The Transition to Entrepreneurship: Human Capital, Wealth and the role of Liquidity Constraints

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Abstract

Hurst and Lusardi (2004) show that the probability of transition to entrepreneurship is inelastic along most of the wealth distribution. They interpret this finding as evidence that wealth holding is not an important determinant of entrepreneurship. This paper challenges this view. I estimate a life cycle model of occupational choice that includes human capital heterogeneity, which generates a flat transition probability profile with respect to wealth. However, I show that the shape of such aggregate relationship cannot be interpreted as evidence of the lack of liquidity constraints in the economy, but as a result of the optimal decisions of agents with different levels of human capital and assets within a cross-section. Moreover, quantitative analysis suggests higher credit constraints characterize better the data for the U.S. economy. Altogether, the results in this paper imply wealth is a key element of the occupational decision at the individual level.

JEL Classification: M13, G11, J24

KEYWORDS: Entrepreneurship, human capital, wealth distribution, life cycle, transition probability.

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1 Introduction

It is widely recognized today that entrepreneurship plays a key role as an important driver of economic development, capital accumulation and growth. Estimations from representative population surveys indicate this group receives more than 20% of income and owns around 40% of total wealth. Following Moskowitz and Vissing-Jørgensen (2002) the total value of private equity was about the same size as the total value of public equity in the U.S. during the 1990's. Since the late 1980's and until recent years *liquidity constraints were considered the main entry barrier for individuals with entrepreneurial ideas or projects.*[1] This claim has important policy implications. In fact, incentives to promote entrepreneurship through the expansion of credit channels are nowadays at the top of the policy agenda around the world. Yet, in a very influential paper Hurst and Lusardi (2004) question this idea based on empirical evidence for the U.S. economy. They estimate the probability of transiting into entrepreneurship as a function of wealth, and show it is inelastic for almost all agents in the economy and only monotonically increasing at the top 5%-10% of the wealth distribution. They interpret this finding as evidence against the importance of liquidity constraints in the decision to become an entrepreneur. On the other hand, Buera (2006) shows that a model where agents are heterogeneous in ability and wealth implies a hump-shaped relationship between the transition probability and wealth. However, his results don't reconcile with Hurst and Lusardi's (2004) estimation.

Thus, the goal of this paper is to provide a theoretical framework to understand the role of liquidity constraints in the transition to entrepreneurship, and to reconcile recent findings in the literature. Following this line, I construct a life-cycle model of occupational choice that includes human capital and wealth heterogeneity. Agents in this environment face idiosyncratic shocks to entrepreneurial earnings, deterministic labor market earnings, and may be subject to credit constraints. Human capital, composed by permanent (entrepreneurial skills and education) and dynamic components (experience), is a key determinant of labor and entrepreneurial earnings. These define respectively, opportunity costs and expected benefits in the individuals' valuation of the decision to start a business.

Empirically, the decision to incorporate human capital heterogeneity in a life cycle framework is motivated in two ways. The first is by the key differences across entrepreneurs with different educational attainment in earnings, wealth accumulation, returns and transition probability profiles documented in Mondragon (2005). While most of the literature has studied entrepreneurs as a homogeneous group that share some unobserved characteristics, these facts suggest education is an observable characteristic by which entrepreneurs differ

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[1] See Evans and Jovanovic (1989), Evans and Leighton (1989) and Gentry and Hubbard (2001)

in important ways. Second, the experience component of human capital implies dynamic opportunity costs for individuals as they age.[2] Section 3 presents a set of facts that highlight important differences implied by education and age in terms of workers and entrepreneurs' earnings profiles, and the fraction of the population involved in entrepreneurial activities for an average cohort along the life cycle.

The model is estimated numerically using the method of simulated moments to replicate U.S. data on earnings and fractions of entrepreneurs by age-education groups. Simulation results show that while the transition probability profiles for agents with the same educational attainment within a cohort are consistent with Buera (2006), the (cross-sectional) aggregation of agents from different cohorts implies a transition probability profile with the same qualitative properties as the one in Hurst and Lusardi (2004) *regardless of the degree of liquidity constraints*. Hence, even a case where no credit is available to potential entrepreneurs may still imply an inelastic transition profile below the 90^{th} wealth percentile. This suggests the shape this relationship is not necessarily a consequence of the lack of liquidity constraints in the economy, but the result of the aggregation of cohorts at a point in time facing different opportunity costs (a feature not captured by age/cohort controls in reduced form estimations). Moreover, when the degree of available credit is assumed to be a known structural parameter in the model, sensitivity analysis suggests higher credit constraints characterize better the data.

To uncover the intuition behind this result one can think of a simplified economy where agents differ only in wealth and human capital (defined as some function of education and age). Assume wealth can always be invested in a risk-free asset and no borrowing or lending takes place. Each period agents must choose between two alternative occupations. As workers they earn a wage determined by education and age (as a proxy for experience). As entrepreneurs they operate a convex technology that requires a fraction of their wealth in the form of physical capital, as well as their own human capital. Take two agents in this economy (Y and A) who were workers in the previous period. Let Y be a 26 year-old high school graduate whose wealth at the beginning of this period is $\$7,000$, and A be a 36 year-old college graduate with $\$70,000$ of wealth. In this context, my model highlights that while Y decides to become an entrepreneur, A may continue being a worker despite owning 10 times as much wealth. The explanation relies on the fact that these individuals (with different levels of human capital) face two different decision problems. In particular, the environment described above implies that for each level of human capital, there exists a wealth threshold

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[2] While Evans and Leighton (1989) argue that the probability of transition to self-employment is independent of age, Åstebro and Bernhardt (2004) show that human capital has an undetermined net effect on the capital size of start-ups.

above which agents are better off being entrepreneurs than workers (Suppose for instance that the wealth thresholds for Y and A are \$6,000 and \$80,000 respectively). Moreover, within any group of workers that are homogeneous in human capital, only those with wealth near the previous period threshold will be able to accumulate enough assets to make the transition to entrepreneurship next period (For example, assume that at the beginning of last period Y had \$5,000 of wealth and faced a \$5,500threshold, while A had \$60,000 of wealth with a \$70,000 threshold). In general, note that most workers who have not transited to entrepreneurship up until this period do not populate the highest deciles of the wealth distribution. This implies that for a group of workers with the same level of human capital, the distribution of wealth tends to be concentrated around its median. Therefore, the mass of workers who are above the median this period (that is, those who where close enough to the threshold in the previous period) explains why the fraction of workers that transit to entrepreneurship at a point in time tends to be small when wealth thresholds increase with human capital.

Now, why is this fraction of agents transitioning to entrepreneurship inelastic for most of the wealth distribution? Think again of the distribution of wealth for a group of agents with the same level of human capital. Given wealth increases over the life cycle, this distribution shifts to the right as the group ages (with some increase in skewness as well due to fixed returns to wealth). In addition, for most human capital levels (except those workers near retirement age) this shift in wealth is accompanied by an increasing wealth threshold that keeps the fraction of workers "in the margin" for the group fairly constant. In other words, any positive impact on the probability of becoming an entrepreneur due to wealth accumulation in time is offset by increasing human capital (and therefore wealth thresholds) for most agents in the economy. Thus, since wealth increases with human capital for young workers, the profile observed for any cross-section is a consequence of aggregating the behavior of groups of workers with different human capital levels at a point in time. In the case of the two agents analyzed above, while Y may have started life with a wealth level above the median of her peer group and was able to transit to entrepreneurship early in the life cycle, A has not been able to overcome her increasing wealth threshold and may never enter entrepreneurship. This example could also be extended to explain the strong positive monotonicity of the transition profile at the top of the wealth distribution. It will reflect the behavior of older workers with high levels of accumulated assets who face a decreasing human capital profile at the end of their productive life. Furthermore, there is support for this explanation in the data, given by a higher average age observed for individuals at the top of the wealth distribution who transit to entrepreneurship. The key assumption that drives the particular dynamics in this example is the behavior of the so-called "wealth threshold" with respect to human capital. Since it is not possible to derive a closed analytical solution to uncover such dynamics, the model's numerical estimation is a crucial element of this study.

In addition to the analysis of the transition probability profiles I also study the dynamics of savings along the life cycle. In particular, I estimate the differences in saving behavior for agents without any entrepreneurial skills relative to that of agents with some potential to become entrepreneurs in the future. The results are consistent with the findings of Quadrini (1999), in the sense that potential entrepreneurs save more than ever-to-be workers until they can overcome their liquidity constraints.

In sum, while some studies have presented empirical evidence against the relevance of age for entrepreneurship and only a few include education and human capital in the analysis, this paper highlights the role of human capital as the key driver of life-cycle dynamics in the occupational decision problem faced by agents. The inclusion of human capital in the model implies age is not only related to the accumulation of wealth through savings, but also determines the opportunity costs and expected returns of human capital associated to the occupational decision over the life-cycle. Therefore, age and education are key determinants of the transition process at the individual and aggregate levels. And when considered, they provide a better way to understand the role of liquidity constraints in decision to become an entrepreneur. The paper is organized as follows. Section 2 reviews related research on entrepreneurship; section 3 presents facts on entrepreneurship related to education and age; section 4 describes the model; section 5 describes the estimation procedure; section 6 presents the results; and section 7 concludes and points the direction of future research.

2 Related Literature

The empirical studies of Evans and Leighton (1989) and Evans and Jovanovich (1989) that emphasized the role of liquidity constraints as important barriers for entrepreneurship, influenced all subsequent studies for more than a decade. Most occupational decision models since then included liquidity constraints in their structure. Banerjee and Newman (1993) and Galor and Zeira (1993) incorporate financial frictions to study problems related to development, economic growth and wealth distribution dynamics. More recent studies like Quadrini (2000), Cagetti and De Nardi (2003) and (2006), and Boháček (2003) incorporate these frictions in a general equilibrium framework and show entrepreneurship is key to explain the right tail of the wealth distribution. Other studies use this general equilibrium setting to analyze other aspects of entrepreneurship such as taxation (Meh (2000) and (2002)), altruism (Cagetti and De Nardi (2003) and (2006)), and differences across specific education types (Terajima (2003)). In regards to this line of research, the results of this paper imply that potential entrepreneurs save more not only before the transition as in Quadrini (1999), but also accumulate more wealth after the transition in the form of physical capital required to operate their business. The latter is implied by the lower size of start-ups relative to the efficient size. Estimated entrepreneurial earnings profiles show that successful entrepreneurs earn more than their peer workers not only in cross-section but also over the life cycle. In addition, college educated entrepreneurs run bigger firms than their non-college educated peers given their access to better technologies with higher growth potential, consistent with Mondragon (2005).

Cagetti and De Nardi (2003) show that higher altruism generates a higher number of entrepreneurs in the economy. Although in the present framework agents are heterogeneous with respect to wealth when they enter the model at a young age, this particular feature is not a key driver of the results. In fact, the estimated distribution of wealth for the young is very concentrated at low values near zero. Hence, since most agents transiting to entrepreneurship build up their wealth through savings, the role of inheritances in this model may be more associated to the educational attainment of the young. In addition, the size of start-up businesses is relatively small for most entrepreneurs, specially the young. These results are consistent with the lack of evidence towards the importance of inheritances and the small average size of businesses documented in Hurst and Lusardi (2004). In addition my own estimations form SCF data show that the majority of entrepreneurs don't rely on inheritances to start their businesses.[3] On the other hand, the environment studied by Cagetti and De Nardi (2003) and (2006) incorporates a life cycle dimension that includes young and old workers, and the retired. However, the equilibrium nature of their model cannot be used to study in detail the transition process. In this sense, Buera (2006) is (to the best of my knowledge) the first attempt of a multi-period occupational choice framework to analyze the dynamics of the transition to entrepreneurship over the life cycle. His model is a multi-period extension of Evans and Jovanovic (1989) that includes ability and wealth heterogeneity. In contrast with Hurst and Lusardi (2004), this model implies a theoretical hump-shaped relationship between the probability of transition to entrepreneurship and wealth. However, the empirical estimates provided as support to this theory incorporate a measure of wealth adjusted for opportunity costs (wealth to wage ratio). Along this line, the contribution of this paper is to show that incorporating human capital in the analysis reconciles Buera's (2006) results with those of Hurst and Lusardi (2004). And more importantly, provide a theoretical based interpretation of the latter. Furthermore, the results in this paper are in

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[3] According to these estimations only 4% of entrepreneurs inherit their businesses directly, while less than 1/4 of entrepreneurs who bought or started their own businesses (which correspond to more than 90% of all entrepreneurs) received an inheritance at some point in time.

line to those of Akyol and Athreya (2006), who use a model similar to the one described in section 4 to study the effects of limits to liability on entrepreneurial activity.

On the empirical side, Hurst and Lusardi's (2004) main contribution was to show that the positive correlation between the probability of becoming an entrepreneur and wealth documented in Evans and Jovanovich (1989), was generated mainly by the strong monotonicity at the top of the wealth distribution. Mondragon (2005) shows that the functional form emphasized in Hurst and Lusardi (2004) doesn't fully capture the relationship suggested by a non-parametric estimation (which is the consequence of differentiated behavior by college education groups), and that the monotonicity at the top of the wealth distribution has weak statistical support. However, in the non-parametric estimation the transition probability is still inelastic up to the top percentiles of the wealth distribution at the aggregate level and for each education-group. In this sense, the results presented in this paper replicate the behavior suggested by these non-parametric estimations for different education groups. Finally, Åstebro and Bernhardt (2004) estimate a reduced form version of Evans and Jovanovic's (1989) model that includes human capital. They use cross-sectional data from the 1987 CBO (Characteristics of Business Owners), and include several controls for education and experience. Through this framework, they don't find any conclusive evidence about the role of human capital in the transition to entrepreneurship. In other words, within a cross-section of agents the net effects of human capital in the decision to become an entrepreneur are ambiguous. The latter result constitutes additional motivation for this paper, in the sense that there is a need to understand the role of human capital in the transition process. Moreover, their finding supports the main intuition behind the results presented in this paper, in the sense that the dynamics of human capital imply some kind of offsetting effect in terms of the transition to entrepreneurship. Hence, any analysis of this phenomena using cross-sectional samples will not be able to disentangle such offsetting effects.

3 Some facts on education and entrepreneurship over the life cycle

The usual facts that have motivated research on entrepreneurship point to the observed differences in income and wealth between workers and entrepreneurs. Using cross-sectional analysis, Mondragon (2005) shows an important part of these differences is mainly driven by college education and business type. That is, college educated entrepreneurs who usually run "high-tech" businesses make the average entrepreneur's income and accumulated wealth significantly higher than those of the average worker. Furthermore, since the fraction of entrepreneurs among the college educated is higher than for the non-college educated, the same effect takes place in terms of median income and wealth. Thus, education plays a key role in the determination of entrepreneurial technology, income and wealth. On the other hand, the relationship between age and entrepreneurship remains an open question. The cross-sectional pattern of the fraction of entrepreneurs and workers by age, typically observed in both PSID and SCF data is summarized in Figure 1 (which corresponds to SCF 1998). This pattern suggests there are age effects associated to the fraction of entrepreneur households. However, Evans and Leighton (1989) arrived to different conclusions using CPS data.[4]

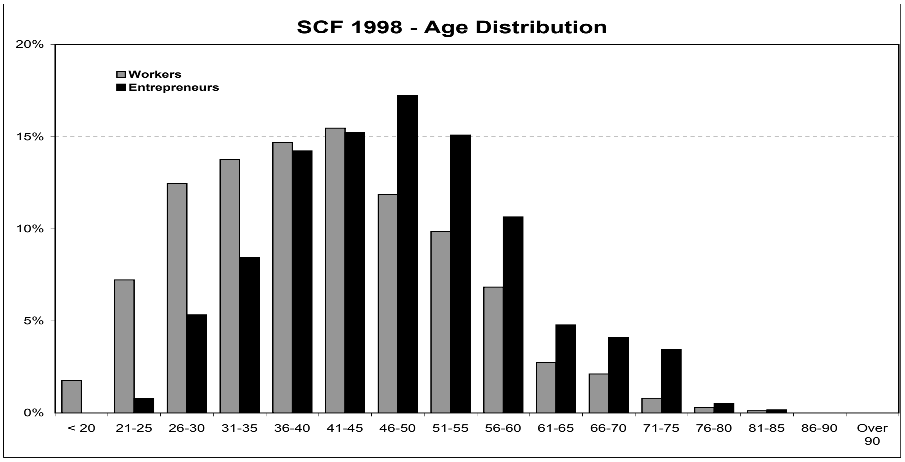

Figure 1: Fraction of workers and entrepreneurs by age groups in cross-section

As in the case of the transition probability profile, the latter figure is the cross-sectional result of life-cycle dynamics at a point in time. Thus, the goal of this section is to provide additional facts on entrepreneurship and education over the life cycle, to be used as inputs to model and understand the dynamics of the transition to entrepreneurship. In particular, I estimate earnings profiles for both worker and entrepreneur households, and fractions of entrepreneur households by age and education groups for an average cohort. I define entrepreneur households as those who declare to own a business and where either the household head or her spouse declare to be self-employed.[5]

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[4] They use CPS data and a time homogeneous Markov model to show that entry rates to self-employment are independent of age and experience, and that exit rates decrease with tenure. Consequently, the fraction of those self-employed increases up to some plateau at age 40, which remains flat up to retirement years.

[5] As discussed in Hurst and Lusardi (2004), various studies use alternative definitions of entrepreneur. In particular, they don't find any significant difference for alternative definitions by ownership or occupation. In

The estimation of earnings profiles[6] was done using PSID data for years 1968-1991, and separately for the two occupational groups (worker and entrepreneur households) and educational groups (non-college and college educated) defined in the model.[7] The estimated specification is described by:

$$\varepsilon_{it} = \gamma_0 + \gamma_i + u_t + \gamma_1 age + \gamma_2 age^2 + \gamma_3 sex + \xi_{it}$$

where ε_{it} is the earnings level of household i at time t, γ_i corresponds to household's i random effect, u_t is the unemployment rate in year t to control for time effects,[8] and *age* and *sex* are based on the characteristics of the household head. Using the estimated parameters, the mean value for the unemployment rate in the period 1968-1991 and the fraction of male headed households in each subsample, a life-cycle earnings profile was estimated at each age j and separately for each occupation-education group. Figure 2 shows the comparison between estimated earnings profiles for college and non-college educated worker and entrepreneur households. This estimation shows earnings profiles for worker households are not only lower but flatter than those of entrepreneur households for both education levels. Consistent with the cross-sectional facts mentioned above, the earnings gap between college educated entrepreneurs and workers evidence the role of education on entrepreneurial earnings along the life cycle. In addition, the profiles for worker and entrepreneur households get closer at the end of the life cycle for both education levels (and more for the non-college educated). As will be described in section 4, these profiles determine the expected benefits (entrepreneur's profile) and opportunity costs (worker's profile) of human capital in the decision to become an entrepreneur. Thus, the dynamics represented in these profiles play a crucial role in the transition to entrepreneurship for individuals within different age-education groups.

I now describe two alternative estimations of the fraction of entrepreneur households by age and education groups for an "average cohort", using PSID data. The results of these estimations are shown in tables 1 and 2. In the first exercise (table 1) I compute the fraction of entrepreneur households by (4-year and 8-year) age groups and education levels for each

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this model business ownership and self-employment are fundamental characteristics of entrepreneurs, given that the decision takes into account opportunity costs for both physical and human capital.

[6] Earnings are defined as wages and salaries for worker households, and labor plus business capital components for entrepreneur households. For a detailed discussion on earnings data for entrepreneurs see Mondragon (2005).

[7] In the definition of these education groups, the college-educated include all those household heads who attained at least 1 year of college. Two alternative specifications where estimated. The first one included a dummy variable for the college educated and the second one estimated one regression for each education group. The latter specification showed a steeper profile for the college educated group; which cannot be determined through the first specification.

[8] An alternative specification including cohort effects instead of time effects was estimated. For each educational group both specifications show a very similar life cycle profile for an "average cohort". This result is consistent with Huggett et. al. (2005).

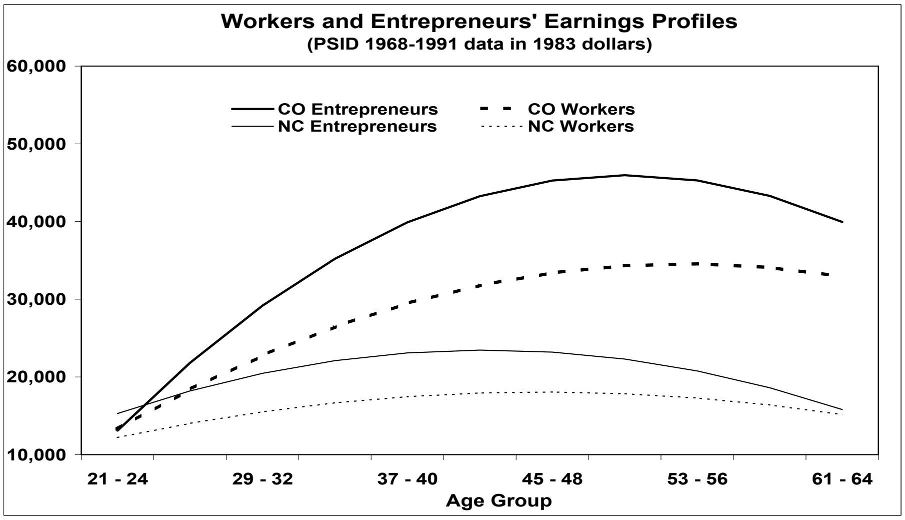

Figure 2: Estimated earnings profiles by occupation-education groups

of the PSID cross-sections between 1984-1991,[9] and take the average for all the groups across time. Since the PSID follows a sample of households across time adding new ones formed by individuals who where part of a household in previous years; and assuming that most of the new households are formed by young individuals; these repeated cross-sections can be taken as being very close to a panel.[10] The low standard deviation levels in table 1 reflect the fact that the fraction of entrepreneur households by age is very stable across cohorts for both education groups.

In the second exercise I compute the fraction of entrepreneur households within each cohort that is part of the 1984 PSID cross section as the cohort ages, and take averages across 4-year age groups separately for both education levels. For example, the first cohort is composed by individuals who are 25 years old in year 1984. For this group I observe the number of (non-college and college) entrepreneur households at age 25 (year 1984) to age 28 (year 1987) and the number of (non-college and college) entrepreneur households at age 29 (year 1988) to age 32 (year 1991). With this information and the total size of the cohort's age-education groups I can compute the fraction of entrepreneurs between ages 25-28 and

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[9] I select the last years in the PSID sample used for earnings profiles estimations, in order to have the highest sample sizes available to take averages across age groups and education levels.

[10] Deaton and Paxson (1994) argue that repeated cross sections are in some dimensions better than panel data.

Table 1: (%) Fraction of entrepreneurs by age-education groups and PSID year (1984-1991)

Age	Non-College Educated										College Educated									
Group	1984	85	86	87	88	89	90	1991	$\bar{x}$	sd	1984	85	86	87	88	89	90	1991	$\bar{x}$	sd
25-28	2	3	3	3	5	3	4	3	3	1	6	7	5	5	6	8	6	6	6	1
29-32	5	7	6	4	3	4	3	4	5	1	10	8	8	6	8	10	7	10	8	1
33-36	6	6	5	9	9	10	7	5	7	2	11	11	11	10	12	9	8	9	10	1
37-40	9	10	10	6	6	5	7	11	8	2	19	15	14	14	11	13	12	11	14	3
41-44	10	12	13	14	15	11	9	5	11	3	14	20	19	20	17	16	17	13	17	2
45-48	11	8	9	12	11	14	10	14	11	2	16	11	13	14	17	19	15	18	15	3
49-52	10	11	12	14	15	13	12	11	12	2	15	27	23	18	15	13	17	13	18	5
53-56	8	9	10	8	10	8	10	12	9	1	19	14	19	19	23	26	21	20	20	3
57-60	9	8	11	7	10	8	8	7	8	2	18	22	24	21	20	18	22	21	21	2
61-64	7	7	5	17	12	16	10	11	11	4	4	13	17	21	16	31	31	21	19	9
Age	Non-College Educated										College Educated									
Group	1984	85	86	87	88	89	90	1991	$\bar{x}$	sd	1984	85	86	87	88	89	90	1991	$\bar{x}$	sd
25-32	4	5	5	4	4	4	3	4	4	1	8	8	7	6	8	9	7	8	7	1
33-40	7	8	7	8	8	8	7	8	8	0	14	13	13	12	11	11	10	10	12	2
41-48	10	10	11	13	13	12	10	9	11	2	15	16	16	18	17	17	16	15	16	1
49-56	9	10	11	11	12	10	11	11	11	1	17	20	21	18	19	18	18	16	18	2
57-64	8	8	9	11	11	11	8	8	9	1	14	20	22	21	19	23	26	21	21	4

29-32 for this cohort. Using PSID data for years 1981 to 1991 I can compute the fractions shown in table 2. As it is shown in this table the average fractions of entrepreneur households for different age ranges using this "panel dimension" of the sample are very similar to the 4-year averages obtained from the cross sections in table 1. This confirms that the exercise using the repeated cross-sections is a good approximation of the panel dimension. For the model's estimation I use 8-year age groups average fractions for the two education levels.

The estimation shows that the fraction of entrepreneurs within a cohort increases in time up to ages 45-50 for the non-college educated, and ages 50-55 for the college educated. In addition, the fraction of college educated entrepreneurs is higher than the fraction of non-college entrepreneurs for all age groups. The fraction of non-college educated entrepreneurs increases from 2% (at ages 25-28) to 10%-12% after age 45, and from 6% (at ages 25-28) to around 20% after age 50 for the college educated. Thus, a higher fraction of entrepreneurs is observed in the college educated group, where earnings differentials seem to be more attractive than for their non-college educated peers. The model that follows will be estimated so as to replicate the facts presented in this section; in order to provide a deeper understanding of the transition to entrepreneurship and its determinants.

4 The Model

Time is discrete. Agents live for J periods where age $j = \{1, ..., J\}$. At age $j = 1$ they exhibit ex-ante heterogeneity in initial assets $a_0 \in R^+$ and human capital permanent components (education level $e \in \{NC, CO\}$ (non-college, college) and entrepreneurial ability or skills $s \in S$). All agents have a productive life of R periods $(1 < R < J)$ where they can generate income (in addition to risk- free returns on their wealth) either from working for someone else or becoming entrepreneurs. After retirement age R, their only income source are risk-free returns on accumulated assets. At the end of age J individuals exit the economy.

4.1 Preferences

Agents in this economy are assumed to be homogeneous with respect to preferences and maximize expected lifetime utility.[11]

$$E[\sum_{j=1}^{J} \beta^j u(c_j)]$$

4.2 Productive Life - Individual Decision Model

During each of the periods along their productive life agents face consumption-saving and occupational decisions in the presence of idiosyncratic shocks associated to the entrepreneurial activity. The timing is as follows (see figure 3). At the beginning of period t agent i observes her accumulated assets and last period's (entrepreneurial) productivity shock z; she also observes her own age, permanent entrepreneurial skills and education level. Using this information, she decides whether to be a worker or an entrepreneur during the period, and in the latter case how much capital k to invest in her venture. In all cases, she must also decide at the beginning of t how much to consume during the period. After these decisions are made, consumption c takes place while the actual (entrepreneurial) productivity shock z' realizes and income is generated. According to the initial decision on consumption and income realization, the new assets' level a' is known at the end of the period.

It is important to note that this model assumes no uncertainty on labor income.[12] The

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[11] Although it has been argued that risk-aversion heterogeneity plays a key role in the entrepreneurial decision, this paper focuses on other elements that characterize entrepreneurs' heterogeneity. See for example Moskowitz and Vissing-Jorgensen (2002) and, Caggetti and De-Nardi (2003). However, as will be discussed later entrepreneurial ability/skills heterogeneity can be thought of as a substitute for risk aversion heterogeneity in regards to the transition process.

[12] Labor income will be assumed to follow a deterministic profile that depends on age and education level. That is, all workers earn the average income of their age-education group. Uncertainty could be introduced either by iid shocks or through some markov structure. Labor income uncertainty will create additional

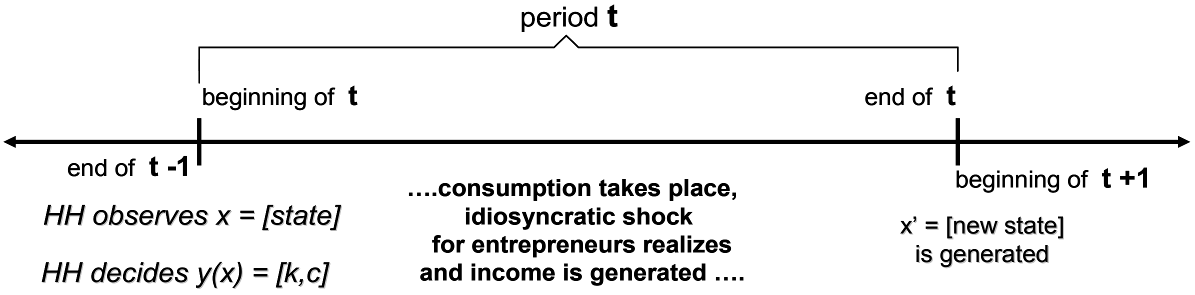

Figure 3: Individual decision timing for productive life periods

only uncertainty included is the one associated to entrepreneurship (see figure 4). In this setup agents "trigger" a stochastic process for entrepreneurial productivity only when they decide to start a new business. In particular, I assume a Markov process to model this uncertainty $Q\left(z'|z\right)$ where there is some neutral "middle state" z_M that doesn't affect entrepreneurial earnings.[13] Hence, agents are born at this middle state ($z_0 = z_M$) and remain in it as long as they don't transit to entrepreneurship, or return to it every time they decide to become workers again. This stochastic structure also reflects the fact that while start-up entrepreneurs have no prior information on their probability of success in the business, entrepreneurs with longer tenures learn about their business and their probability of failure or success.

4.3 Human Capital and Earnings

Human capital $H\left(e, j, s\right)$ is a function of age j, education level e and entrepreneurial skills s. The level of human capital accumulated by individuals at each point in their productive life is a key determinant of earnings for both workers and entrepreneurs. As mentioned above, individuals are born with permanent levels of entrepreneurial skills $s \in S$ and education $e \in \{NC, CO\}$ (non-college, college).[14] Therefore, agents accumulate human capital

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sources of wealth heterogeneity along the life cycle, different savings incentives and interesting dynamics with labor shocks histories and the entrepreneurial decision. All these at the cost of having more parameters to estimate and more complexity in understanding the mechanisms driving the transitional dynamics. This assumption was made to reflect the fact entrepreneurial income is in general more risky than labor income in a simple way and concentrate on average savings and opportunity costs mechanisms driving the transition to entrepreneurship.

[13] This is a multiplicative shock to entrepreneurial earnings. Hence the middle state z_M is assumed to take the value of 1.0.

[14] PSID data for years 1985-1990 shows that only 55% of household heads with at least some college education, finished their schooling by age 24; 20% attain their last college education level between ages 25-29; while 25% graduated from college between ages 25-29. Although these are interesting facts regarding college education attainment along the life-cycle, this model doesn't include a (college) educational decision over the life cycle, nor it distinguishes the precise educational attainment among the Non-College or the

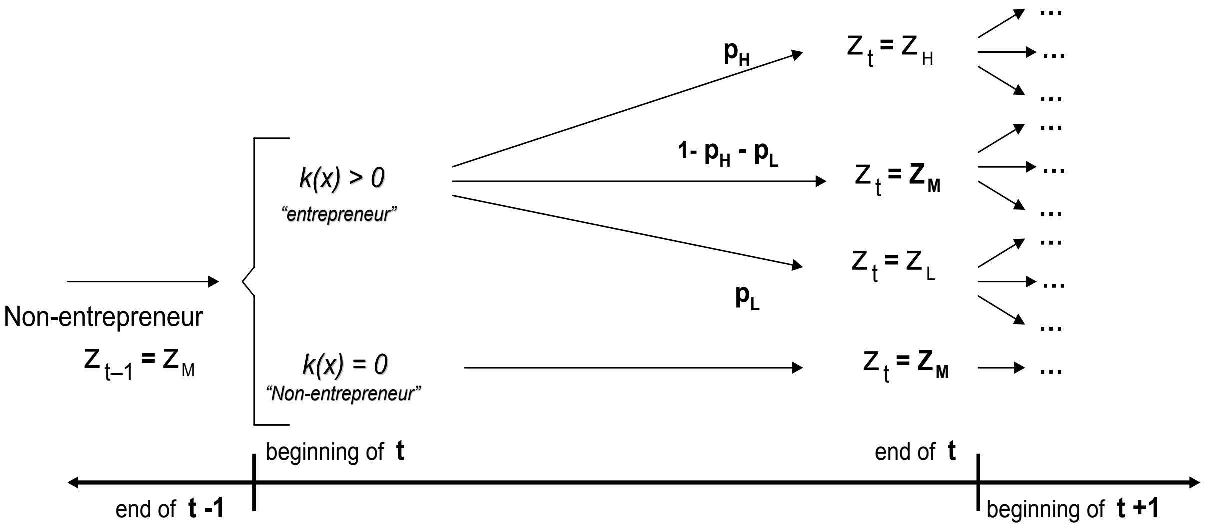

Figure 4: Entrepreneurial productivity shock stochastic structure

as they age (as a proxy for experience). As mentioned in section 3 data shows that college educated individuals accumulate more human capital than non-college educated ones; thus, $H(CO, j, s) > H(NC, j, s)\ \forall\ j = \{1, ..., J\}$ and any $s \in S$. Regarding earnings, it is assumed that all age j workers' earnings are deterministic and exactly proportional to the human capital level associated to their education level (and independent of the level of entrepreneurial skills). Let $h(e, j)$ be the part of human capital related to education and age, and labeled from now on as "workers' human capital" since is the part of H relevant to workers. Then, age j non-college workers will earn $h(NC, j)$ and age j college workers will earn $h(CO, j)$ with probability 1. In other words, $h(e, j)$ is the opportunity cost of human capital for entrepreneurs. On the other hand, entrepreneurial earnings $\Pi_e(k, h, s, z')$ are indexed by education level $e \in \{NC, CO\}$, and are a function of human capital components (entrepreneurial ability/skills $s \in S$ and $h(e, j)$), idiosyncratic productivity shock $z' \in Z$ and capital k. The indexation by education reflects the fact that agents with different education levels run different technologies. The inclusion of the entrepreneur's human capital components ($h(e, j)$ and s)[15] and productivity shock z[16] as inputs, imply the transmission of

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College educated.

[15] Recall that individuals who decide to become entrepreneurs can only work in their own business in this setup. This implies that entrepreneurs not only face financial opportunity cost and risk for the physical capital they invest in the business, but also face an opportunity cost for their human capital associated to the occupational decision.

[16] This creates two effects. On the one hand, there will be cutoff values of entrepreneurial ability that bound the decision of becoming an entrepreneur (as in Buera (2005)). In addition, the risk associated to entrepreneurship is captured through the stochastic process of z, which makes the occupational decision dependent on this process for entrepreneurs with some tenure.

idiosyncratic characteristics from the entrepreneur to the business. In addition, it is assumed entrepreneurs can sell their undepreciated physical capital at the end of every period. Hence, physical capital depreciation δ adds to the financial opportunity cost and the risk embedded in the investment decision.

4.4 Financial Constraints

All individuals face a financial constraint that limits the amount of physical capital that can be invested in the new or existing venture each period. This constraint determines an upper bound on k that depends on the level of assets a the individual has to offer as collateral at the beginning of each period:

$$k \leq (1+\phi)a$$

In the benchmark version of the model it will be assumed individuals are completely constrained, which means borrowing is not allowed ($\phi = 0$). Afterwards, some sensitivity analysis on the value of ϕ will introduce borrowing for entrepreneurs.[17] In an additional simulation exercise the value of ϕ will be part of the estimated vector of parameters. In the cases where $\phi > 0$, entrepreneurs may borrow resources under 1 period contracts at the risk-free interest rate r.[18]

4.5 Recursive Formulation

In order to formalize the model outlined before, I now describe the recursive formulation of the problem solved by individuals during each period of their productive life through a finite dynamic programming structure:

State Vector $(x, j) = ([a, e, s, z], j)$, where:
a = Total assets at the beginning of the period
e = Education level ($e \in \{NC, CO\} \equiv$ {Non College Educated , College Educated})
s = Permanent entrepreneurial skills/ability
z = Previous period (entrepreneurial) productivity shock
j = Age

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[17] In these cases bankruptcy is not allowed. A non-negativity constraint on assets implies entrepreneurs take loans they will be able to repay even under the lowest realization of earnings.

[18] The sensitivity analysis will focus on the effects of liquidity constraints on the relationship between the transition probability to entrepreneurship and wealth. The parameters determining liquidity constraints will be summarized in ϕ. Although, differential interest rates for borrowing and savings could be introduced as in Quadrini (2000), for this paper purposes this will be equivalent to tightening the constraints directly through a smaller value for ϕ.

Control Vector $y = [k, c]$ where:

k = Capital invested in the business at the beginning of the period

c = Consumption for the period

Let $P_j(x)$ be the problem solved by an age j individual ($1 \leq j \leq R$) with state (x, j) at the beginning of period t:

$$
\begin{aligned}
V_j(x) = \max_{k,c} & \; E[u(c) + \beta V_{j+1}(x')|z] \\
s.t. \;\; & c + a' = (a - k)(1 + r) + Y(k, z', x) && \text{(resource constraint)} \\
& 0 \leq k \leq (1 + \phi) * a && \text{(borrowing constraint)} \\
& V_{R+1}(x) = W_{R+1}(a) && \text{(retirement value function)} \\
& a', c \geq 0 \;\; , \;\; s' = s \quad z' = Q(z)
\end{aligned}
$$

where:

$$
Y(k, z', x) = \begin{cases} h(e, j) & \text{if } k = 0 \\ \Pi_e(k, z', x) + (1 - \delta)k & \text{if } k \geq 0 \end{cases}
$$

$h(e, j)$ describes human capital accumulation through education/experience relevant to workers and is defined exogenously through the estimated worker earnings profiles from data. The terminal value at retirement $V_{R+1}(x) = W_{R+1}(a)$ results from solving the following standard consumption-saving decision problem:

$$
\begin{aligned}
W_j(a) = \max_c & \;\; u(c) + \beta \; W_{j+1}(a') \\
s.t. \;\; & c + a' = a(1 + r) \\
& W_{J+1}(a) = 0 \\
& \text{where } j \in \{R + 1, ..., J\}
\end{aligned}
$$

4.6 Transition to Entrepreneurship over the Life Cycle

In this section I provide some intuition about the transition to entrepreneurship along the life cycle within the environment provided by the model presented in section 4. First, I discuss the effects of the main elements included in the model on the occupational decision. Then, I describe how these affect the relationship between the transition probability and wealth.

Figure 5 panel a) describes the key elements of the occupational choice problem.[19] Every period agents compare the benefits of becoming an entrepreneur $\Pi_e(k, z', x) + (1 - \delta)k$ with

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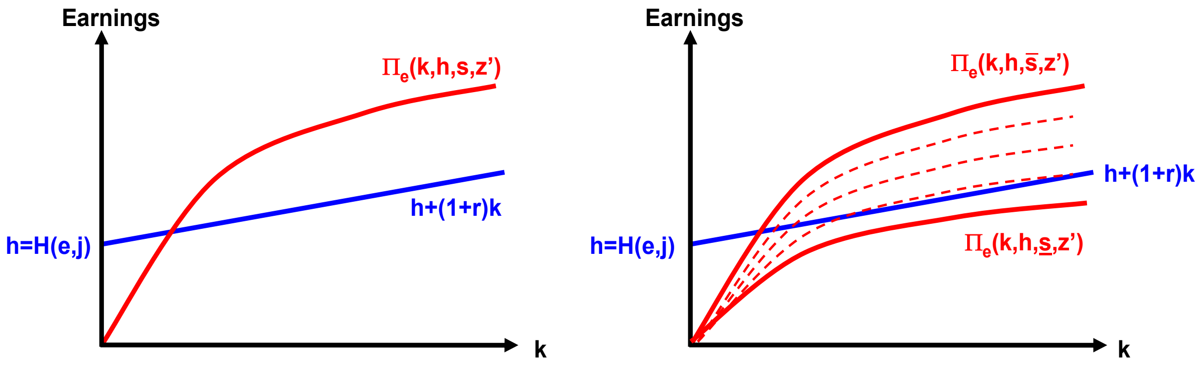
[19] Uncertainty will be ignored in the first part of the exposition.

the opportunity cost of such a decision $h\left(e,j\right)+\left(1+r\right)k$ (given by their potential earnings in the labor market and the risk-free returns for the capital invested in the business). The complexity of the model arises in an environment where heterogeneous agents face uncertainty on z' and have a multidimensional state x. Thus, in this economy transitional dynamics depend on human capital $H\left(e,j,s\right)$, risk $\left(z'\right)$ and opportunity costs for human $\left(h(e,j\right)$ and physical capital(r), as well as available liquidity (assets level a and the degree of credit availability ϕ) (see figure 5 panel a).[20]

While the level of entrepreneurial ability s is assumed to be permanent during the life cycle, workers' human capital h has permanent (education level e) and dynamic (experience j) components. The level of entrepreneurial ability divides the population between those that will never choose to enter entrepreneurship (all levels below some cutoff value $\underline{s}$) from the ones that have at least the minimum level of ability to start a business with some chance of success.[21] On the other hand, those above the minimum level of required entrepreneurial ability ($s>\underline{s}$) differ in the potential income generated by their business (other things equal). Hence, entrepreneurial ability defines different output levels for all combinations of physical and human capital (see figure 5 panel b) for those above the minimum required level of ability; and thus different wealth thresholds defined by the minimum physical capital requirement that make entrepreneurship more attractive than the labor market.



(a) (b)

Figure 5: Elements of the occupational decision problem and the role of entrepreneurial skills/ability

Workers' human capital h defined by education level e and age j (as a proxy of experience), has alternative effects on the entrepreneurial decision. First, permanent education

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[20] Buera's (2006) model of entrepreneurship studies the role of ability and liquidity as drivers of entrepreneurship.

[21] See Buera (2006) for more details and theory on this cuttoff values.

defines the type of technology entrepreneurs can run; in particular it is assumed that there are only two types of technologies available (low-tech, high-tech) associated with the education level attained by the entrepreneur when young (non-college, college), where the high-tech technology implies higher earning profiles at same levels of physical capital k, entrepreneurial ability s, age j and idiosyncratic productivity z (see figure 6 panel a).[22] Second, workers' human capital is defined in the model by the potential labor earnings of an individual, conditioning on age and education level. The life cycle earnings profiles estimated in section 3 exhibit a hump-shape (see figure **??**), with a lower (and flatter) profile for the non-college educated. Thus, regarding the transition to entrepreneurship, workers' human capital has two main effects: 1) it shifts the entrepreneurial earnings function for all possible productivity levels as the individual ages according to the life cycle labor earnings profile and; 2) shifts the labor income level (first component of the opportunity cost) as the individual ages according to the life cycle labor earnings profile (see figure 6 panel b).[23] The net effect of changes in human capital over the life cycle determines period to period changes in the minimum capital size required to enter entrepreneurship for particular types of agents; and in a more deeper sense the decision rule regarding occupation for all potential entrepreneurs with some state x. These net effects, which play a crucial role in the dynamics of the transition probability over the life cycle, depend ultimately on the workers' human capital estimates and the parametrization of the entrepreneurial technologies.

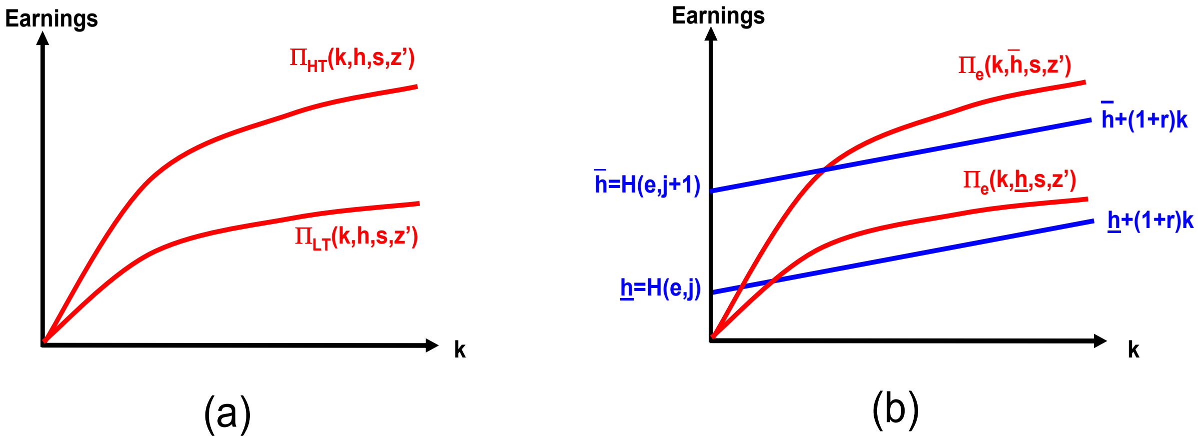

Figure 6: The role of human capital dynamics in the occupational decision problem

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[22] Mondragon (2005) motivates and studies important differences between entrepreneurs with different (college) education level attainment; and documents a high correlation between educational attainment and business industry types.

[23] The relative effect of human capital on the opportunity cost line and the entrepreneurial earnings function depends on the parameters of the entrepreneurial earnings function, the workers' earnings profiles, and the particular age of the individual; and may differ from the one shown in figure 6 panel c.

The uncertainty associated to the entrepreneurial activity is introduced through an idiosyncratic productivity shock z', which has the same type of effects on the entrepreneurial earnings function as those described for entrepreneurial ability levels in figure 5 panel b above. All individuals will take the risk associated to z' into account and compute an expected return function (period utility plus continuation value) conditioned on their actual shock z. The estimated parameters that define such stochastic process will generate entry and exit rates, the fraction of entrepreneurs in the cohort and a distribution of earnings and returns to the entrepreneurial activity; as the cohort ages.

Once the state vector is defined for each individual at the beginning of the period, the entrepreneurial decision main mechanism is the evaluation of expected entrepreneurial earnings with respect to the opportunity cost of physical and human capital for each possible future productivity shock, in terms of expected utility of consumption. The opportunity cost of human capital is defined by the potential average income the individual could earn in the labor market $h(e, j)$. The opportunity cost of physical capital is defined by the risk-free rate of return (r) on accumulated assets. Finally, the amount of physical capital that can be invested in the business is limited. Hence, a liquidity constraint in the form of some upper bound on available physical capital is included in the entrepreneurial earnings/opportunity cost evaluation. The effect of liquidity constraints can be tested through sensitivity analysis on the parameter ϕ, which describes the additional fraction of their wealth entrepreneurs can borrow at the risk-free interest rate r to invest in entrepreneurial projects.

In regards with the relationship between the probability of transition to entrepreneurship and wealth, Buera (2006) shows that in a model with heterogeneity in entrepreneurial ability and assets, the transition probability as a function of wealth is hump shaped. At lower levels of wealth it increases due to increasing numbers of ability types being able to make the transition, and decreases at higher values of wealth where all ability types are already included and the mass of agents decreases. While this prediction should hold in this model for individuals within the same age-education group; Buera's (2006) prediction regarding the effects of age on the probability profile don't hold in this environment due to the absence of human capital in his model.[24]

On the other hand, when looking at the relationship between the transition probability and wealth in cross section, other elements have to be taken into account. In particular, if the estimated parameters imply that the minimum physical capital size required to enter entrepreneurship is non-decreasing in human capital, cohort specific effects will define the aggregate transition probability profile. In this case, all agents who have not achieved their maximum human capital age will face in general increasing minimum physical capital re-

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[24] In the environment studied by Buera (2006), the transition probability profile shrinks as individuals age.

quirements to enter entrepreneurship as they age. This implies an offsetting effect: agents at the margin who save this period in order to overcome minimum physical requirements to enter entrepreneurship, face an increase in these requirements next period. This has a direct effect on the transition profile at the aggregate level, since for all these agents wealth accumulation in time by itself doesn't necessarily increase the chance of becoming entrepreneurs. Agents above the maximum human capital age on the other hand, will face decreasing minimum physical capital requirements and thus, aging plus wealth accumulation in time imply an increasing chance of becoming entrepreneurs. Given agents accumulate wealth as they age, the majority of agents below the maximum human capital age populate the first deciles of the wealth distribution, while older agents nearer retirement age and above the maximum human capital age populate the top of the wealth distribution. Therefore, human capital effects may explain the shape of the aggregate probability profile observed in the data. Thus, the model's estimation is critical in determining the direction and magnitude of these effects.

5 Estimation

I solve the model using the method of simulated moments (MSM).[25] The idea is to select parameters so that model simulations replicate as close as possible a set of life cycle moments estimated directly from the data. The main steps of the MSM algorithm are the following:

1. Write a dynamic programming model to describe life-cycle decisions of individuals.
2. Select functional forms, the parameters vector λ that will be defined exogenously, and the parameters vector θ to be estimated.
3. Estimate a collection of life cycle moments from data $\left(\widehat{\Psi}\right)$ and define a distance function $D\left(\widehat{\Psi}, \Psi\left(\theta, \lambda\right)\right)$between these data moments vector $\widehat{\Psi}$ and the moments vector implied by the model $\Psi\left(\theta, \lambda\right)$.
4. Choose initial distributions for state variables $G_0\left(x, \theta\right)$.
5. Guess initial values θ_0 for model parameters in θ.
6. Using $[\theta_0, \lambda]$ solve the dynamic programming model numerically and find the decision rules vector $y\left(x\ ; \theta_0, \lambda\right)$for all possible states $x \in X$.
7. Using $G_0\left(x, \theta\right)$, $y\left(x\ ; \theta_0, \lambda\right)$ and $[\theta_0, \lambda]$ generate simulated data for a cohort with a large number of individuals at each age $j = \{1, ..., J\}$. Compute $\Psi\left(\theta_0, \lambda\right)$ and $D\left(\widehat{\Psi}, \Psi\left(\theta_0, \lambda\right)\right)$.

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[25] For a detailed exposition of such methodology refer to French (2005).

8. Iterate over steps 5 through 7 using a minimization routine to update the guess on θ_0 until $D\left(\widehat{\Psi}, \Psi\left(\theta_0, \lambda\right)\right)$ is minimized.

The rest of this section describes each of these steps in more detail.

5.1 Functional forms and parameter vectors

In order to estimate the model numerically, the following functional form assumptions where made:

1. Individuals are risk averse and exhibit a standard CRRA utility function $u\left(c\right)=\frac{c^{1-\sigma}}{1-\sigma}$ where the degree of risk aversion σ is part of the estimated parameters vector.

2. The earnings function for entrepreneurs is given by $\Pi_e(k,h,s,z')=z'\ s\ A_e\ k^{\alpha_e}h^{\upsilon_e}$.

Most of the key parameters will be estimated. The vector of parameters λ defined exogenously is given by:

$$\lambda=\left[R,J,\phi,s_{1,}s_{2,}z_{2},\left\{h\left(e,j\right)\right\}_{e,j}\right]$$

Each period in the model will represent 1 year. For estimation purposes I'll assume individuals are born in the economy at age 23.[26] The retirement age will be 65, which implies $R=43$. I'll assume all individuals live up to 90 years, which implies $J=68$. As mentioned above, the benchmark model assumes $\phi=0$. Sensitivity analysis will be run for this parameter ($\phi>0$). In addition, an estimation that includes ϕ as part of the estimated parameters vector will be presented. Entrepreneurial ability s is assumed to take 3 possible values $S=\left\{s_{1,}s_{2,}s_{3}\right\}$.[27] The lower value $s_1=0$ defines the population of those that regardless of their level of accumulated assets and human capital will never enter entrepreneurship.[28] $s_2=1$ defines a middle neutral value above which individuals may enter entrepreneurship, while $s_3>1$ (estimated value) corresponds to a high-ability type that will run (on average) more productive businesses. The Markov chain that characterizes the uncertainty on entrepreneurial earnings z is assumed to have 3 states as well. The middle state $z_2=1$ is assumed to be a neutral state where entrepreneurial earnings are

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[26] This implies age $j=1$ corresponds to 23 years of age, a time where it is assumed college educated individuals graduate and enter the labor market.

[27] It will be desirable to have a richer set of entrepreneurial skill levels, but the dimensions of the state space and computational capability impose a limit on the number of levels assumed on the heterogeous characteristics of individuals.

[28] The fraction of the population born at each of the ability levels will be estimated, and will determine the need of such a minimum level. This minimum level could be related to individuals with very low entrepreneurial initiative or poor entrepreneurial ideas.

determined education-indexed technology, physical capital and human capital. The other two states levels and the transition matrix probabilities will be part of the estimated vector of parameters θ. The other parameters defined exogenously correspond to the workers' human capital levels by age and education level $h\left(e,j\right)$. Hence, the vector of estimated parameters θ is then given by:

$$\theta = [\sigma, r, s_3, G_0(s_1), G_0(s_2), z_{1,}z_3, Q(z'|z), \{A_e, \alpha_e, \upsilon_e\}_{e\in\{NC,CO\}}, \delta]$$

Both preferences parameters are estimated. The coefficient of risk aversion σ directly and the utility discount factor β indirectly by assuming $\beta = \frac{1}{1+r}$.[29] Given that the distribution of entrepreneurial skills is unobservable in the data the highest level ϵ_3 and the densities associated to each level are part of the estimated parameters vector.[30] The minimum and maximum values for the entrepreneurial productivity shock z, as well as the transition probabilities between its 3 states determine in part the dynamics of transiting into and out of entrepreneurship; and as will be discussed below there will be data moments related to these dynamics.[31] Finally, there are no references in the literature related to the estimation of technologies for differentiated education levels that include the entrepreneur's human capital as in the model proposed. Hence, the technology parameters (multifactorial productivity A_e, physical capital intensity α_e, and human capital intensity υ_e) for each education type; in addition to their common physical capital depreciation rate δ are estimated and related directly to the moments associated to entrepreneurial earnings, as will be discussed below.

5.2 Human Capital

As described in section 4.3 workers' human capital is a function of education and age ($h\left(e,j\right)$); and proportional to the level of earnings of workers. Therefore, the estimation of workers' human capital profiles $\left\{h_j^e\right\}$ corresponds to the one of earnings profiles for worker households described in section 3. These profiles determine the opportunity cost of human capital for individuals deciding to become entrepreneurs, as well as the human capital input of the entrepreneur into her business. As can be observed from figure **??**, the life-cycle

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[29] Both of these parameters could be also defined exogenously by assuming standard values in the literature. The decision to include these as estimated parameters relies on the fact that the occupational decision in the model is greatly influenced by attitudes towards risk, which in this case are assumed to be homogeneous across individuals. The decision to assume $\beta = \frac{1}{1+r}$ is taken to exclude from the environment distortions on assets accumulation derived from any differentials across the discount factor and the return rate on savings.

[30] Only two densities are included directly since $G_0(\epsilon_3) = 1 - G_0(\epsilon_1) - G_0(\epsilon_2)$.

[31] Again in this case, more possible states for z are desirable, but state space dimension and computational capabilities impose limits on the numbers of levels for these shocks. In addition, only 6 of the 9 transition probabilities in $Q(z'|z)$ need to be directly estimated, given the properties of transition matrices.

dynamics of human capital are clearly differentiated by education groups; and therefore the effects on the occupational decision along the life cycle may be different for each education group as well.

5.3 Life Cycle Moments

The life cycle moments replicated through model simulations to estimate model parameters are:

1. Average earnings of entrepreneurs by age group and education level
2. Fraction of entrepreneurs by age group and education level

The estimations of these moments are described in section 3. I use 8-year age groups and the two education levels included in the model (Non-College and College).[32] Thus, the total number of moments is the same as the number of parameters to be estimated. While entrepreneurs' average earnings are directly related and defined by the entrepreneurial technologies parameters $\left(\{A_e, \alpha_e, v_e\}_{e\in\{NC,CO\}}, \delta\right)$ and ability / productivity shocks levels $(s_1 \equiv 0, s_2 \equiv 1.0, s_3, z_1, z_2 \equiv 1.0, z_3)$; the second group of moments is related to the occupational choice dynamics embedded in the model (and defined by not only by earnings of both workers and entrepreneurs; but also by the distribution of abilities and the transition matrix for z). Given that the simulations follow an "average cohort" of agents along the life cycle, the transitional dynamics across occupations will depend on the opportunity costs valuation made by all agents across time. This valuation takes into account entrepreneurial earnings (directly related to the first subset of parameters); risk and attitudes towards risk $(\sigma, Q(z'|z))$; and the opportunity costs of physical capital (r) and human capital (defined exogenously for workers through $h(e,j)$). In addition to these elements, the fraction of the population transiting to entrepreneurship is closely related to the initial distribution of entrepreneurial ability $(G_0(s_1), G_0(s_2))$.

5.4 Initial Distributions

In order to generate simulated data from the model described in section 4, initial distributions for entrepreneurial ability (s) and productivity (z), education level (e) and asset holdings (a) need to be defined. The distribution of entrepreneurial ability defined by $(G_0(s_1), G_0(s_2))$ is part of the parameter vector θ estimated to replicate the life cycle moments defined in

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[32] The age groups are: $\{25-32, 33-40, 41-48, 49-56, 57-64\}$. This selection doesn't affect the general results. I perform estimations using 4-yr age groups with no significant changes in the overall results.

the previous section. Hence, an arbitrary guess for these parameters is used to start the simulation-estimation algorithm. Regarding entrepreneurial productivity (z), it is assumed that all agents in the cohort start at the non-entrepreneur middle state ($z_2 = 1$) at age $j = 1$. The fraction of college educated agents within the cohort is set to 35%, which corresponds to the estimated average fraction of young household heads within the PSID during years 1971 to 1992 who had at least some college education by age 25. This estimate is robust to different age groups or PSID years included in the sample.[33]

The estimation of the initial distribution of assets is based on the observed distribution of wealth from PSID data for years 1984 and 1989.[34] The sample includes young household heads between 21 and 25 years of age who are active in the labor force. Figure 7 shows the histograms by education level and year. The first thing to note is the high concentration of mass between \$0 and \$10,000 (in 1983 dollars), which is not surprising given the population in the sample are individuals at the beginning of their productive lives. Negative values of wealth are present but low in levels and density; and right skewness is also present but very low. In addition, there tends to be more mass above the \$10,000 level for the college educated; but the difference not being very high with respect to their non-college educated peers. For simulation purposes, the initial distribution of wealth will be computed as an average of the observed distributions from PSID data by education level, not allowing for initial negative wealth (by adding all the corresponding mass to the zero wealth level).

5.5 Numerical Estimation

As mentioned above, this model generates simulated data for a cohort of individuals as it ages (for 43 years: ages 23-65). The cohort is composed by 10,000 individuals.[35] Steps 5-8 at the beginning of this section where coded in Fortran and use the numerical routine AMOEBA[36] as the minimization routine mentioned in step 8 (using a tolerance factor of 1×10^{-3}). For every guess on the value of θ, the individual decision model is solved using backward iteration; where assets (a), physical capital (k) and consumption (c) take values on a 50 point grid that ranges from 0.00 to 10.00 where 1 model unit represents \$100,000

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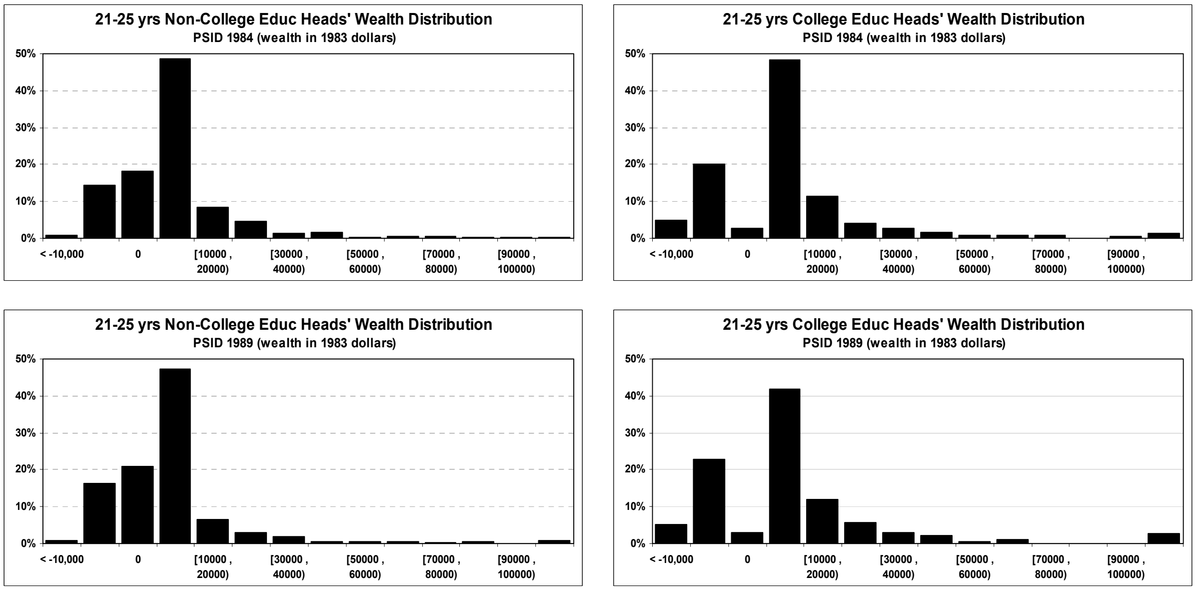
[33] The sample includes young household heads (ages 23-25 or 23-24 or 24-25) who are active in the labor force; that is they are either workers or entrepreneurs (where the latter declare to own a business and be self-employed). The fraction of agents with at least some college education over the total is taken individually for each PSID cross-section during the period 1971-1992. In all cases this fraction varies from 30% to 40% with an average of 35%.

[34] The PSID measures wealth every five years since 1984. All PSID data after year 1993 is not final.

[35] This number was selected due to computational time constraints. In any case, a small number of simulations with larger samples where run to test this constraint. In all cases, none of the results show significant changes.

[36] For more details on AMOEBA see Numerical Recipes in Fortran by Press et. al. (1992)



21-25 yrs Non-College Educ Heads' Wealth Distribution
PSID 1984 (wealth in 1983 dollars)

21-25 yrs College Educ Heads' Wealth Distribution
PSID 1984 (wealth in 1983 dollars)

21-25 yrs Non-College Educ Heads' Wealth Distribution
PSID 1989 (wealth in 1983 dollars)

21-25 yrs College Educ Heads' Wealth Distribution
PSID 1989 (wealth in 1983 dollars)

Figure 7: Wealth distribution by education level for young household heads in the PSID

in 1983 dollars. The grid has more points concentrated in the lower assets value range, and the distance between grid points increases for higher ranges of asset values.[37]

Once decision rules are numerically computed, random number generation is used jointly with initial distributions to define a state vector for each individual in the cohort at model age $j = 1$ (which corresponds to age 23). After the initial state is defined, randomly generated productivity shocks (z) and decision rules determine the life-cycle dynamics for each individual in the cohort. When data for the cohort at all ages is generated, life cycle moments from simulated data $\Psi(\theta_0, \lambda)$ and the corresponding distance function $D\left(\widehat{\Psi}, \Psi(\theta_0, \lambda)\right)$[38] are computed. After the iterations needed by the minimization routine to find $\theta^*$are completed, life cycle moments are generated using life cycle simulations based on $\theta^*$and 100 cases of randomly generated initial distributions and life-cycle entrepreneurial productivity shock histories.[39]

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[37] The individual decision rules are solved using the theoretical results derived in Appendix A.

[38] The weights for the different moments included in this distance function may vary. In fact, when earnings moments and fractions of entrepreneurs moments distances have the same weight, the model tends to concentrate its efforts in replicating the former while generating an "averaging" flat profile for the latter. Thus, a higher weight in the distance function is assigned to the fractions of entrepreneurs moments to obtain a balanced solution that approximates both sets of moments more accurately. This weighting approximation implies several trial estimations of the entire vector of parameters. These set of weighting estimations are done separately for each value of ϕ in the sensitivity analysis.

[39] The last step guarantees that the results are not conditioned on a particular realization of initial and life-cycle entrepreneurial productivity shocks. Again, some exercises with a larger sample of initial distributions where run but show no significative differences.

Before turning to the main simulation results for the transitional dynamics, I describe the parameters vector estimates for the benchmark case where borrowing for entrepreneurs is not allowed $(\phi = 0)$[40] and other sensitivity analysis cases with respect to the level of available borrowing $(\phi > 0)$.[41] In both cases wealth is restricted to be non-negative. Table 3 shows the estimated parameters vector for the benchmark case.

Risk aversion $(\sigma = 1.03)$ is lower than the standard value used in the macroeconomics literature $(\sigma = 2.00)$. This result shows that risk aversion homogeneity implies a lower value of risk aversion under which some agents will be willing to face the risk of transiting to entrepreneurship. It is important to note that risk aversion in this model can be thought to be an alternative to entrepreneurial ability (s) as the parameter defining the fraction of agents that are sometimes or never willing to enter entrepreneurship. Thus, the lack of heterogeneity in attitudes toward risk is substituted in some sense by heterogeneity in entrepreneurial ability.[42] However, if the model excluded entrepreneurial ability and included risk aversion heterogeneity, one should find levels of risk aversion associated to the actual levels of entrepreneurial ability; that is, related to the fraction of agents that are more willing, less willing or not willing to ever transit to entrepreneurship. Such a model should result in some values below 1.0 (related to s_{high}) and others well above 1.0 (related to $s_1 = 0$). In this estimation, about 3/4 of the "average" cohort have low entrepreneurial ability $(s_1 = 0)$ and will never enter entrepreneurship; and from the remaining 25%, 10% exhibit high entrepreneurial ability (s_3), which is about 1.5 times the middle level entrepreneurial ability $(s_2 = 1.0)$ held by approximately 15% of the "average" cohort.

The real interest rate estimate of 3.4% takes a value close to the long run estimate standard in the literature $(r = 4\%)$, implying a realistic cost of capital in this estimation. This value implies a discount factor $\beta = 0.97$, which is in the ballpark of the standard values used in the literature. In regards with the stochastic process for the entrepreneurial productivity shock, we observe that the lowest (z_1) and highest (z_3) levels are 38% below and 47% above the value assumed for the middle "neutral" level $(z_2 = 1.0)$, respectively. The transition matrix for this stochastic process doesn't imply very high persistence for any of the states (54% for z_1, 54% for z_2 and 70% for z_3). The persistence of the lowest level (z_3) implies that more than 2/3 of entrepreneurs in this state will continue operating at low levels of productivity in the following periods, which might result in the decision of most

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[40] Thus, in this case agents are completely constrained by their level of asset holdings a and cannot start a business of (physical capital k) size above their available assets $(k \leq a)$.

[41] As mentioned before, since the level of liquidity constraints is a non-observed structural parameter; the complete vector of model parameters has to be re-estimated for each level of ϕ considered.

[42] In any model including both sources of heterogeneity, it would be difficult to understand the conditions that deter some from ever transiting to entrepreneurship regardless liquidity constraints considerations.

of them to close their businesses once they hit this low state. About half of entrepreneurs starting their businesses will continue operating at the middle state in the future.[43] From the remaining starting entrepreneurs, 55% will face a negative shock with higher persistence and 45% will face a positive shock with lower persistence in the next period. Hence, this transition matrix implies entrepreneurship is a risky activity, compared to the riskless labor market assumed in the actual environment. These persistence figures imply on the one hand that long tenures are not a full guarantee of future success, while the higher persistence of negative shocks imply a higher chance of closing the business once the low productivity state is entered. Entrepreneurs face potential losses related to opportunity costs of physical and human capital, and direct losses of physical capital related to a depreciation rate (δ) of 5% per year.

The technology parameters conditional on education determine the rewards for entrepreneurs facing such a risky environment. The non-college technology exhibits lower physical capital intensity ($\alpha_{NC} < \alpha_{CO}$) and more human capital intensity ($\upsilon_{NC} > \upsilon_{CO}$) than the college technology. That is, while the businesses of the non-college educated tend to depend more on the entrepreneur's human capital, the college educated' businesses tend to have a more balanced dependency on human and physical capital. In addition, the multifactorial productivity of the college educated technology is 25% higher than the non-college one; which implies that this technology generates more output for the same ability, productivity shock, physical and human capital inputs.[44] These results also imply that college educated entrepreneurship exhibits higher growth potential in terms of size and earnings.

Now I turn to the parameters vector estimations in the sensitivity analysis cases shown in figure 4, where there is some available credit for entrepreneurs ($\phi > 0$). The first thing to note is that most of the parameters in these cases are in general in the same ballpark as the ones observed for the benchmark case, the exception being the degree of risk aversion and the set of parameters directly associated to the entrepreneurial technology. This implies on the one hand that the parameters associated to interest rate, entrepreneurial ability distribution and entrepreneurial productivity shocks are consistent along these different economy structures and simulations. The degree of risk aversion σ is 30-40% higher than the benchmark case in all the other cases where some degree of borrowing exists, and increases with ϕ. The intuition behind this result is that less general risk aversion in the economy is needed when more credit is available to potential entrepreneurs.

The implications on the parameters directly associated to the entrepreneurial technology

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[43] Recall agents are in the middle state as long as they don't start a new business.

[44] But recall that any college educated entrepreneur will have higher human capital levels than any non-college educated entrepreneur of the same age.

are clearly observed on figure 8, which shows the moments estimated from the data and the simulated moments generated by the model for different levels of credit availability (ϕ). While the fractions of entrepreneurs by age-education groups show in general some alignment with the moments estimated from the data, the entrepreneurial earnings profiles don't. In all cases, the model overestimates the earnings profiles;[45] moreover, the differences with respect to the profiles estimated from data increase as ϕ increases. The latter result implies in some sense that very high degrees of credit availability may be less consistent with the data, than structures including a higher degree of credit constraints. Some intuition behind this result can be derived from the parameter estimates in table 4. As ϕ increases and more credit is available for potential entrepreneurs, a higher fraction of the population within all cohorts and education levels will have the incentive to enter entrepreneurship. This will overestimate the observed fractions of entrepreneurs by age-education groups. Thus the higher fractions of entrepreneurs due to higher ϕ, are offset by lower fractions of entrepreneurs due to higher risk aversion (σ) and a higher mass of those with low entrepreneurial skills in the initial distribution of ability ($G_0(s_2)$). In addition, some fraction of those agents that would have been entrepreneurs regardless of the level of available credit could drop out due to higher risk aversion. Therefore, the only way to compensate this group is through higher expected entrepreneurial earnings. In sum, since the estimation controls for the fraction of entrepreneurs by age-education groups, the effect of higher credit availability is offset by higher risk aversion and a lower fraction of potential entrepreneurs in the economy; however this compensation has to be accompanied by higher expected entrepreneurial earnings.

6 Simulation Results

In this section I present the simulation results on decision rules, the dynamics of the relationship between the transition probability to entrepreneurship an wealth for a specific cohort over the life cycle, as well as for an aggregate cross-section of cohorts at a point in time (so as to replicate Hurst and Lusardi (2004)). In addition, I present some results on individual savings behavior over the life cycle. The qualitative results on all these issues are very similar regardless of the level of available credit ϕ; therefore the presentation that

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[45] Recall from section 4 that higher weights where needed for the fractions of entrepreneurs moments in the distance function, within the estimation procedure. In this sense, the model replicates better the dynamics of the occupational choice at the cost of overestimating entrepreneurial earnings profiles. However, there are several measurement problems with entrepreneurial earnings data recognized in the literature, that in general point to underreporting due to taxation issues. In fact, I estimate average and median entrepreneurial earnings from SCF data and find these are higher than those of PSID data in cross-section. Thus, actual overestimation from the model simulations seems to have some support in measurement problems with the PSID data used for earnings profiles estimations.

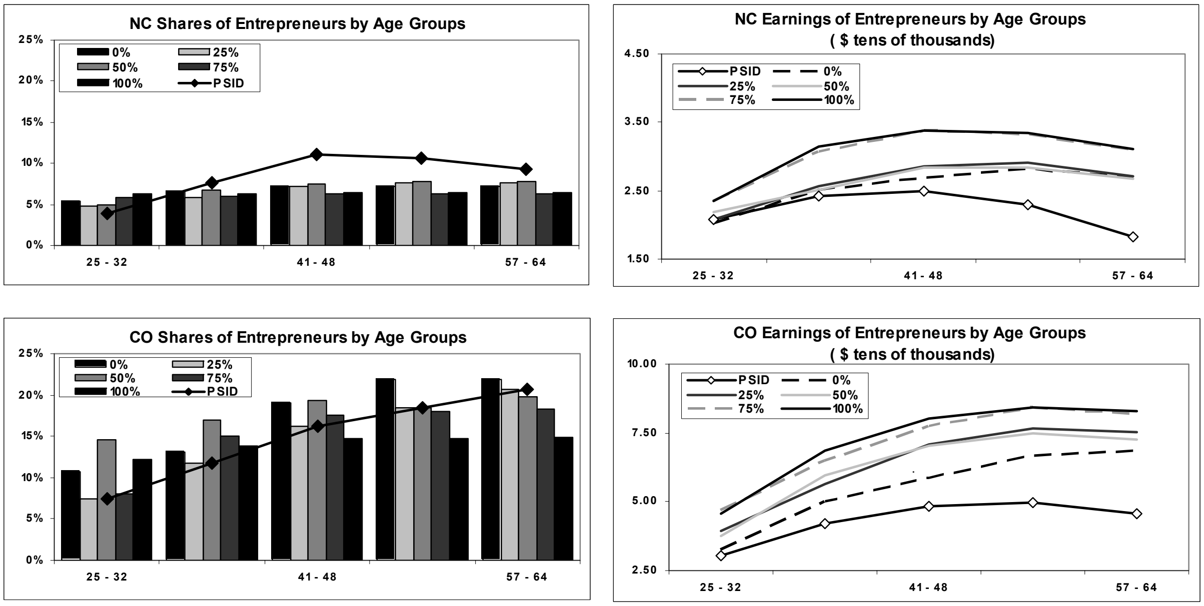

Figure 8: Data moments and simulated moments for various levels of credit availability

follows corresponds to benchmark case ($\phi = 0$) simulations. Any important difference with other cases will be described in the exposition.

6.1 Occupational Decision Rules

Figure 9 summarizes the decision rules on the minimum size in terms of physical capital required to enter entrepreneurship. These are presented separately by age, education levels and entrepreneurial skills (above the zero ability type). Dotted lines correspond to non-college educated agents, solid lines to college educated ones, and bold lines indicate high entrepreneurial skills type.[46] First note that in this case the only non-college educated entrepreneurs are high ability individuals; which implies that the returns to non-college entrepreneurship are in general lower and do not overcome the risks and costs associated for those below the high skill level. More importantly, note that minimum capital requirement is non-decreasing in age for younger agents (up to around ages 37-47) and only decreasing for agents near retirement in some cases. This results from the opportunity cost of human capital embedded in the entrepreneurial decision, entrepreneurial technologies and the shape of the estimated human capital profile, which is increasing for younger individuals and declines at the end of the life cycle. This will have direct implications for the aggregate profile of the transition probability with respect to wealth, as described in section 4.6.

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[46] Recall low entrepreneurial ability agents never enter entrepreneurship. Hence, their decision rule in this case is at the zero level at all ages for both education levels.

High ability non-college and college educated agents tend to enter entrepreneurship at low levels of physical capital (below \$15,000 and \$25,000 respectively in 1983 dollars); and only medium ability college entrepreneurs enter at increasing levels of physical capital that achieve a maximum of \$60,000 in 1983 dollars. Given the latter group is less than 1/5 of the potential entrepreneur's population, these results agree with the documented facts by Hurst and Lusardi (2004) and others, who show that the majority of entrepreneurs don't start businesses with high initial investment levels. Finally, the minimum capital requirement increases more with age for college entrepreneurs; and within these, it increases significantly more for the middle ability types. This is due to higher opportunity costs faced by the college educated.

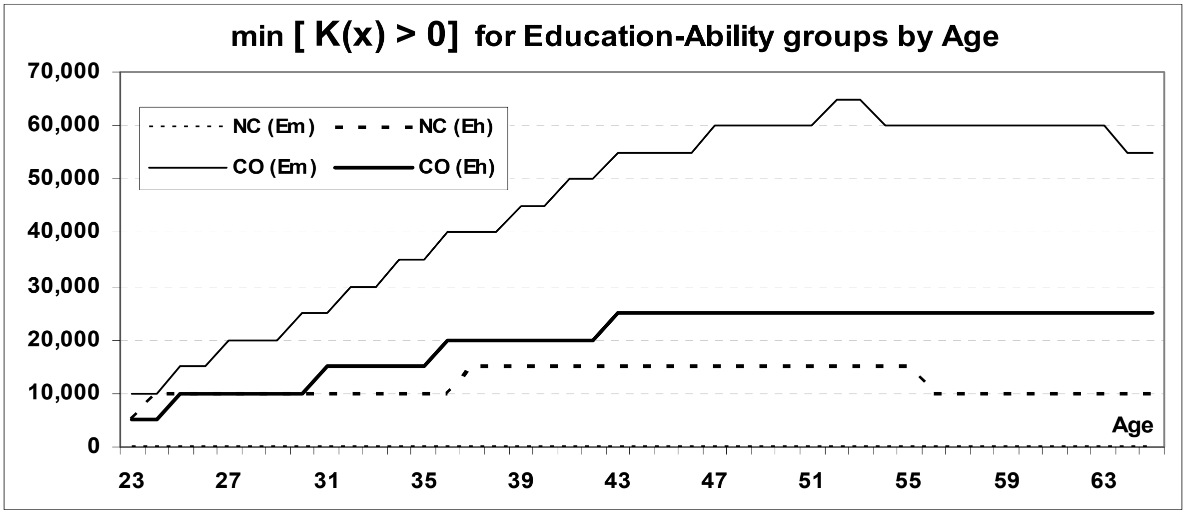

Figure 9: Minimum physical capital required for start-up entrepreneurs by age, education and ability types

6.2 Transition to entrepreneurship and wealth

Now I turn to the main goal of this paper and look at the implications of the model regarding the relationship between the probability of transition to entrepreneurship and wealth. I use the data generated by the estimated model and find the fraction of agents (by age and education level) transiting to entrepreneurship between two periods of time (1 year) at different (beginning of period) wealth level. Figure 10 contains the results of this exercise for a selected sample of ages. The dots in the graphs indicate the computed fraction of entrepreneurs and the solid line is a high order polynomial trend regression of these fractions with respect to accumulated wealth. The first important thing to note is that all the trends imply a hump-shaped relationship, which not only shifts to the right over the life cycle, but also widens. This result agrees partially with the work of Buera (2006), where he proves theoretically the hump-shaped relationship in a model with heterogeneity in entrepreneurial ability and wealth. Since his model doesn't include human capital dynamics within the life-cycle, the hump-shaped relationship determined by ability and wealth heterogeneity applies in this framework for individuals with the same level of human capital (i.e. same age and education level).[47] On the other hand, the lack of human capital dynamics in Buera's (2006) model implies this hump-shaped relationship shrinks as the cohort ages; a behavior not observed in this environment. First, human capital dynamics imply a relationship where the level of wealth at which the transition probability starts to be positive shifts to the right over the life cycle, due to the monotonicity of minimum capital requirements with respect to human capital. At the end of the life cycle, human capital opportunity costs either decline or flatten. Therefore agents at various levels of wealth start transiting to entrepreneurship, which causes the relationship to widen significantly. That is, agents at various levels of wealth may enter entrepreneurship at the end of the life cycle due to decreasing human capital opportunity costs that make entrepreneurship viable at their levels of accumulated wealth. Finally, the relationship seems to widen all along the life cycle instead of shrinking. This is again due to increasing human capital which implies increasing earnings and, as will be described in section 6.3, increasing savings differential of potential entrepreneurs. That is, young agents' savings increase as they age, which in turn helps them to overcome their liquidity constraints. Finally, these shifting and widening effects are higher for the college educated than for the non-college educated (given the steeper human capital profile and higher savings potential of the former).

The ultimate purpose of this paper is to understand how the life cycle effects of human capital on the transition to entrepreneurship impact an aggregate measure for the whole economy, as the one in Hurst and Lusardi's (2004) estimation. Hence, the first task is to briefly understand the type of data analyzed by them, and then decide how to use the model in hand to simulate such results. The PSID data used by Hurst and Lusardi (2004) is a pooled sample from two cross sections (PSID years 1989 and 1994). This sample includes all non-entrepreneurs observed in years 1989 and 1994, who stayed in the PSID sample in years 1990 and 1995. The key issue is that while this cross-section includes individuals of different ages and education levels; the results presented above refer to an "average" cohort along the life cycle, including two broad types of education levels within the cohort.[48] Given

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[47] This is precisely the reason why his empirical estimations support his theoretical results, only when the measure of wealth is adjusted by wages, as a proxy of differences in opportunity costs.

[48] Although Hurst and Lusardi (2004) control for age and education, Mondragon (2005) shows that while age coefficients are not significative in parametric and semi-parametric reduced form estimations (as in

that the model presented in section 4 can be used to simulate a cohort along the life-cycle, a natural extension is to generate with it simulated data for a collection of cohorts in order to construct cross-sectional data and replicate estimations such as the one performed by Hurst and Lusardi (2004). There are two technical problems with this approach. The first one is that the data used to construct the estimates presented above is a panel from the PSID where all estimates (human capital, entrepreneurial earnings profiles and fraction of entrepreneurs by age groups) use data from 1968 to 1992 and refer to an "average" cohort. As far as I know, nor the PSID or any other panel have sufficiently large data sizes (on entrepreneurs) to produce such estimates separately for all cohorts present in any representative cross-section. Thus, I'll assume all cohorts follow the same earnings profiles and fractions of entrepreneurs by age-education group figures. The second issue is population growth, where some cohorts have higher sizes in the cross-sections than others. This is an easier problem to deal with and some sensitivity analysis can provide a sense of the importance of this factor for the aggregate estimation of interest (i.e. the relationship between the probability of transition to entrepreneurship and wealth).

Figure 11 shows the estimated cross-sectional exercise, which assumes no population growth (i.e. all cohorts have the same size). Again, the dots indicate the fraction of agents at each level of wealth transiting to entrepreneurship from some period t to period $t+1$; and solid lines are a high order polynomial trend regressions of these fractions of entrepreneurs on asset holdings for the total sample and education subsamples. In addition, the 90^{th} percentile wealth level is marked on each graph for the corresponding sample. The results are qualitatively similar to those of Hurst and Lusardi (2004) in the sense that the relationship is strongly monotone only above the 90^{th} percentile of the wealth distribution. Recall these results correspond to the benchmark case that assumes zero credit available for entrepreneurs. At the aggregate level, the relationship is flat up to \$150,000 which corresponds to the 86^{th} percentile of the wealth distribution within the cross-section, and becomes strongly monotone above this level. For the non-college educated the same behavior is observed but with a declining relationship at top levels of wealth. In this case it is important to note that \$150,000 corresponds to the 97^{th} percentile of the wealth distribution within the non-college cross-section.[49] For the college educated, the relationship is monotonic above \$120,000 which corresponds to the 60^{th} percentile of the wealth distribution within the college cross-section. In sum, a version of the model where agents are completely constrained by liquidity produces the same qualitative results as the empirical exercise of Hurst and Lusardi (2004), and some

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Evans and Jovanovic 1989), there are some important differences in the relationship between the transition probability and wealth across (college) education groups.

[49] Also note that less than 1% of non-college agents have assets above \$300,000 where the relationship shows a declining trend

of the qualitative differences associated to college education described in Mondragon (2005). Hence, Hurst and Lusardi's (2004) interpretation of this statistic as evidence against the importance of liquidity constraints in the transition process is in question. From the model's implications presented in section 4.6, these results and their relationship to the theoretical and empirical results of Buera (2006), it is possible to say that liquidity constraints are in the center of the argument of the transitional dynamics generated by this model. In fact, it produces a statistic with the same qualitative properties as the one used to question the role of liquidity constraints; which appears to be more a consequence of the aggregation of different age-education groups within an observed cross-section of individuals in the economy.

6.3 Savings behavior

Finally, I look at the implications of the consumption decision rules for non-entrepreneurs in order to compare their saving behavior by entrepreneurial skills (knowing that those non-entrepreneurs with at the lowest skill level will never enter entrepreneurship and won't have any incentive to incur in additional savings associated to future entrepreneurial activities). In other words, this exercise determines the levels of precautionary savings related to entrepreneurship as the ones documented by Quadrini (1999). Figure 12 shows the differential of the consumption to assets ratio for medium and low entrepreneurial ability college educated agents at different ages.[50] First, savings of agents with some entrepreneurial ability are higher than those of agents with no entrepreneurial ability from the beginning of the life cycle and up to their mid 40s; point from which the behavior is the same. Furthermore, the savings differential exhibits a hump-shaped with respect to age; that is, the difference is increasing for younger agents and then starts decreasing for young adults up to the point where it is zero. This behavior indicates that agents who may become entrepreneurs in the future save increasingly more than their peers "ever-to-be" workers at the beginning of the life cycle. This differential starts decreasing as the cohort ages due to the fact that the fraction of potential entrepreneurs who haven't transit yet decreases with age. At the end of the life cycle, only those with insufficient wealth are still non-entrepreneurs. They may never be able to overcome their capital constraints and will behave just as their low entrepreneurial ability peers. This result agrees with the findings of Quadrini (1999) in the sense that most potential entrepreneurs accumulate more capital than "ever-to-be" workers through savings before transiting to entrepreneurship.[51]

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[50] I chose the College Educated for this exercise given that for the benchmark case medium entrepreneurial ability non-college agents never enter entrepreneurship.

[51] Recall that the estimated fraction of entrepreneurs within a cohort increases with age and is flatter at the end of the life cycle for both education groups.

7 Conclusions

The importance of liquidity constraints in the decision to become an entrepreneur was recently put in question by Hurst and Lusardi (2004), given the low elasticity of the aggregate transition probability profile observed up to the 90^{th} percentile of the wealth distribution. Therefore, the purpose of this paper is to provide a theoretical framework to understand the role of liquidity constraints for potential entrepreneurs in the context of this and other related findings in the literature.

I present a life cycle model of occupational choice that includes human capital and wealth heterogeneity. Human capital in this context is defined as a function of education, entrepreneurial skills, and experience. Agents enter the model as either non-college or college educated with some permanent level of entrepreneurial skills. Each period along their productive life agents decide to be either workers or entrepreneurs. As workers they earn a wage proportional to the human capital component relevant in the labor market, and defined by education and age (as a proxy for experience). As entrepreneurs they must invest some fraction of their wealth in the form of physical capital and all their human capital in a convex technology with uncertain returns. Thus, as agents age they accumulate wealth according to each period's consumption and the realization of income associated to their occupational decision, as well as human capital through labor or entrepreneurial experience.

The occupational decision is the result of an evaluation of the benefits and opportunity costs of becoming an entrepreneur. The benefits of entrepreneurship are defined by the potential earnings of this activity. The opportunity costs are those associated to physical and human capital investment. The opportunity cost of physical capital is given by the return on a risk free asset available to all agents in the economy. On the other hand, entrepreneurs forgo wage earnings in the labor market associated to their level of human capital. Consequently, for each level of human capital there exists a wealth threshold associated to the entrepreneurial decision. The magnitude and behavior of this threshold along the life cycle is key to understand the relationship between the transition to entrepreneurship and wealth at the individual and aggregate levels. However, these characteristics cannot be derived analytically.

Thus, the model is solved numerically by the method of simulated moments. Simulated data for a large cohort of agents along the life cycle is generated in order to replicate the observed fraction of entrepreneurs and entrepreneurial earnings across age-education groups. The benchmark case assumes no borrowing is allowed, and sensitivity analysis with respect to the availability of credit is presented. Simulated data generated by the model is used to study the role of liquidity constraints through the relationship between the probability of transition to entrepreneurship and wealth. First, I show that the benchmark case (where agents are completely constrained) generates an aggregate (cross-sectional) transition probability profile with the same qualitative properties as the ones documented by Hurst and Lusardi (2004). Furthermore, sensitivity analysis shows that the same shape for the aggregate transition probability profile with respect to wealth can be generated regardless of the degree of credit constraints. Thus, the cross-sectional estimation of the relationship between the probability of transition to entrepreneurship and wealth is uninformative of the importance of liquidity constraints for start-ups. On the other hand, I show that the model produces a hump-shaped relationship for groups of agents with the same age and education, consistent with Buera (2006). Hence, the probability of becoming an entrepreneur is increasing in wealth for some range at fix levels of human capital. In addition, the decision rule for physical capital shows the wealth threshold associated to the decision of becoming an entrepreneur is non-decreasing in age for most of the life cycle (except for the years close to retirement age). In other words, since human capital is increasing in age for most of the life cycle (and up to some point when it starts declining near retirement), the opportunity cost of becoming an entrepreneur increases, which implies the required size of the venture must increase in order to generate enough benefits for the potential entrepreneur to get in.

The intuition behind the flat probability profile at the aggregate level can be derived from the life cycle dynamics of wealth and human capital: for most agents in the economy any increase in the probability of becoming an entrepreneur due to the accumulation of wealth over the life cycle is offset by an increase in the opportunity costs of human capital. Moreover, an explanation of the strong monotonicity of the transition probability profile at the top of the wealth distribution can also be derived from this framework. In this case, declining opportunity costs of human capital in addition to high levels of wealth observed for those near retirement, explain a higher rate of transition to entrepreneurship for this group. The latter explanation has some support in the data, given by a higher average age of those transiting at high levels of wealth in the PSID sample used by Hurst and Lusardi (2004). Thus, in contrast to a "representative-agent" interpretation derived from a reduced form estimation, liquidity constraints play an important role in the transition to entrepreneurship. Two additional results derived from the model support this idea. First, the savings rate of potential entrepreneurs is higher than that of those with no entrepreneurial skills, with higher differentials at young ages. These results agree with Quadrini (1999) in the sense that potential entrepreneurs save at a higher rates to overcome their liquidity constraints. Second, consistent with documented facts in the literature, the amount of (physical) capital invested in new ventures is typically low and way below the efficient size. Therefore, the majority of entrepreneurs lack of sufficient financial resources to start businesses at their full potential.

In sum, the main finding of this paper is that the shape of the aggregate relationship between the transition probability to entrepreneurship and wealth cannot be interpreted as evidence against the importance of liquidity constraints, but as the result of the aggregation of the optimal decision of agents facing different human capital opportunity costs. Finally, sensitivity analysis suggests that structures with tighter borrowing constraints tend to replicate the data better than those with more relaxed credit environments.

In sum, the observed relationship between the transition probability and wealth doesn't imply that liquidity constraints are not an important element in the transitional dynamics to entrepreneurship. Contrary to this view, liquidity constraints in this environment play a key role in defining minimum capital entry thresholds that change over the life cycle and determine such aggregate profile in cross-section. There are other key elements in addition to wealth heterogeneity which drive this transition, and are related to special skills, specific human capital, preferences or attitudes towards risk.

As better data becomes available, efforts to disentangle the role of other sources of heterogeneity in the transition process will foster our understanding about the motivations and barriers faced by potential entrepreneurs. Future research on this topic should also incorporate life cycle structures within an equilibrium framework, to study the effects of initial wealth or education distributions on the creation of different types of entrepreneurship and production structures in the economy; as well as policy questions related to incentives to entrepreneurship, production structure and growth. The stagnation or lack of sufficient growth accompanied with the existence of large and growing informal market sectors in many developing economies are challenging areas claiming for alternative views and approaches.

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Appendix A: Theoretical Results

The following results are key tools in the algorithm to solve the individual decision model numerically. Given that the model described above is a non-standard dynamic setup, a constrained grid search is used to find the individual decision rules. In this sense, the results from Claim 2 in particular, constrain the search region within the grid in an important way.

Claim 1: $V_j(x)$ is non-decreasing in a.

Proof: Let $a^* > \tilde{a}$ where $a^*, \tilde{a} \in A$ and $s = [\ e\ ,\ \epsilon\ ,\ z] \in S$ and let $\left[\tilde{k} \equiv k\left(\tilde{a}, s\right),\ \tilde{c} \equiv c\left(\tilde{a}, s\right)\right]$ be the solution to $P_j(\tilde{a}, s)$ as defined in section 4.

Define

$$\Gamma(a,s) = \begin{cases} 0 \leq (a - k(a,s))(1+r) + Y(k(a,s), h(s), s'; \delta) - c(a,s) \\ \qquad\qquad\qquad \text{for all } (s'|s) \in S \\ \\ 0 \leq k\left(a,s\right) \leq (1+\phi)a\ ;\ c\left(a,s\right) \geq 0 \end{cases}$$

1. By definition $\left[\tilde{k}\ ,\ \tilde{c}\right] \in \Gamma(\tilde{a}\ ,\ s)$

2. If $\left[\tilde{k}\ ,\ \tilde{c}\right] \in \Gamma(\tilde{a}\ ,\ s) \Longrightarrow \left[\tilde{k}\ ,\ \tilde{c}\right] \in \Gamma(a^*\ ,\ s)$ since for each $(s'|s) \in S$:

   $0 \leq \tilde{k} \leq (1+\phi)\tilde{a} < (1+\phi)a^*$

   $0 \leq (\tilde{a} - \tilde{k})(1+r) + Y(\tilde{k}, h\left(s\right), s'; \delta) - \tilde{c} \leq (a^* - \tilde{k})(1+r) + Y(\tilde{k}, s'; \delta) - \tilde{c}$

3. From 1 and 2: $\Gamma(\tilde{a}, s) \subseteq \Gamma(a^*, s) \Longrightarrow V_j(\tilde{a}, s) \leq V_j(a^*, s)\ \forall\ a^* > \tilde{a}$

Q.E.D.

Claim 2: $k(x,j)$ is non-decreasing in a:

Let $[k^* \equiv k\left(a^*, s\right),\ c^* \equiv c\left(a^*, s\right)]$ be a solution to $P_j(a^*, s)$ where $x^* = [a^*, s]$,
$\left[k^{\tilde{}} \equiv k\left(a^{\tilde{}}, s\right),\ c^{\tilde{}} \equiv c\left(a^{\tilde{}}, s\right)\right]$ be the solution to $P_j(a^{\tilde{}}, s)$ where $x^{\tilde{}} = [a^{\tilde{}}, s]$
and $0 < a^{\tilde{}} < a^*$.

Then,

$i)(a^* - k^*)(1+r) + Y(k^*, s' \ ; \ \delta) > 0$ for all $s' \in S$ and $0 \leq k^* \leq (1+\phi)a^*$

$ii)(a^{\tilde{}} - k^{\tilde{}})(1+r) + Y(k^{\tilde{}}, s' \ ; \ \delta) > 0$ for all $s' \in S$ and $0 \leq k^{\tilde{}} \leq (1+\phi)a^{\tilde{}}$
given $\lim_{c \longrightarrow 0} U'(c) = \infty$ (i.e. $c(x,j) > 0$ for all $[x,j] \in X \times J$)

Assume $k^{\tilde{}} > k^*$. Given $Y(k=0, s' \ ; \ \delta) = h\left(s,j\right) > 0$ and $\lim\limits_{k \to 0} \partial \Pi_e / \partial k = \infty$ this implies:
$Y(k^{\tilde{}}, h, s'; \delta) - k^{\tilde{}}(1+r) > Y(k^*, h, s'; \delta) - k^*(1+r)$ for all $s' \in S$

Adding $a^*(1+r) - c^*$ at both sides:

$iii)$ $(a^* - k^{\tilde{}})(1+r) + Y(k^{\tilde{}}, h, s'; \delta) - c^* > (a^* - k^*)(1+r) + Y(k^*, h, s'; \delta) - c^* \geq 0$
for all $s' \in S$

Given $0 < a^{\tilde{}} < a^*$ and $ii)$ we have that:
$iv)$ $0 \leq k^{\tilde{}} \leq (1+\phi)a^{\tilde{}} < (1+\phi)a^*$

From $iii)$, $iv)$ and Claim 1, $\left[k^{\tilde{}},\ c^*\right] \in \Gamma(a^*, s)$ and
$V_{j+1}((a^* - k^{\tilde{}})(1+r) + Y(k^{\tilde{}}, h, s'; \delta) - c^*, s') >$
$V_{j+1}((a^* - k^*)(1+r) + Y(k^*, h, s'; \delta) - c^*, s')$ for all $s' \in S$

therefore,

$$E[u(c^*) + \beta V_{j+1}((a^* - k^{\tilde{}})(1+r) + Y(k^{\tilde{}}, h, s'; \delta) - c^*, s')|s] > V_j(x^*)$$

which contradicts the fact that $[k^*,\ c^*]$ is the solution to $P_j(a^*, s)$.

Q.E.D.

Table 2: (%) Fraction of entrepreneurs by (PSID 1984) cohorts and age-education groups

1984	Non-Colllege Educated										Colllege Educated									
Age	25-28	29-32	33-36	37-40	41-44	45-48	49-52	53-56	57-60	61-64	25-28	29-32	33-36	37-40	41-44	45-48	49-52	53-56	57-60	61-64
25	2	2									7	10								
26	3	4									5	7								
27	2	3									10	11								
28	2	5									4	5								
29		4	6									8	7							
30		8	13									9	10							
31		7	9									7	13							
32		7	7									9	14							
33			6	7									7	10						
34			0	1									8	10						
35			9	8									12	14						
36			6	5									13	14						
37				11	11									17	17					
38				9	20									16	17					
39				12	14									20	20					
40				9	17									16	17					
41					7	8									22	24				
42					10	11									13	15				
43					10	14									21	20				
44					8	8									2	8				
45						8	13									8	13			
46						10	17									18	18			
47						9	12									15	5			
48						15	17									28	36			
49							15	7									33	30		
50							4	6									19	17		
51							10	10									14	22		
52							8	11									10	21		
53								11	9									15	24	
54								9	6									12	16	
55								6	5									18	14	
56								8	19									23	28	
57									3	3									22	29
58									14	24									20	29
59									4	11									20	25
60									12	13									9	4
$\bar{x}$	2	5	7	8	12	10	12	8	9	13	6	8	11	14	16	17	18	20	19	22
sd	1	2	4	3	4	3	5	2	6	9	2	2	3	4	6	7	11	5	6	12

Table 3: Benchmark case estimated vector of parameters

Parameter	Value	Parameter	Value	Parameter	Value
σ	1.03	z_1	0.62	A_{NC}	0.915
		z_3	1.47	α_{NC}	0.27
r	3.4%			υ_{NC}	0.42
		$Q_z(1,1)$	54%		
s_3	1.46	$Q_z(1,2)$	37%	A_{CO}	1.13
		$Q_z(2,1)$	21%	α_{CO}	0.36
$G_0(s_2)$	74%	$Q_z(2,2)$	54%	υ_{CO}	0.34
$G_0(s_3)$	90%	$Q_z(3,1)$	14%		
		$Q_z(3,2)$	16%	δ	5.17%

Table 4: Estimated parameters for various levels of credit availability

Parameter	$\phi = 0.00$	$\phi = 0.25$	$\phi = 0.50$	$\phi = 0.75$	$\phi = 1.00$
σ	1.03	1.32	1.34	1.37	1.41
r	0.03	0.03	0.04	0.04	0.04
s_3	1.46	1.72	1.74	1.78	1.78
$G_0(s_2)$	0.74	0.78	0.78	0.8	0.8
$G_0(s_3)$	0.9	0.91	0.91	0.92	0.92
z_1	0.62	0.69	0.73	0.72	0.71
z_3	1.47	1.37	1.39	1.33	1.36
$Q_z(1,1)$	0.54	0.6	0.61	0.63	0.62
$Q_z(1,2)$	0.37	0.29	0.3	0.25	0.26
$Q_z(2,1)$	0.21	0.22	0.2	0.19	0.18
$Q_z(2,2)$	0.54	0.58	0.61	0.5	0.52
$Q_z(3,1)$	0.14	0.13	0.14	0.16	0.15
$Q_z(3,2)$	0.16	0.16	0.15	0.14	0.13
A_{NC}	0.91	0.9	0.92	0.92	0.93
α_{NC}	0.27	0.31	0.3	0.38	0.36
υ_{NC}	0.42	0.48	0.48	0.4	0.41
A_{CO}	1.13	1.18	1.2	1.08	1.14
α_{CO}	0.36	0.39	0.39	0.48	0.45
υ_{CO}	0.34	0.42	0.41	0.35	0.34
δ	0.05	0.12	0.12	0.15	0.14

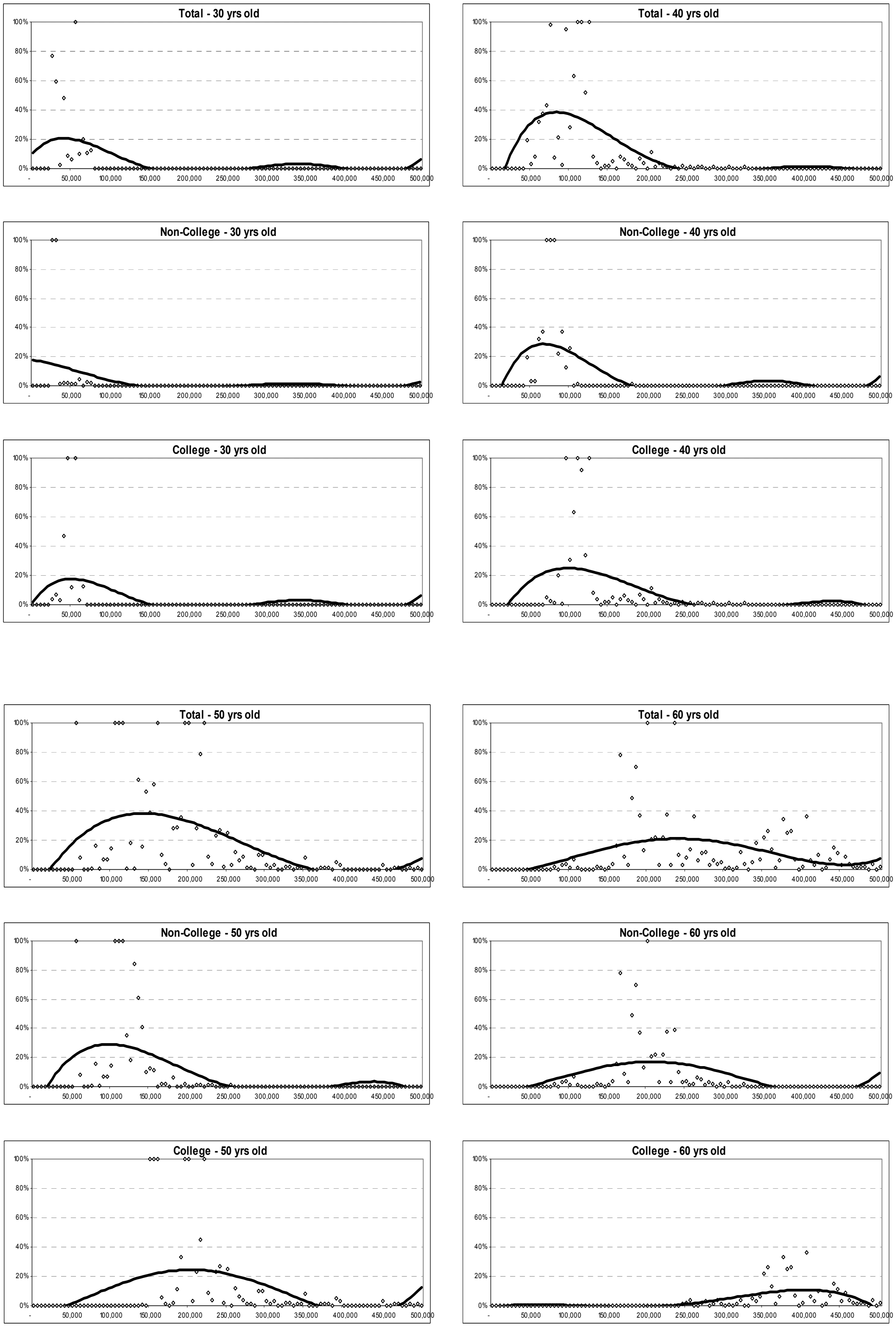

Figure 10: Probability of transition to entrepreneurship and wealth over the life cycle

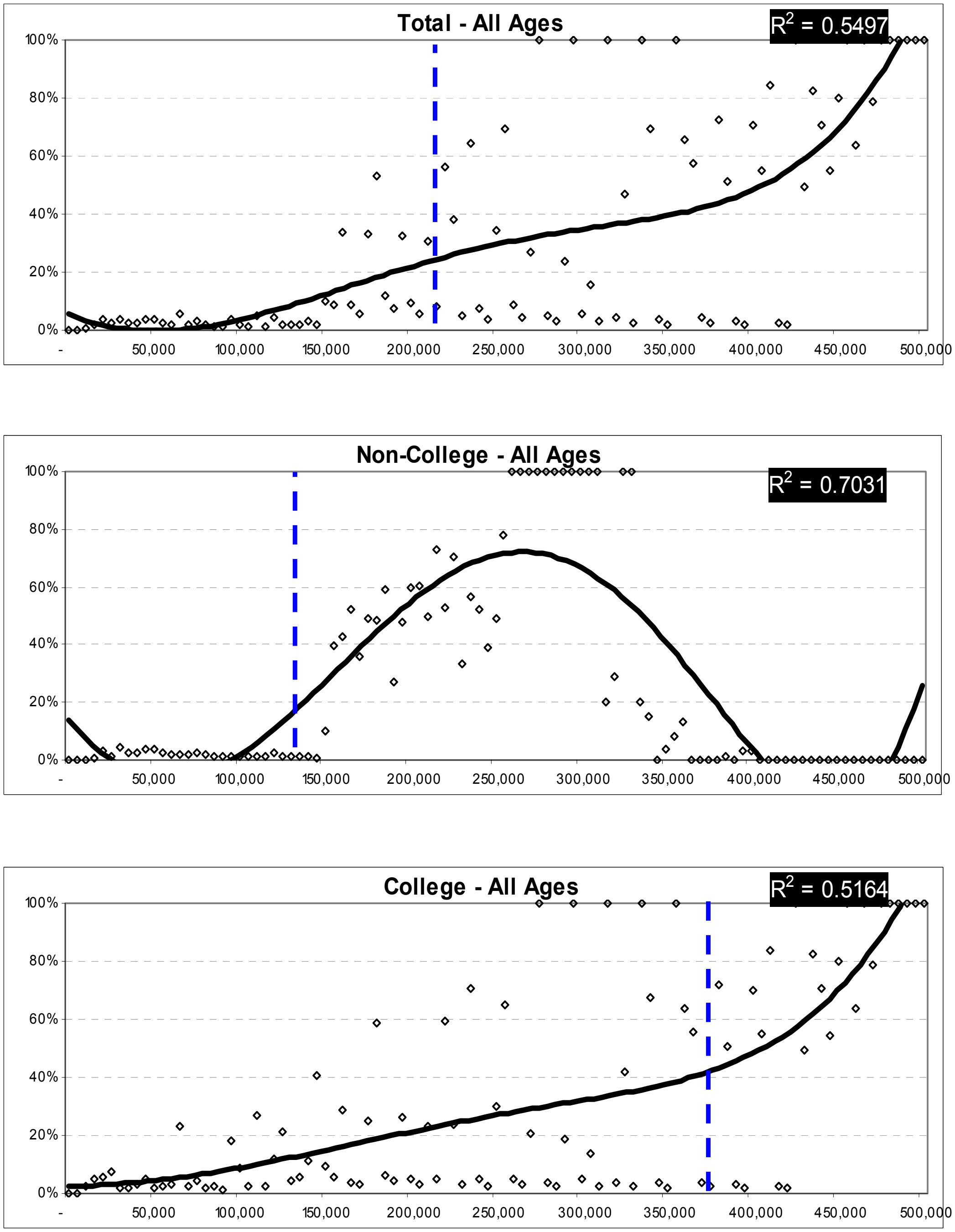

Figure 11: Probability of transition to entrepreneurship and wealth in cross section

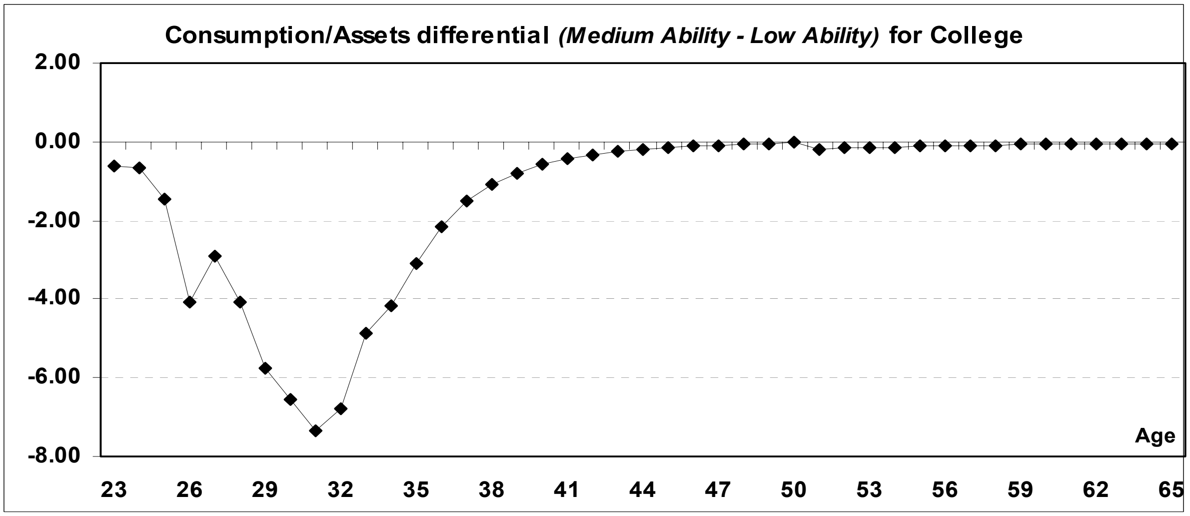

Figure 12: Consumption to assets ratio differential between medium and low entrepreneurial ability types