation is based on the market value of total household belongings.[11] In Column (2), the estimation results where the ability and wealth are allowed to be correlated are presented. The parameter δ_3 that captures this correlation is estimated at 0.0297 with a standard error of 0.0691. This indicates a positive but insignificant correlation between ability and initial wealth. I can therefore reject the hypothesis that this measure of initial wealth is a proxy for entrepreneurial ability. Moreover, with this alternative specification, the other coefficients do not significantly change while the overall likelihood deteriorates. In Column (3), the correlation between ability and experience also appears positive but insignificant. Other specifications that exclude the schooling or parent covariates yielded worse likelihoods. These results confirm the robustness of the baseline specification.

From the structural results the predicted average delay to entry for high talents is estimated at 7.11 years with a standard deviation of 2.15 years. The structural parameters

[11] When I reestimate the model with the index of wealth used in Nguimkeu (2014) I obtain a comparable estimate for λ. However, the fit of the model is less good since, as explained in Nguimkeu (2014), the wealth index represents only 31% of variations in household belongings.

Table 3: Structural Parameter Estimates

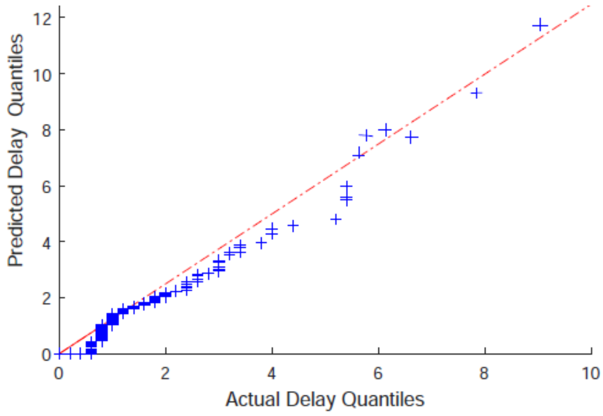
Parameter	Name	Estimate		
		(1)	(2)	(3)
Elasticity of capital	α	0.5112	0.4930	0.5041
		(0.1201)	(0.182)	(0.202)
Borrowing constraint	λ	1.1045	1.1286	1.1462
		(0.4102)	(0.5102)	(0.5251)
Log talent - constant	δ_0	3.4861	3.3590	3.2502
		(0.0312)	(0.0117)	(0.0158)
Log talent - education	δ_1	0.1102	0.0913	0.1021
		(0.0141)	(0.0081)	(0.0122)
Log talent -parent	δ_2	0.0723	0.0681	0.0695
		(0.0304)	(0.0382)	(0.0311)
Log talent -experience	δ_3	—	—	0.0792
				(0.2231)
Log talent -wealth	δ_4	—	0.0297	0.0304
			(0.0691)	(0.0586)
Log talent -std. dev.	σ	0.3362	0.2955	0.3076
		(0.0457)	(0.0352)	(0.0313
Subsitence income - minimum	μ	300.67	296.75	299.13
		(12.002)	(18.016)	(15.132)
Subsistence income - education	γ	0.1934	0.2009	0.1987
		(0.0003)	(0.0005)	(0.0011)
Number of Obs.	n	4337	4337	4337
Log-likelihood		−1032.5	−1109.3	−1234.1
Specification test		1.929	1.941	1.952

Asymptotic standard errors in parenthesis.

also allow to compute the likelihood of entrepreneurship and individual poverty taps. The proportion of missing entrepreneurs is estimated at 12.1% of subsistence households (that is, 10.9% of the full sample), and is obtained by subtracting the current proportion of entrepreneurs from the proportion of potential entrepreneurs predicted by the model. Among these missing entrepreneurs, 32% have wealth below their estimated poverty traps.

Before discussing implications from the structural estimates, it is useful to assess how well the model rationalizes the data. The CM model specification test statistic described in Section 4.1 is computed for all specifications, and none of the t-statistics exceeds the critical value of 1.96 at the 5% level. Therefore, I do not have enough evidence to reject the hypothesis that the distribution of occupations and earnings predicted by the model is identical to the actual distribution. Moreover, at the estimated parameter values, the model predicts occupational choice proportions (10% and 90%) that are

Figure 9: Actual versus Predicted Delay to Entry for Entrepreneurs



closely comparable to the observed counterparts (9.8% and 90.2%). Finally, the QQ-plot presented in Figure 9 comparing the actual (known) delay for current entrepreneurs with their predicted delay estimated from the structural model shows that their matched quantiles are closely aligned with the 45 degree line. This confirms that both quantities follow fairly similar distributions, further demonstrating the model's goodness of fit.

4.3 Simulations of a Credit Access Policy

The structural estimates obtained above can be used to evaluate the impact of various policies. The estimated model is regarded as the status quo and policy changes from this initial state can be used to assess their counterfactual impacts on the economy, taking the model as a benchmark. Since the theory emphasizes the role of credit constraints, the focus of this exercise is to investigate the effects of a policy that promotes increased credit access, on the time to entry, the fraction of switchers, welfare and wealth inequality.

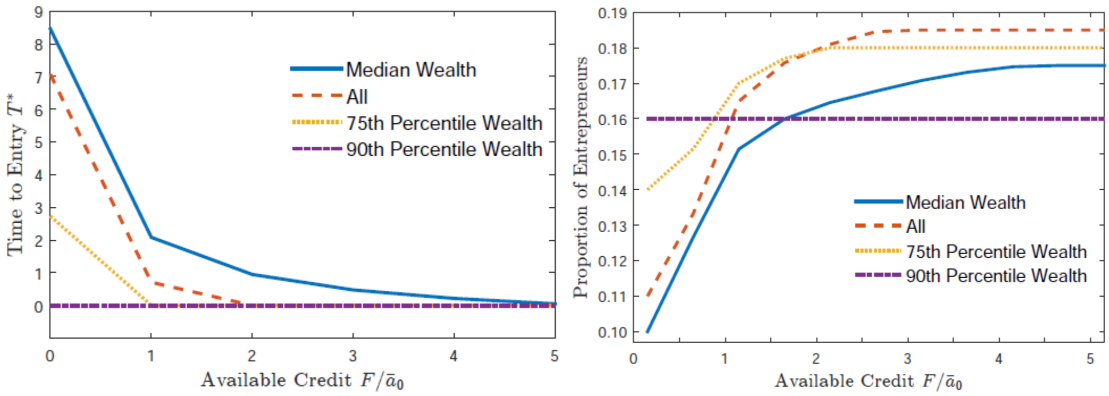
I start by simulating the average time to entry into entrepreneurship, T^*, among high talent and the fraction of switchers, when individuals have increasing access to credit. For this purpose, I relax individuals capital constraints as follows,

$$0 \leq k \leq \lambda a + F,$$

where F represents the additional capital that individuals can obtain, which does not depend on their initial wealth. Entrepreneurs therefore have access to both the traditional credit subject to the collateralized borrowing limit as well as the additional uncollateralized credit.[12] The impact of this policy within the context of the model is depicted in Figure 10. The effects are quantified for several values of the additional capital F ranging from 0, the current state, to higher multiples of the mean household initial wealth $\bar{a}_0$ (estimated at CFA 2,380.2).

[12]The additional funding can come from a Microcredit program as in McKernan (2002) or other types of policies that favor increases in corporate credit

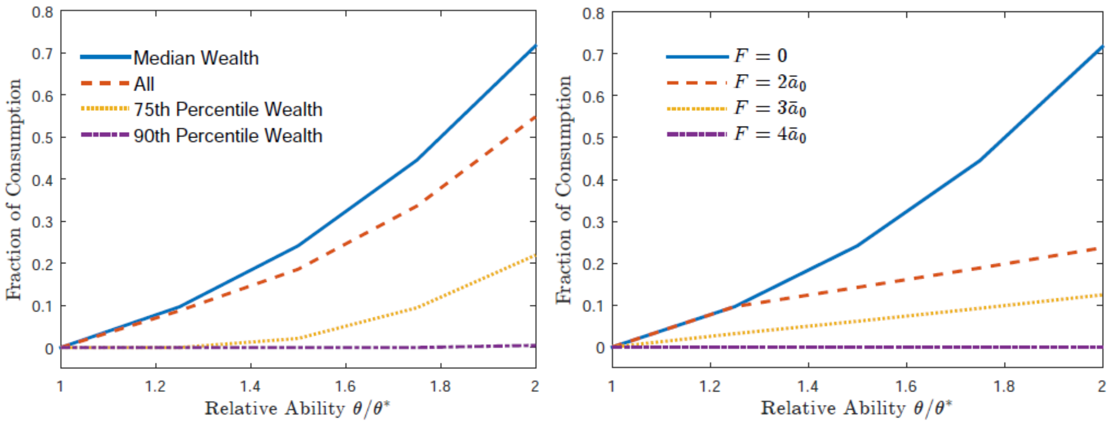
Figure 10: Impact on Entry Time and Entrepreneurship



The left panel of Figure 10 depicts the impact of increasing credit access on the average time to entry into entrepreneurship among individuals with high entrepreneurial skills ($\theta \geq \theta^*$). I compute the overall average time, denoted "All", as well as the average time for various percentiles of the initial wealth distribution (median, 75^{th} and 90^{th} percentiles). The results show that starting from the status quo where the average delay is about 7 years, this delay decreases progressively with increased access to credit and reaches zero when the amount of additional credit is about twice the mean household wealth. As expected, higher levels of initial wealth are associated with shorter delays. Interestingly, individuals above the 90^{th} percentile of the wealth distribution enter entrepreneurship right away. The right panel of Figure 10 shows the impact of credit access on the fraction of switchers for the same categorizations considered in the left panel. The fraction of switchers increases with increasing access to credit, starting from 10%, the current proportion of entrepreneurs and reaches a maximum of 19% where further increases in credit access do not change the outcome. This suggests that the remaining 81% of workers are not credit constraints, but are rather skills-constrained. The fraction of switchers is higher among individuals with higher wealth and remains constant at 16% for individuals above the 90^{th} percentile of the wealth distribution.

Delayed entry into entrepreneurship also suggests welfare losses for high talents as stylized in Figure 4. I quantify these losses in the Cameroon data by computing the fraction by which the path of consumption must be increased to make an individual of a given relative ability indifferent between living in the Cameroon economy and in a similar economy with perfect capital markets (i.e. $0 \leq k < \infty$). I compute the overall equivalent compensation of high talents, denoted "All", as well as the compensation of those among them who start their work lives with different levels of wealth (e.g. median, 75th or 90th percentiles). The results are depicted in the left panel of Figure 11 and suggests that there are potential enormous welfare losses due to borrowing constraints. In particular, individuals who could otherwise earn up to 25% higher lifetime income as entrepreneurs

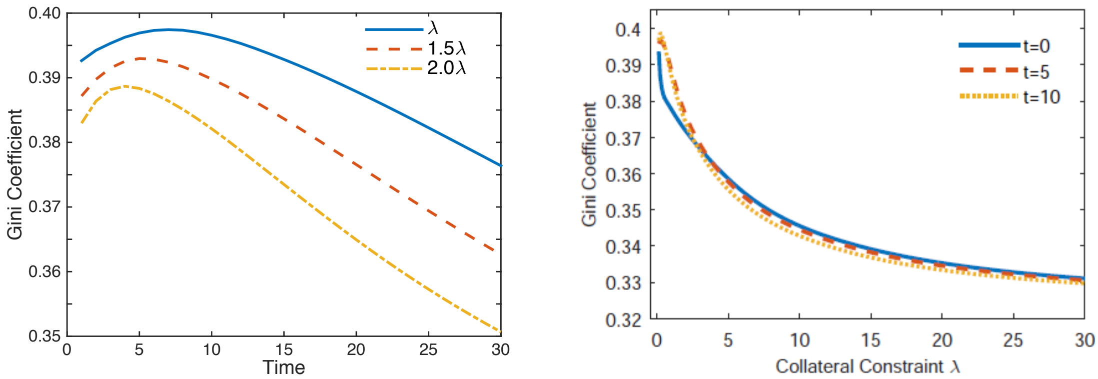
Figure 11: Impact on Welfare (Consumption Equivalent Compensation)



remain workers for about 7 years. Similarly, the average lifetime consumption of the median-wealth entrant into entrepreneurship in the data must be increased permanently by 30% to match their consumption in a similar economy with perfect credit markets. The right panel of Figure 11 depicts the consumption-equivalent compensation of the median-wealth high-talent, and shows that this compensation decreases with increased access to credit, implying welfare gains. Consistent with the simulations obtained above, only individuals with initial wealth above the 90^{th} percentile are indifferent between living in the Cameroon economy and in a similar economy with perfect credit markets.

Finally, the delay to business creation also suggests important dynamics for income inequality as found in previous work (e.g. Quadrini 1999, 2000; De Nardi and Fella 2017; Halvarsson et al. 2018). I analyze this by considering a cohort of young individuals in the data (less than 26 years old) who are potential entrepreneurs. The distribution of their wealth is then taken as the initial wealth distribution of high talents in the economy. The dynamic model is used to simulate their occupation and earning paths over a period of 30 years, starting from the statu quo, for various degrees of financial friction λ, and at various point in time. Figure 12 plots the corresponding patterns of income inequality as measured by the Gini index. The left panel shows that inequality follows the well-known Kuznets' inverted U-shape over time (see, e.g. Greenwood and Jovanovic 1990, Claessens and Perotti 2007). Because the return to capital is larger above a certain wealth threshold, those with higher initial wealth will be able to get disproportionally higher earnings sooner, which creates a temporary widening of inequality. However, after a number of years when the less wealthy prospective entrepreneurs in the cohort reach the threshold, they are able to close the income disparity gap. Moreover, with better financial markets, the decrease in inequality happens in a shorter time span. The right panel of Figure 12 shows that with better financial markets, inequality can drop by around 6.4 percentage points in the Gini from the current initial wealth distribution. The flattening of the curves at high values of the collateral constraint shows that as more prospective entrepreneurs become unconstrained entrepreneurs, the wealth disparity within the cohort shrinks towards a value that reflects the disparity in entrepreneurial skills. This limiting value of inequality does not depend on entry time.

Figure 12: Impact of Credit Constraints on Income Inequality



The above findings suggest that financial deepening and policies aimed at favoring credit access to talented individuals regardless of their wealth do not only accelerate economic growth through a timely enterprise creation, but also have the potential to shorten the duration of sharp inequality in the Cameroon context. Related policy interventions can take various forms. For instance, one approach could be to leverage the current mega trends in digital technologies in Africa to mitigate information asymmetries hindering the traditional formal lending market as discussed in Nguimkeu and Okou (2021). These authors explain that combining mobile finance transaction data with network operator data provides a powerful platform for tracking small business behavior across time and space in a way that could be used for better risk assessment within banks and to the benefit of both parties. Governments can also play a central role in the financial inclusion effort by creating the associated legal and regulatory framework such as protecting creditor rights, regulating business conduct, insuring data privacy and cybersecurity, educating and protecting consumers. Finally, in addition to microfinance programs that have been intensively discussed in the literature, a possible short term solution could be to increase potential microentrepreneurs resources through asset grant programs, such as those that have been implemented in Bangladesh, Ethiopia, Ghana, Haiti, and India, targeting the ultra poor to help them escape poverty traps (Buera et al. 2014).

5 Conclusion

This paper empirically examines the extent to which borrowing constraints delay business creation and the associated implications in terms of entrepreneurship, welfare, and inequality in countries with large informal sectors and poor financial markets. I use a standard, partial equilibrium, dynamic model of occupational choice under financial constraints to derive poverty traps, the optimal time that households switch from subsistence activity to entrepreneurship, as well as income-skill gaps as functions of entrepreneurial talent, initial wealth, and the degree of financial frictions in the economy. Using data from the Cameroon informal sector, the implications of the model are first tested with reduced-form estimates of a survival regression model where conditional hazard rates are estimated. The results show that duration in subsistence activity is negatively correlated with initial wealth which empirically confirms the existence of binding collateral constraints in credit access, even when controlling for other key factors such as schooling/apprenticeship and parents entrepreneurial status, and this duration is longer in industries with higher levels of starting capital. I then structurally estimate key parameters of the theoretical model using maximum likelihood, and found that it takes on average 7.1 years for prospective entrepreneurs to accumulate the minimum wealth required to become business runners in the Cameroon informal sector. These results also predict that 10.9% of households who would otherwise be microentrepreneurs are still operating in subsistence activities, among which more than 32% have wealth below their estimated poverty traps. Counterfactual simulations based on the estimated model show substantial welfare gains to be reaped by talented individuals. High-ability households who could otherwise earn up to 25% higher lifetime income as microentrepreneurs remain subsisters for about seven years, and the permanent consumption of a high-talent median wealth household would increase by 30% should credit frictions be removed completely. Intriguingly, allowing individuals to borrow up to twice the value of mean household wealth without collateral reduces the average delay to zero and nearly doubles the fraction of entrepreneurs in the informal sector. Relaxing collateral constraints also allows households to close their income-skill gap sooner while reducing wealth inequality by 6.4 percentage points in the country's Gini index. Only individuals whose initial wealth is above the 90^{th} percentile of the wealth distribution are unaffected by any policy aiming at improving access to credit.

The evidence found in this work most directly complements those found in studies of entrepreneurial choice under borrowing constraints in the context of industrialized countries. It provides a ground for comparison between formal economies with well developed financial markets and sub-Saharan African countries whose economies are predominantly informal with poorly developed formal financial markets. However, given the data content and limitations as well as the analytical tractability required for structural estimation, the model overlooked possible enterprise dynamics such as microenterprise survival and labor shocks, which may have potentially subtle interactions with credit constraints. This is a consideration that future empirical research could address, provided micro-panel data with detailed information related to wealth, earnings, risk-aversion, socioeconomic activities and program participation become more available for African countries.

A Appendix: Proofs

A.1 Proof of Proposition 1

Proof. (i) The function $\pi(\theta, \lambda, a_t)$ is clearly increasing in θ and in a_t and reaches its maximum at $\bar{a} = \bar{a}(\theta, \lambda)$. Notice that we can write

$$\pi(\theta, \lambda, \bar{a}) - w = (1-\alpha)\theta^{\frac{1}{1-\alpha}} \left(\frac{\alpha}{r}\right)^{\frac{\alpha}{1-\alpha}} - w = \left(\left[\frac{\theta}{\theta^*}\right]^{\frac{1}{1-\alpha}} - 1\right) w$$

Hence, for $\theta \leq \theta^*$, $\pi(\theta, \lambda, \bar{a}) - w \leq 0$ and therefore $\pi(\theta, \lambda, a_t) \leq w$ for all a_t.

(ii) Suppose $\theta > \theta^*$; Then from the above equation, we see that $\pi(\theta, \lambda, \bar{a}) - w > 0$. On the other hand, we have $\pi(\theta, \lambda, 0) - w = -w < 0$. By the intermediate value theorem, there exists $\underline{a}(\theta, \lambda) \in (0, \bar{a})$ such that $\pi(\theta, \lambda, \underline{a}) - w = 0$. It follows from the monotonicity of $\pi(\theta, \lambda, a_t)$ that $\underline{a}(\theta, \lambda)$ is unique, and $\pi(\theta, \lambda, a_t) - w \leq 0$ for all $a_t \leq \underline{a}(\theta, \lambda)$ and $\pi(\theta, \lambda, a_t) - w \geq 0$ for all $a_t \geq \underline{a}(\theta, \lambda)$.

(iii) We know that $\pi(\theta, \lambda, \underline{a}) - w = 0$. If we differentiate this equation with respect to θ, we have $\frac{\partial \pi}{\partial \theta} + \frac{\partial \pi}{\partial a_t}\frac{\partial \underline{a}(\theta, \lambda)}{\partial \theta} = 0$, which implies $\frac{\partial \underline{a}(\theta, \lambda)}{\partial \theta} = -\frac{\partial \pi / \partial \theta}{\partial \pi / \partial a_t} < 0$ (by the monotonicity of π in θ and a_t).

Likewise, differentiating with respect to λ gives $\frac{\partial \pi}{\partial \lambda} + \frac{\partial \pi}{\partial a_t}\frac{\partial \underline{a}(\theta, \lambda)}{\partial \lambda} = 0$. This implies $\frac{\partial \underline{a}(\theta, \lambda)}{\partial \lambda} = -\frac{\partial \pi / \partial \lambda}{\partial \pi / \partial a_t}$. The remaining step is then to show that $\partial \pi(\theta, \lambda, a_t)/\partial \lambda > 0, \forall a_t \in (0, \bar{a})$. Notice that we can write

$$\partial \pi(\theta, \lambda, a_t)/\partial \lambda = \alpha \theta \lambda^{\alpha - 1} a_t^{\alpha} - r a_t = r a_t \left(\left[\frac{\bar{a}}{a_t}\right]^{1-\alpha} - 1\right) > 0, \quad \forall a_t < \bar{a}.$$

Hence, $\frac{\partial \underline{a}(\theta, \lambda)}{\partial \lambda} < 0$. Finally, since $\lim_{\lambda \to \infty} \bar{a}(\theta, \lambda) = 0$ and $0 < \underline{a}(\theta, \lambda) < \bar{a}(\theta, \lambda)$, then it must be the case that $\lim_{\lambda \to \infty} \underline{a}(\theta, \lambda) = 0$

□

A.2 Proof of Proposition 2

Proof. (i) This follows from Proposition 1(i). Since for $\theta < \theta^*$, $\pi(\theta, \lambda, a_t) < w$ for any period $t = 0, 1, \ldots, \infty$, this implies that the agent is a lifetime wageworker.

(ii) Suppose $\theta > \theta^*$. Notice that $\{a_t\}_{t=0}^{\infty}$ is an increasing sequence of assets.

(a) If $a_0 \geq \underline{a}(\theta, \lambda)$, then by the monotonicity of the sequence of assets, we have $a_t > \underline{a}(\theta, \lambda)$, for all $t = 0, 1, \ldots, \infty$. By Proposition 1(ii), this means that $y_t = \pi(\theta, \lambda, a_t), \forall t \geq 0$ and the agent is a lifetime entrepreneur.

(b) If $a_0 < \underline{a}(\theta, \lambda)$, then we know from the preceding discussion that $a_t < \underline{a}(\theta, \lambda)$ for all $t < T^*$, and $a_t \geq \underline{a}(\theta, \lambda)$ for all $t \geq T^*$. The result then follows from Proposition 1(ii)

(iii) Let's start by deriving the limit of $T^*(a_0, \theta, \lambda)$ when λ is large. We have

$$\begin{aligned}
\lim_{\lambda \to \infty} T^*(a_0, \theta, \lambda) &= \max\left\{0, \lim_{\lambda \to \infty} \frac{\ln\left[(s + r\underline{a}(\theta, \lambda))/(s + ra_0)\right]}{\ln(1+r)}\right\} \\
&= \max\left\{0, \frac{\ln\left[s/(s + ra_0)\right]}{\ln(1+r)}\right\}, \quad \text{since } \lim_{\lambda \to \infty} \underline{a}(\theta, \lambda) = 0 \\
&= 0, \quad \text{because the second term in the } \max\{\} \text{ is negative.}
\end{aligned}$$

Now, let's look at the remaining properties. If $T^* = 0$, all partial derivatives are 0. Suppose that T^* is positive and defined by $T^*(a_0, \theta, \lambda) = \dfrac{\ln\left[(s + r\underline{a}(\theta, \lambda))/(s + ra_0)\right]}{\ln(1+r)}$. Then,

$$\begin{aligned}
\frac{\partial T^*(a_0, \theta, \lambda)}{\partial a_0} &= -\frac{r}{(s + ra_0)\ln(1+r)} < 0, \\
\frac{\partial T^*(a_0, \theta, \lambda)}{\partial \theta} &= \frac{r}{(s + r\underline{a}(\theta, \lambda))\ln(1+r)} \frac{\partial \underline{a}(\theta, \lambda)}{\partial \theta} < 0, \quad \left(\text{since } \frac{\partial \underline{a}(\theta, \lambda)}{\partial \theta} < 0\right) \\
\frac{\partial T^*(a_0, \theta, \lambda)}{\partial \lambda} &= \frac{r}{(s + r\underline{a}(\theta, \lambda))\ln(1+r)} \frac{\partial \underline{a}(\theta, \lambda)}{\partial \lambda} < 0, \quad \left(\text{since } \frac{\partial \underline{a}(\theta, \lambda)}{\partial \lambda} < 0\right)
\end{aligned}$$

This achieves the proof that

$$\frac{\partial T^*(a_0, \theta, \lambda)}{\partial \theta} \leq 0, \quad \frac{\partial T^*(a_0, \theta, \lambda)}{\partial a_0} \leq 0, \quad \frac{\partial T^*(a_0, \theta, \lambda)}{\partial \lambda} \leq 0 \text{ and } \lim_{\lambda \to +\infty} T^*(a_0, \theta, \lambda) = 0.$$

□

A.3 Proof of Corollary 1

Proof. Part (i) follows from the fact that wage-earners consume the entirety of their income each period, whereas prospective entrepreneurs save in period $[0, \ T^*)$ to eventually fulfill the collateral requirement (see Proposition 2). To see this, assume that $a_0 < \underline{a}(\theta, \lambda)$ so that the agent is not an entrepreneur at $t = 0$. Then, the consumption of the prospective entrepreneur in period $t \in [0, \ T^*)$ is $c_t = c_h = w + r\dfrac{(1+r)^{T^*} a_0 - \underline{a}}{(1+r)^{T^*} - 1}$. Notice that $c_h \leq w + ra_0 = c_l$.

As for Part (ii), the first order conditions shows that $u_c(c_t) > u_c(c_{t+1})$ for $t \in [T^*, \ T^{**})$. Since $u_c(\cdot)$ is decreasing (by the concavity of $u(\cdot)$), this implies that $c_t \leq c_{t+1}$ for all $t \in [T^*, \ T^{**})$. For $t \geq T^{**}$, the first-order conditions, $u_c(c_t) = u_c(c_{t+1})$, imply that consumption is constant. Since the entrepreneur is unconstrained, his earnings are given by $\pi^u = \pi(\theta, \lambda, \bar{a})$ each period. This implies a per-period consumption of $c_t = c_u = \pi(\theta, \lambda, \bar{a}) + r\bar{a}$, $\forall t > T^{**}$. Since $\bar{a} \geq a_0$ and $\pi(\theta, \lambda, \bar{a}) \geq w$, then $c_u \geq c_l \geq c_h$, that is, consumption is maximum during those later periods. □

A.4 Proof of Proposition 3

Proof. It has been shown above (see Proof of Proposition 2) that $\pi(\theta_t, \lambda, a_t)$ is increasing in λ. This means $y_t(\theta_t, \lambda, a_t) = \max\{w, \pi(\theta_t, \lambda, a_t)\}$ is also increasing in λ, so that $\forall(\theta_t, a_t)$, $y_t(\theta_t, \lambda', a_t) \geq y_t(\theta_t, \lambda, a_t)$ for any $\lambda' \geq \lambda$. This implies $\{(a_t, \theta_t) : y_t(\theta_t, \lambda', a_t) \leq y\} \subseteq \{(a_t, \theta_t) : y_t(\theta_t, \lambda, a_t) \leq y\}$ so that $F_t(y, \lambda') \leq F_t(y, \lambda)$. It follows that $\{y : F_t(y, \lambda') \geq u\} \subseteq \{y : F_t(y, \lambda) \geq u\}$ so that $F_t^{-1}(u, \lambda') \leq F_t^{-1}(u, \lambda)$.

The result then follows from the fact that the Gini index is coherent with second degree inverse stochastic dominance (see, e.g., Muliere and Scarsini 1989, Yitzhaki 1983), that is, $\mathcal{G}_t(\lambda') \leq \mathcal{G}_t(\lambda)$.

□

A.5 Proof of Proposition 4

Proof. - The joint probability of subsistence occupation and income is:

$$f(y, E = 0|X) = f(y|E = 0, X) \Pr[E = 0|X] \qquad \text{(by the Bayesian rule)}$$

Now, Since for $E = 0$, income is $y = w = \mu(1 + S)^\gamma \xi$, and $\ln \xi \sim N(-\sigma_\xi^2/2, \sigma_\xi^2)$, it follows that

$$f(y|E = 0, X) = \phi\left(\frac{\ln y - \ln \mu - \gamma \ln(1 + S) + \sigma_\xi^2/2}{\sigma_\xi}\right)$$

Likewise, the joint probability of entrepreneurship and income is:

$$f(y, E = 1|X) = f(y|E = 1, X) \Pr[E = 1|X] \qquad \text{(by the Bayesian rule)}$$

Then, by the law of total probabilities, we can write:

$$f(y|E = 1, X) = f(y|E = 1, X, a < \bar{a}) \Pr[a < \bar{a}] + f(y|E = 1, X, a > \bar{a}) \Pr[a > \bar{a}] \quad (19)$$

Since for $E = 1$ and $a < \bar{a}$, income is $y = \theta(\lambda a)^\alpha - \lambda r a$, and $\ln \theta \sim N(\bar{\theta}, \sigma^2)$, it follows that

$$f(y|E = 1, X, a < \bar{a}) = \phi\left(\frac{\ln\left[(\lambda a)^{-\alpha}(y + \lambda r a)\right] - \bar{\theta}}{\sigma}\right) = \phi\left(\frac{\ln \theta^{II}(y) - \bar{\theta}}{\sigma}\right)$$

Likewise, for $E = 1$ and $a > \bar{a}$, income is $y = (1 - \alpha)\theta^{\frac{1}{1-\alpha}}\left(\frac{\alpha}{r}\right)^{\frac{\alpha}{1-\alpha}}$, and $\ln \theta \sim N(\bar{\theta}, \sigma^2)$, it follows that

$$f(y|E = 1, X, a > \bar{a}) = \phi\left(\frac{\ln\left[(r/\alpha)^\alpha \left(y/(1 - \alpha)\right)^{1-\alpha}\right] - \bar{\theta}}{\sigma}\right) = \phi\left(\frac{\ln \theta^*(y) - \bar{\theta}}{\sigma}\right)$$

Finally, $$\Pr[a > \bar{a}] = \Pr\left[a > \frac{1}{\lambda}\left(\frac{\theta\alpha}{r}\right)^{1/(1-\alpha)}\right] = \Pr\left[\theta < (\lambda a)^{1-\alpha}\frac{r}{\alpha}\right]$$

$$= \phi\left(\frac{\ln[(\lambda a)^{1-\alpha} r/\alpha] - \bar{\theta}}{\sigma}\right) = \phi\left(\frac{\ln \theta^I - \bar{\theta}}{\sigma}\right)$$

I now compute $\Pr[E = 1|X]$, denoted $\Gamma(X, \psi)$. By the law of total probability, we have

$$\begin{aligned}
\Pr[E = 1|X] &= \Pr[E = 1|X, a < \bar{a}] \Pr[a < \bar{a}] + \Pr[E = 1|X, a > \bar{a}) \Pr[a > \bar{a}] \\
&= \Pr[\pi > w|X, a < \bar{a}] \Pr[a < \bar{a}] + \Pr[\pi > w|X, a > \bar{a}) \Pr[a > \bar{a}]
\end{aligned}$$

with

$$\Pr[\pi > w|X, a < \bar{a}] = \Pr[\theta(\lambda a)^\alpha - \lambda r a > w] = \Pr[\theta > \theta^{II}(w)] = \Phi\left(\frac{\ln \theta^{II}(w) - \bar{\theta}}{\sigma}\right)$$

and

$$\Pr[\pi > w|X, a > \bar{a}] = \Pr\left[(1-\alpha)\theta^{\frac{1}{1-\alpha}}\left(\frac{\alpha}{r}\right)^{\frac{\alpha}{1-\alpha}} > w\right] = \Pr[\theta > \theta^*(w)\Big] = \Phi\left(\frac{\ln \theta^*(w) - \bar{\theta}}{\sigma}\right)$$

□

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