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SYMPOSIUM

The probability of transition to entrepreneurship revisited: wealth, education and age

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Abstract This paper revisits the empirical relationship between the probability of transition to entrepreneurship and wealth. Given that wealth is correlated with both education and age, these observable characteristics cannot be treated as independent covariates in the estimation. Thus, I document the differences in the transition probability profile across age and education groups. The main result of this paper is that the estimated probability of transition to entrepreneurship is hump-shaped in wealth across cohorts defined by age and education. Therefore, the aggregate profile estimated by Hurst and Lusardi (J Polit Econ 112(2):319–347, 2004) is not representative at the micro level. In addition, this paper provides facts that evidence important differences between entrepreneurs and workers, as well as among entrepreneurs, across education and age.

Keywords Entrepreneurship · Wealth · Transition probability

JEL Classification M13 · G11 · J24

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1 Introduction

The recognition of entrepreneurship as a driver of capital accumulation, technological innovation, job creation and economic growth has motivated increasing research since the late 1980's. In fact, the main channels through which policy makers promote entrepreneurship around the world are linked to the idea that financial constraints constitute the main barrier for entrepreneurial activity in the economy; a view supported by the early work of Evans and Leighton (1989) and Evans and Jovanovic (1989), who documented the positive correlation between the probability of becoming self-employed and wealth. This view dominated the literature during the 1990s and found further evidence in the work of Díaz-Giménez et al. (1997), Quadrini (1999, 2000), Gentry and Hubbard (2001 unpublished), Åstebro and Bernhardt (2003, 2004); and Cagetti and De Nardi (2006, 2008) in regards to entrepreneurs' wealth. Hurst and Lusardi (2004) challenge this view. They show that the probability of becoming an entrepreneur is inelastic to wealth for the majority of the population and positively monotone only for those at the top 10th percentile of the wealth distribution, and interpret this as evidence of the lack of liquidity constraints for most potential entrepreneurs in the economy. Although recent empirical studies have tried to provide further evidence in this regard, their findings are either mixed or use non-comparable definitions and datasets.[1] On the other hand, Buera (2008) derives some analytical results from a theoretical model of occupational choice. While his model implies a hump-shaped transition probability profile relative to wealth; the empirical evidence he uses to support this fact implies a measure of wealth adjusted by wage.

Thus, this paper takes a different route in contributing to the debate by focusing on a potential problem in Hurst and Lusardi (2004) estimation. Given that wealth is the explanatory variable of interest in the estimation of the transition probability, all other covariates in the estimation should be uncorrelated with wealth. There are at least two clear exceptions: education and age. As shown in Sect. 3 (and a large literature), the accumulation of wealth is linked to the life-cycle and educational attainment. In addition the facts documented in Sect. 2 suggest these characteristics imply important differences across entrepreneurs, as well as between entrepreneurs and workers. Thus, the role of wealth in the context of occupational choices may differ as well across these dimensions. Therefore, the question this paper intends to answer is *how does the empirical relationship between the probability of transition to entrepreneurship and wealth differ across education and age*?

I estimate this relationship using the same data as Hurst and Lusardi (2004), through three alternative specifications: a linear probability model, a probit model (both with a polynomial in wealth), and a semi-parametric model (non-parametric in wealth). I start by verifying that the results for the total sample agree with Hurst and Lusardi (2004), in the sense that strong growth in the transition probability is only observed at the top of the wealth distribution. In particular, while the parametric specifications suggest the profile increases for the lowest wealth levels, the semi-parametric profile is flat at the bottom of the wealth distribution but suggests a combination of a

[1] See for instance Fairlie and Krashinsky (2006 unpublished) and Demiralp and Francis (2008 unpublished).

polynomial and a step function.[2] Then, I estimate the transition probability profiles for broad education groups (high school or less, and some college or more). The results show that the aggregate profile suggested by the semi-parametric specification could be explained through differences across education groups. While the transition probability for the non-college educated is below 4% up to the 90th wealth percentile (of their group) and increases towards a 6% plateau afterwards, the profile for the college educated is around 5–6% up to the 90th percentile of this group's wealth distribution, and increases strongly afterwards. Hence, while the *first step* in the aggregate profile seems to be mainly associated with the behavior of the non-college educated, the *second step at top wealth levels* seem to be associated to the college educated (who in addition, tend to populate higher percentiles within the aggregate wealth distribution). Finally, I perform the estimation across age-education groups to study the dynamics of this relationship over the life course. I construct 10-year age groups for each education level (due to sample size constraints). The estimations suggest hump-shaped profiles, which seem to shift upwards (relative to wealth) as the cohort ages. While the former result agrees with the main finding in Buera (2008), the latter provides evidence against his *shrinkage* prediction with age.[3] Furthermore, the wealth to wage metric he uses as empirical support, could be thought of as an adjustment to account for wealth accumulation along the life-course. In sum, these results imply that the aggregate transition probability profile documented by Hurst and Lusardi (2004) is not representative at the micro level.

The paper is organized as follows. Section 2 describes the data and highlights differences across education and age among entrepreneurs. Section 3 provides evidence of the relationship between wealth and education over the life-cycle, using the sample data. Section 4 describes the estimations of the probability of transition to entrepreneurship and wealth for the total sample, as well as education and age-education groups. Section 5 concludes.

2 Data, definition and facts about entrepreneurs

This section describes the data and characterizes entrepreneurs across education, age and other observable characteristics. The first task though, is to define who are considered *entrepreneurs* for the purpose of this study. There are several ways to define entrepreneurs used in the literature. These include self-employment, business ownership (which may include in addition firm size or business sector constraints), or both.[4] This paper uses the joint business ownership and self-employment criterion. The selection of this definition is justified conceptually and by the structure of the data. While business ownership (the criterion used in Hurst and Lusardi 2004) and wealth are measured at the household level, demographic characteristics are measured at the individual level. In addition, given the main object of analysis is the

[2] Hurst and Lusardi (2004) also find evidence of a step function probability profile in wealth.

[3] Since his model doesn't account for human capital accumulation; *fixed opportunity costs in paid work* imply that individuals who don't transit at some level of wealth but do so afterwards, are those less skilled.

[4] See Hurst and Lusardi (2004) for details on previous studies.

Table 1 Business ownership and occupation (weighted sample shares, PSID 1994)

Household head occupation	Household owns a business		
	No (%)	Yes (%)	Total (%)
Works for someone else	74	7	81
Self-employed	4	11	15
Other	4	0	4
Total	82	18	100

relationship between the transition to entrepreneurship and wealth as a measure of the degree of liquidity constraints, I focus the analysis on those households that not only invest financial resources in the new venture, but a significant portion of their labor and human capital endowment as well. For instance, it would be misleading for the analysis to define as entrepreneurs business-owner households where its head, whose demographics are used in the analysis, doesn't have anything to do with the business. However, as shown in Table 1 there is significant overlap between business ownership and self-employment in the data. While about 75% of households where the head declares to be self-employed own a business, 60% of business-owner households have a self-employed head.[5] As argued in other studies, the main results don't change substantially when either of these criteria is used.

2.1 Data

The sample data comes from the Panel Study of Income Dynamics (PSID) survey; which has been following a representative sample of U.S. households across time since 1968.[6] The selection of the PSID for the estimation of interest is driven by the fact that not only the panel dimension allows the researcher to follow the characteristics and decisions of households and individuals across time, but provides data on household wealth.[7] However, these advantages come at the cost of working with a limited number of observations. Furthermore, the data is the same one used in Hurst and Lusardi (2004), which mainly comprises family data files from 1984 through 1996. Thus, the results in this paper are fully comparable with theirs in terms of sample selection.

The sample of interest for the estimation of the probability of transition is that of non-entrepreneurs in year t that become entrepreneurs in year $t+1$. Given the limited number of transitions observed within annual waves of the PSID, a pooled sample (from years 1989 and 1994) is used.[8] The question that addresses business ownership for year t is: "*Did you* (*or anyone else in the family there*) *own a business at any time in* $t-1$ *or have a financial interest in any business enterprise?*". Hence, business

[5] This overlap is consistent across all waves of the PSID since 1984; as well as with estimations based on other datasets such as the Survey of Consumer Finances.

[6] Please refer to http://www.psidonline.isr.umich.edu for further details.

[7] The PSID measures wealth every five years since 1984, and every two years since 1999.

[8] From the sample of non-entrepreneurs from years 1989 and 1994, less than 2% become entrepreneurs the next year.

Table 2 Education composition of entrepreneurs and workers (weighted sample shares, PSID 1994)

	Entrepreneurs (%)	Workers (%)
Less than high-school	13	14
Completed high-school	20	33
Some college	25	24
College or more	41	28
Other	1	1

ownership data for year t (1989, 1994) must be extracted from year's $t+1$ (1990,1995) data file; while business ownership information for year $t+1$ must be extracted from year's $t+2$ survey. The dataset includes demographic characteristics, recent labor history and income of the household head; in addition to past business ownership and wealth for the household.[9]

2.2 Facts about entrepreneurs across education and age

To motivate the focus of the paper, I provide some facts about entrepreneurs relative to non-entrepreneurs (*labeled as "workers" in the analysis that follows*) and characterize important differences among them across education and age.[10] The sample used for this purpose is comprised by household heads in the labor force within the 1989 and 1994 PSID cross-sections.[11] Table 2 shows the education composition of entrepreneurs and workers in the 1994 PSID. As documented by many other studies in the literature, there is a larger share of individuals with more than high school education among entrepreneurs. However, around 1/3 of entrepreneurs have at most completed high school. Thus, the issue of whether entrepreneurs with different educational attainment differ across observable characteristics; as well as potential differences in the transition process across groups of entrepreneurs defined by education, may be of interest to researchers and policy makers.

Figure 1 on the other hand, shows that the age distribution of entrepreneurs (with mean 45) is shifted towards higher ages for younger individuals and more skewed for those near retirement, relative to that of workers (with mean 40). In other words, this shows that the share of entrepreneurs among the youngest within the labor force is low and increases with age, while the permanence of older individuals as entrepreneurs within the labor force is higher than that of workers. These differences evidence important effects on the transition process along the life course, and constitute a motivation to study and uncover them.

I now look at the distributions of (household) wealth and (household head) total earnings in Fig. 2.[12] While the distribution of wealth for workers is highly concen-

[9] These data (except income) for any year t is part of PSID year's t data file.

[10] These facts are consistent across the PSID and SCF cross-sections between 1984 and 1998.

[11] These includes more than 4,700 observations per year, from which around 11% (in the weighted sample) are entrepreneurs according to the definition provided above.

[12] Earnings include income coming from assets owned by the household which are partially or fully owned by the household head, in addition to wages and salaries. Wealth and Earnings figures are in 1996 dollars.

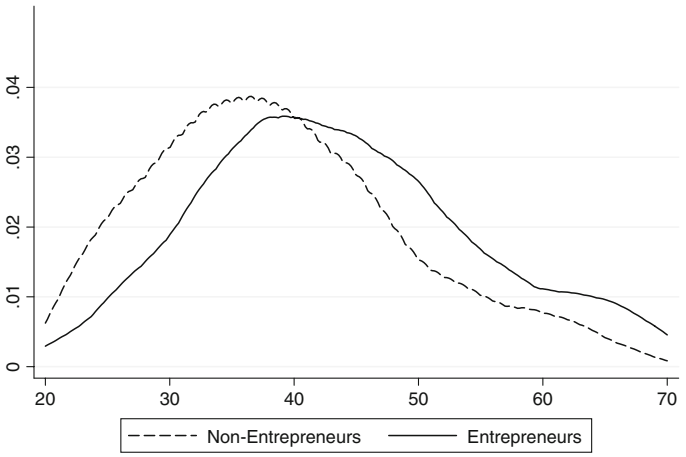

Fig. 1 Age distribution for entrepreneurs and workers (PSID 1994)

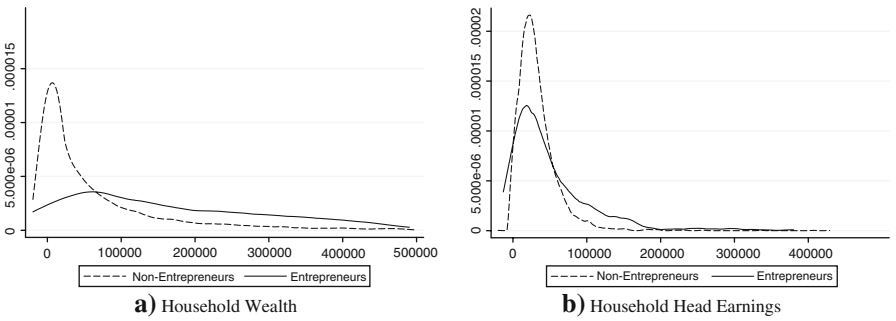

Fig. 2 Wealth and earnings distributions for entrepreneurs and workers (PSID 1994)

trated around the median and exhibits positive skewness, that of entrepreneurs is much flatter and has a thicker right tail. The disproportionate share of entrepreneurs at the top of the wealth distribution has been widely documented and studied in the literature.[13] This finding is consistent across education levels and age groups, although the concentration and density around the median falls with higher education and along the life course. The distribution of earnings though, is concentrated around the median for both entrepreneurs and workers. However, the concentration is lower for entrepreneurs, who exhibit a larger density above the 60th percentile of the earnings distribution (of those within the labor force). Again, this finding is consistent across education levels and age groups, even as earnings dispersion increases with education and age.

The next step in the analysis is to look at median levels. I focus in total earnings since they are linked to the transition process in a particular way, and can be used as a metric to measure or as an indicator to evidence the existence of financial motivations to transit across occupations. Although the issues raised by other studies in

[13] See Díaz-Giménez et al. (1997), Quadrini (2008, 1999), Quadrini and Ríos-Rull (1997), Quadrini (2000) and Cagetti and De Nardi (2006).

Table 3 Entrepreneurs median earnings to workers median earnings

Education level	Age group				
	20–30	30–40	40–50	50–60	Total
Less than high school	1.39	1.23	1.15	0.86	1.19
Completed high school	1.21	1.15	1.08	1.46	1.25
Some college	1.28	1.07	1.09	1.21	1.10
Completed college	0.79	1.25	1.53	0.89	1.28
Total	1.25	1.29	1.31	1.34	1.38

this regard are out of the scope of this paper, I provide some facts about median earnings of entrepreneurs relative to workers.[14] Table 3 shows the ratio of entrepreneurs' median earnings to the median earnings of workers across education levels and age groups.[15] First, note that for most age-education groups median earnings for entrepreneurs are larger than those observed for workers. While these ratios indicate the median entrepreneur could earn as much as 30–50% more than its peer workers within the labor force; the lower bound indicates median entrepreneur's earnings could be 20% lower than those of workers for certain age-education cohorts. In general, we can say there exists some ex-ante financial motivation for potential entrepreneurs to make the transition from the distributional perspective. Also, the median earnings gap between these occupations tends to grow with education when looking at the total; although this is not necessarily the behavior observed across age groups.[16] Similarly, while the median earnings gap increases with age in the total, such trend is not replicated across education levels. This constitutes further motivation for this paper in the sense that trends observed at the aggregate level might not be representative at the micro level. In other words, this indicates the dynamics of entrepreneurial versus paid worker earnings (which have direct implications for the transition process) may vary across both education and age in important ways.[17]

The analysis that follows focuses on the relationship between education level, business industry and technological change for entrepreneurs. Table 4 shows the fraction of entrepreneurs by education level across broad industry sectors. The results suggest an ordering of sectors given by the shares of entrepreneurs with certain educational attainment. In other words, entrepreneurs at certain levels of education tend to run businesses within certain industries. For instance, manufacturing, finance, professional services and communications are sectors where entrepreneurs have higher education profiles on average (as expected). There are certain sectors (construction, agriculture and transportation) for which these trends are not as clear.[18] In any case, for the purpose of this analysis these facts suggest education and business industry might be linked; and highlight once again the importance of education in the analysis of entrepreneurship.

[14] See for instance Hamilton (2000) and Moskowitz and Vissing-Jørgensen (2002).

[15] For this analysis I use unweighted sample figures.

[16] See Huggett et al. (2006) for further insights about the evolution of earnings along the life course.

[17] A test of mean differences in earnings between occupations across age and education groups was attempted. However, confidence levels tend to be low due to the high skewness of the earnings distribution.

[18] To analyze these cases further, a larger sample with detailed sub-sector data is required.

Table 4 Fraction of entrepreneurs by industry sector and education level (%)

Business sector	Education level				Total	
	Less than high school	Completed high school	Some college	Completed college	High school or less	Some college or more
Repair/personal services	16	52	22	10	68	32
Mining	0	67	33	0	67	33
Construction	25	33	27	16	57	43
Agriculture	21	32	23	24	53	47
Transportation	26	24	37	13	50	50
Wholesale trade	19	26	28	28	44	56
Manufact. durables	17	26	17	40	43	57
Retail trade	12	25	36	27	37	63
Manufact. non-durables	14	9	36	41	23	77
Finance/business serv.	7	9	32	52	16	84
Prof/medical serv.	3	5	7	85	7	93
Communication	0	0	0	100	0	100

Table 5 Mean ISTC for entrepreneurs by education level

		Mean	Std. error	95% Confidence interval	
[LH]	Less than high school	3.51	0.126	3.26	3.76
[HS]	Completed high school	3.25	0.087	3.08	3.42
[SC]	Some college	3.74	0.109	3.54	3.96
[CO]	Completed college	4.33	0.107	4.12	4.54
		Means difference test p values (Ho: Mean[i] − Mean[j] = 0)			
		Ha: Mean[i] ≠ Mean[j]		Ha: Mean[i] > Mean[j]	
	[HS] – [LH]	0.0901		0.9550	
	[SC] – [HS]	0.0004		0.0002	
	[CO] – [SC]	0.0002		0.0001	

Taking the analysis a step further, I look the relationship between education and technological change. To measure technological change I use the *rate of investment-specific technical change* (*ISTC*) proposed by Cummins and Violante (2002), and reported in Samaniego (2008) for industry sectors.[19] The idea is to establish if there is a link between education (as a proxy for human capital) and technological change (as a proxy for productivity) for entrepreneurs. Table 5 shows the results of ISTC means difference tests across education groups. The results support the idea of increasing technological change for entrepreneurs at higher education levels. The ISTC mean for

[19] The ISTC is measured as the quality-adjusted price change rate of capital goods.

entrepreneurs with completed college and some college is higher (at 99% confidence levels) than that observed for those with some college and high school education, respectively. The results for high school graduates relative to incomplete high school is reversed, though the hypothesis of equal means cannot be rejected at the 10% significance level. In other words, these facts suggest the type of technologies entrepreneurs run seem not only to differ, but tend to improve with education.

To summarize, the facts documented in this section highlight important differences among entrepreneurs across education and age, including differences relative to workers across these observable characteristics. Furthermore, some of these differences are directly related to the transition process between paid work and entrepreneurship, and thus motivate the main purpose of this study.

3 Wealth, education and age

This section documents empirical facts about the relationship between wealth, education and age. In particular, it aims to evidence the correlation between the observed stock of wealth with both of these demographic characteristics. The accumulation of wealth along the life course and the level of wealth across education groups has been widely documented.[20] Although there are other important determinants of wealth including intergenerational components (initial level of wealth), ability, social networks, alternative credit and liquidity sources, attitudes towards risk and portfolio choice; the facts below are consistent with most of the literature in the sense that regardless of the initial stock of wealth attained when young, individuals (on average) continue accumulating wealth along the life course, and the (average) rate of accumulation tends to increase with the level of education.

The estimations that follow are based on the sample of workers in the 1989 and 1994 PSID waves. Given the main object of study in this paper, the characteristics of this group are precisely the determinants of the transition probability to be estimated in Sect. 4. Thus, it is for this sample of individuals where the independence of wealth with education and age matters in the analysis. Figure 3 shows the observed median level of household wealth (in 1996 dollars) across age and education of the household head. This graph implies that not only the level but also the dispersion of wealth are low for young cohorts; and that both grow over the life course. In addition, wealth dispersion is linked to the education level attained by the household head. While individuals with completed college education accumulate wealth at a higher (and increasing) rate along the life course, the life cycle profile of wealth for those with less than high school education is much flatter.

Having looked at the accumulation of wealth across age and education, I now provide some estimates of the magnitude of such correlations. Table 6 shows the correlation of (household) wealth and (household head's) age across broad education levels for various samples. On the one hand, the results show that the correlation between wealth and age is below 0.20 for non-college educated individuals, and can increase up to 0.30 for college educated individuals. Moreover, the correlation increases as the

[20] See for instance Hugget (1993, 1996), Díaz-Giménez et al. (1997).

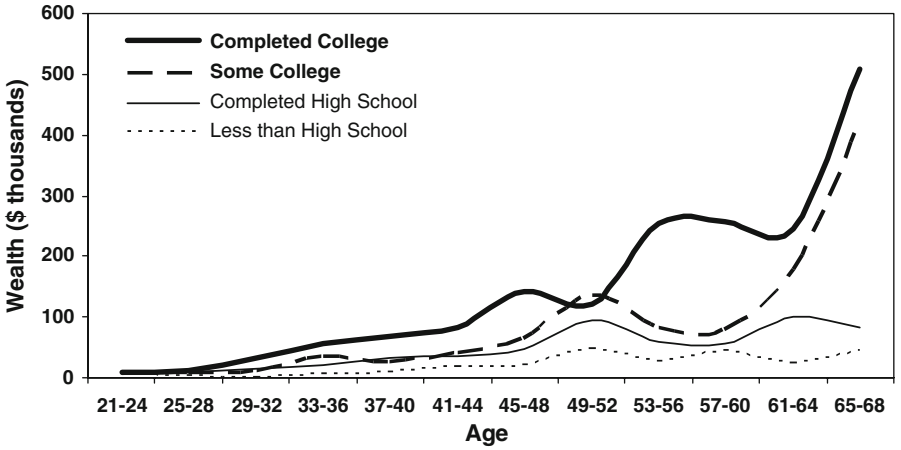

Fig. 3 Median wealth across age and education groups (PSID 1989, 1994)

Table 6 Wealth and age correlation across education groups (PSID 1989, 1994)

Age group	20–30	20–40	20–50	20–60	20–70
High school or less	0.14	0.15	0.19	0.16	0.17
Some college or more	0.09	0.21	0.25	0.28	0.28

sample coverage is extended to include older cohorts. These results not only confirm the facts suggested by Fig. 3, but evidence a sizable correlation between wealth and age. In addition, I run a linear regression of wealth on demographics. Table 7 shows the results of this estimation using samples of workers between ages 20 and 70, from the 1989 and 1994 PSID. According to these results, about 17% of observed wealth is explained by age and education, controlling for other demographics such as gender, race and marital status. The reported coefficients represent the 1996 dollar value of each additional year of age, education level attained and demographic characteristic.[21] In sum, the evidence presented in this section strongly suggests that wealth is not independent of age nor education.

4 Estimating the probability of transition to entrepreneurship as a function of wealth

The facts presented in the previous section imply that education and age cannot be considered fully independent covariates in the estimation of the probability of transition to entrepreneurship as a function of wealth. Thus, this section revisits the estimation of this relationship for different cohorts defined by age and education. Furthermore, the main goal behind this exercise is to verify if the relationship at the aggregate level (that is, using a sample that includes individuals at all ages and education levels) replicates

[21] Non-linear terms in age and interaction terms between age and education are in general not significant or make either age, education or both not significant.

Table 7 Linear regression of wealth on demographics

	1989		1994	
Age	4,667		5,299	
	(244)	***	(505)	***
Completed high school	33,703		30,582	
	(6,539.1)	***	(13,819)	**
Some college	44,171		42,204	
	(7,032)	***	(14,860)	***
Completed college	97,635		100,321	
	(7,399)	***	(15,033)	***
Married	28,069		25,987	
	(6,193)	***	(12,546)	**
Male	20,841		9,855	
	(7,442)	***	(14,559)	
White	34,797		50,004	
	(4,978)	***	(10,006)	***
Constant	−200,182		−214,429	
	(12,236)	***	(24,897)	***
Adjusted R^2	0.177		0.065	

*** Significant at 1% level
** Significant at 5% level

across cohorts, either qualitative or quantitatively. I start by estimating a model that includes wealth along demographic and labor-history characteristics. Then I present the estimation by education and age-education groups. The estimation of interest is of the general form

$$E[y|x, w] = F(h(x, w; \beta))$$

where $y \equiv P\{\text{Starting a business in } t+1 \mid \text{Individual is not an entrepreneur in } t\} \in \{0, 1\}$, x is the vector of covariates except wealth w, and β is a vector of parameters. I use three different sets of assumptions on functions F and h in order to check the robustness of the results to these different specifications. The first is the so called linear probability model (LPM) of the form[22]

$$E[y|x, w] = x\beta + g_p(w) + \varepsilon$$

where $g_p(w)$ is a polynomial in wealth, so as to explore non-linearities. The second is a probit model including a polynomial in wealth as well, which assumes F is the normal distribution function

$$E[y|x, w] = F(x\beta + g_p(w)) + \epsilon$$

[22] The literature has identified two main problems with this approach. First it cannot guarantee that forecasts on y will lie in [0, 1]. In addition, although estimates of β are unbiased, it exhibits heteroscedasticity. The former is not a problem for the estimations that follow, since the forecasted probability of transition is positive for the observed wealth range. To deal with the latter, bootstrap standard errors were computed.

and finally, I use an alternative semi-parametric estimation that imposes no structure on the function of wealth $g(w)$:

$$E[y|x, w] = x\beta + g(w) + \xi$$

First, these models were estimated using a comprehensive set of explanatory variables. The initial set of covariates included demographic characteristics such as age (including quadratic terms), education, gender, race and marital status of the household head; plus current and past 5 years average labor income of household head and wife, current and past 5 years unemployment episodes for the household head, and past 5 years business ownership episodes.[23] The results of these estimations were used to determine a parsimonious model used to construct predictions on y.[24] The selection criterion applied was based on standard individual and joint significance tests across the different specifications (which were in general consistent). In particular, age is not significant (consistent with the analysis of Evans and Leighton 1989), and neither are current and past unemployment episodes (contrary to these authors' findings). Also, while current income components are not significant in any of the estimations, average past 5 years income components are highly significant in the semi-parametric specification.

Thus, the parsimonious model used to predict transition probability profiles includes all covariates x_k in addition to wealth, for which there is strong and consistent evidence to reject $H_0 : \beta_k = 0$ in *any* of the three alternative estimations.[25] This set includes household head gender, race, marital status and education dummies, last year and past 5 years unemployment dummies, and past 5 years family business ownership dummy. In regards to wealth, a 5th polynomial showed the best fit in the probit and linear probability models.[26] The fact that age components are not significant across specifications is an additional piece of evidence in regards to its correlation with wealth. Since all other demographics are included as dummies, their effect on the relationship that describes the probability of transition as a function of wealth is related to expected *probability* levels rather than functional form (in the same way as their relationship to wealth documented in the previous section determines a higher or lower *average level* conditional on the group specified).

The next step is to generate a predicted profile of the transition probability using the estimated parsimonious models. Figure 4 shows the predicted probability using the three alternative specifications, including 95% confidence intervals. The top-left

[23] All these data for any year t is part of PSID year's t data file, except for business ownership and labor income, which are part of PSID year's $t + 1$ data file. Additional constraints are imposed on the data set. As in Hurst and Lusardi (2004), households where the head is retired, out of the labor force or not between 21 and 60 years of age in year t are eliminated.

[24] See Appendix B (Tables 8 and 9) for sample size and composition details, as well as a summary of covariate means for the sample of interest. Detailed econometric estimates and statistics of *all* the estimations that follow in this section are not reported in the paper but can be provided by the author upon request.

[25] This criteria was not applied to the average past 5 years income; which was excluded from the analysis due to the results of the parametric estimations and potential colinearity with wealth. Unemployment covariates were included to test the results of Evans and Leighton (1989) across cohorts.

[26] This is, not surprising given sample selection, consistent with the findings of Hurst and Lusardi (2004).

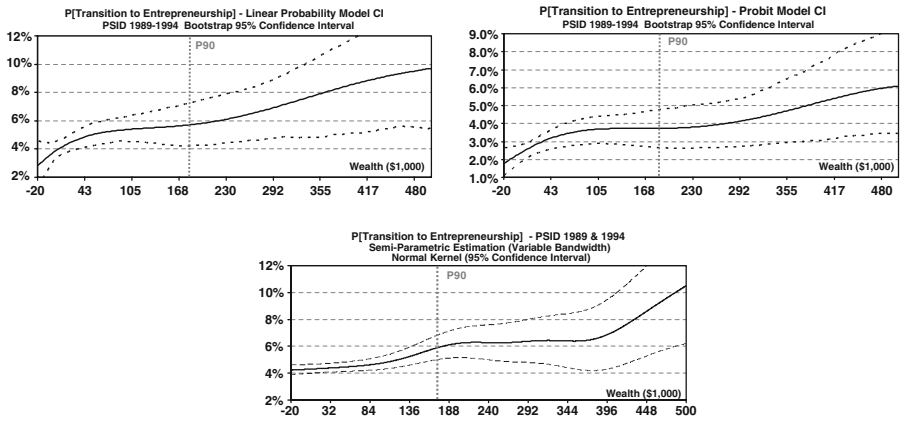

Fig. 4 Aggregate probability of transition to entrepreneurship

figure shows the estimation using the linear probability model, the top-right figure corresponds to the probit model and the bottom figure to the semi-parametric approach.[27] Overall, the results agree with the main findings of Hurst and Lusardi (2004) in the sense that: (1) the transition probability is flat for almost all the wealth distribution and (2) it is only at the top 5–10% that the relationship becomes strongly monotone. It is important to note though, that while confidence bands further support the first finding, more evidence is needed regarding the second. This is a natural consequence of a lower number of observations at the top of the wealth distribution. In any case, it is clear from the semi-parametric estimation and confidence bands that the hypothesis of a flat or linear profile for the entire wealth distribution can be rejected. Finally, the semi-parametric estimation describes a shape somehow different as the one implied by the parametric specifications, which is flat at around 4% for the bottom 80% of the wealth distribution, increasing up to the 90th percentile, flat again at around 6%, and strongly monotone at the top 3% of wealth. This type of step-function behavior cannot be captured by the polynomial imposed in the parametric specifications.[28]

4.1 Estimations across education groups

I now replicate the estimation described above separately for two broad education groups: non-college (high school or less) and college educated (some college and higher), to explore the effects of educational attainment on the probability of transition to entrepreneurship. The estimates are consistent in terms of significance across the alternative specifications and with respect to the results from the total sample. The only exception being that the remaining education dummies within groups are not

[27] All covariates, except wealth, are evaluated at their sample means. The parametric estimations confidence intervals are generated through a bootstrap procedure using 1,000 replications. The semi-parametric approach is summarized in appendix A; for further details see Pagan and Ullah (1999) and Yatchew (1998).

[28] Hurst and Lusardi (2004) find a similar pattern using their "Wealth Dummy model" specification.

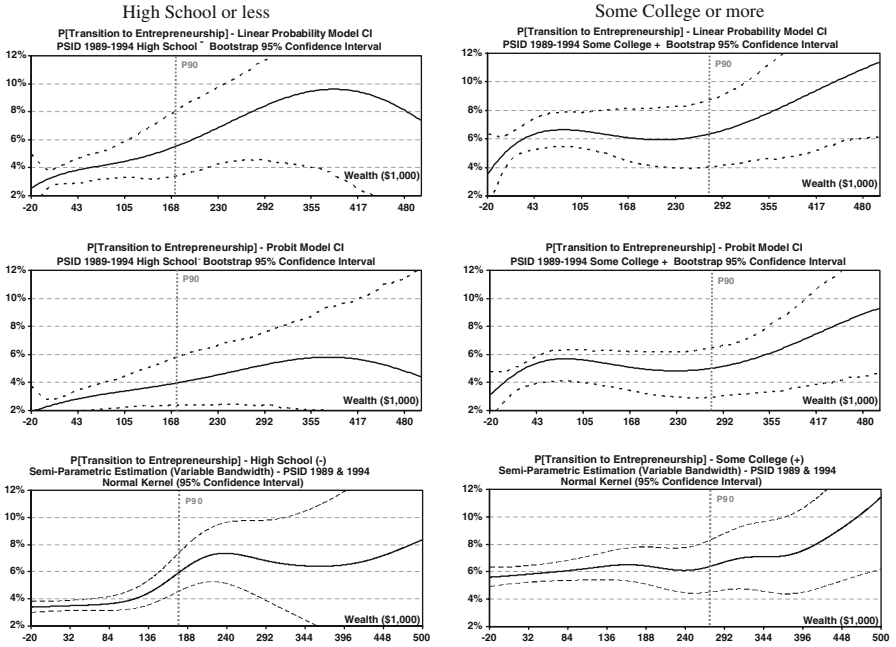

Fig. 5 Probability of transition to entrepreneurship by education

significant (which ultimately supports the selection of broad education groups). It is also worth to note that all wealth terms are not significant for the non-college educated sample in the parametric estimations, implying very wide confidence bands that make difficult to interpret any behavior in the analysis that follows. Figure 5 shows the predicted probability of transition by education groups across alternative specifications (linear probability model at the top, probit model in the middle and semi-parametric approach at the bottom panels).

The first thing to note is that the behavior of the transition probability across education levels differs in important ways. The semi-parametric model for the non-college educated group shows a flat profile at around 3.4% up to the 80th percentile of the wealth distribution of this group, and an increasing profile up to the 95th percentile (above this level the behavior cannot be determined at reasonable confidence levels). On the other hand, the college educated group has a flat profile up to its 95th wealth percentile at a higher level (around 6%), and the same increasing profile at higher levels of wealth with wider bands as in the total sample. In addition, the transition probability for the college educated is 50–100% higher than that of the non-college educated for most of the wealth distribution. Moreover, for those non-college educated at the top of their distribution (above $120,000 in net worth), the probability increases to a level just comparable to the one attained by any college educated at the bottom (nine deciles) of the college educated wealth distribution. The upward trend portion for the college educated at the top of their wealth distribution mimics the behavior in the total sample. Therefore, the finding of Hurst and Lusardi (2004) holds (qualitatively) across education groups.

On the other hand, these results open questions related to the higher propensity of the college educated to become entrepreneurs; which may be related with the type of businesses (and profitability) that individuals across education groups tend to run, as suggested by the facts in Sect. 2. In sum, education effects on the probability profile are mainly related to levels (similar to education effects on wealth in Sect. 3), rather than shape. Moreover, the step function profile suggested by the semi-parametric model using the total sample, is consistent with the aggregation of education groups that have transition profiles at different probability levels along wealth and trend upwards at different wealth levels.[29]

4.2 Estimations across age-education groups

I now explore life cycle effects by estimating the transition probability profiles relative to wealth across age-education groups. Sample size constrains the cohorts to be represented by 10-year age ranges. Thus, the estimation is performed separately for individuals within each of four age groups (21–30, 31–40, 41–50 and 51–60 years old) and education levels as defined before (high school or less, and some college or more). In addition, the functional form on wealth was estimated using parametric as well as non-parametric methods. While the former is a probit model with a fifth polynomial in wealth, the latter doesn't constrain wealth under any functional form but the one suggested by the data. Figures 6 and 7 summarize the results for the non-college and college educated, respectively. For each of these education levels results are shown by age groups (starting with the younger cohort at the top panel, up to the older cohort at the bottom) and specifications (with probit estimates on the left panels and the semi-parametric estimates on the right panels). In addition, some of the percentiles characterizing the wealth distribution associated to the corresponding age-education sample are highlighted in each case.

First, note that the transition probability profiles differ in shape, level and location relative to wealth across age-education groups. Furthermore, there are significant differences with respect to the aggregate profiles as well as those by educational attainment presented in Figs. 4 and 5. Thus, these results suggest that aggregate estimations might not be representative of the transition process for all agents in the economy; as the characteristics of this relationship seem to vary along the life course as well as across education levels. In particular, the estimations by age and education groups suggest hump-shaped transition probability profiles relative to wealth, which start increasing and peak at wealth and/or probability levels that in general tend to increase along the life course.[30] For instance, the probit estimates for the non-college educated peak at 2% probability and $100,000 in wealth for ages 21–30; at 7.6%

[29] Estimations by broad industry sectors mimic the behavior of the predominant education level (in line with the facts documented in Sect. 2). Furthermore, the exclusion of the professional services industry (emphasized in Hurst and Lusardi 2004) from the sectors with college education predominance, doesn't show significant impact on the estimated probability profile.

[30] Buera (2008) derives this hump shape analytically in a model that includes ability and wealth heterogeneity. However, his prediction of shrinking probability profiles along the life course doesn't seem to find support in these results.

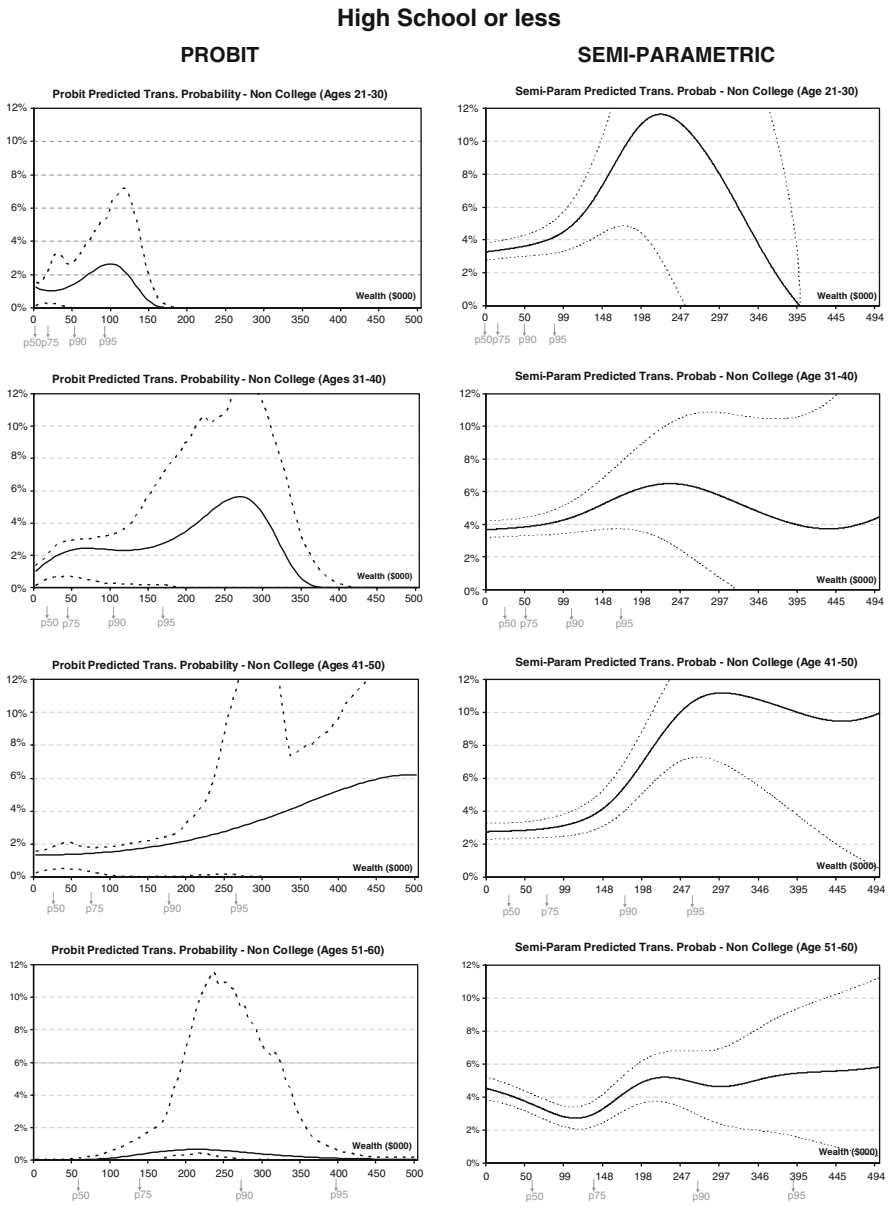

Fig. 6 Probability of transition to entrepreneurship by age: non-college educated

and $265,000 in wealth for ages 31–40; and at 12.5% and $500,000 in wealth for ages 41–50.[31] Also note that the wealth percentile at which the transition probability profile starts trending upwards changes across age and education (in contrast to the

[31] A second hump at the top 3% of the overall wealth distribution (above $500,000) is suggested by both specifications for the two oldest cohorts (41–50, 51–60) across education levels.

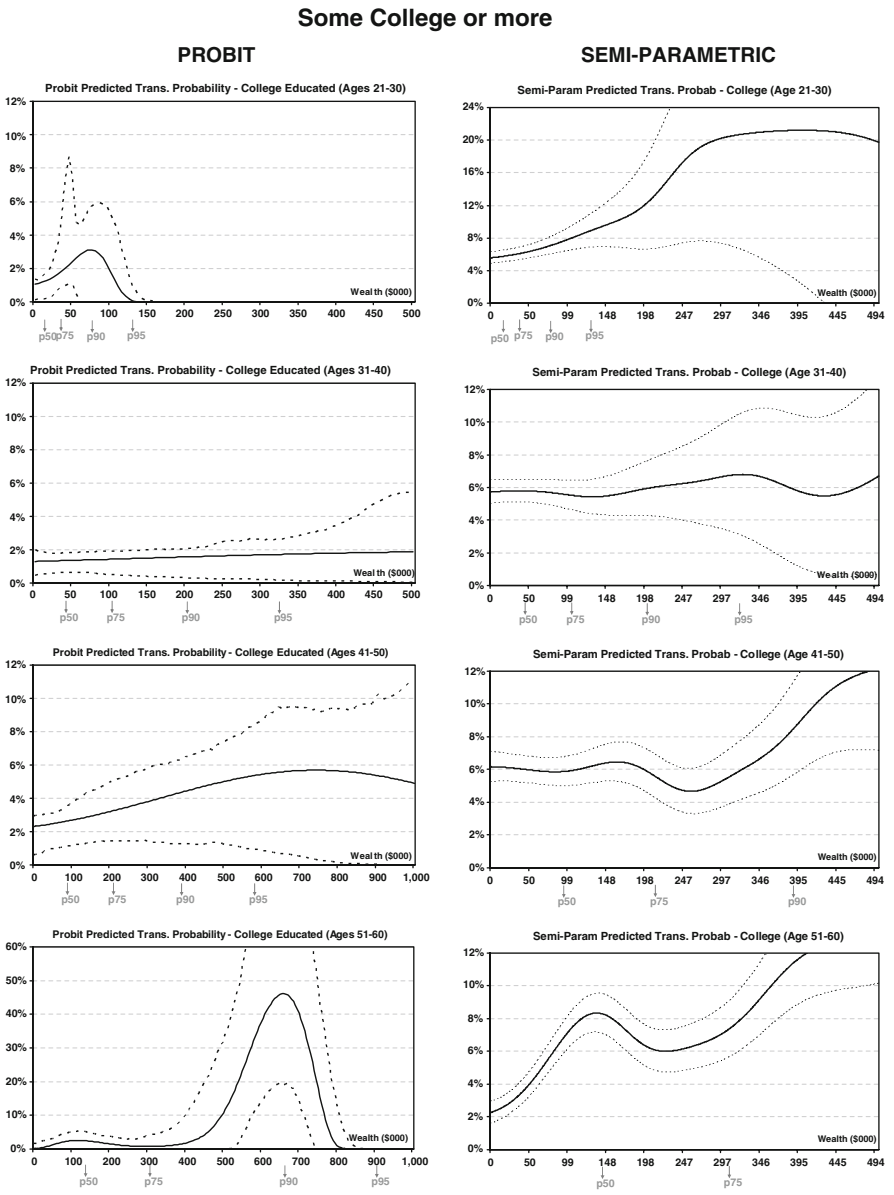

Fig. 7 Probability of transition to entrepreneurship by age: college educated

idea of a single threshold at the very top of the wealth distribution, suggested by the estimations based on the total sample). According to the semi-parametric estimations, the transition probability starts increasing (significantly) at some point above the 50th wealth percentile characteristic of each subsample. Furthermore, while this threshold is closer to the 90th wealth percentile for the younger cohorts, it is closer to (or even below) the 75th wealth percentile for the older cohorts. Therefore, these results

suggest that the fraction of individuals within a cohort that could potentially transit into entrepreneurship at lower levels of (relative) wealth increases as the cohort ages.

An important feature of the semi-parametric estimations is that while confidence bands tend to support the increasing portion of the hump-shape, the confidence of the estimates at higher levels of wealth (around the 90th wealth percentile associated to the specific subsample) is low. This is a natural consequence of the skewness of the wealth distribution in any representative sample, which in fact implies that the transition probability estimate should start decreasing above such (age-education specific) wealth threshold simply because it is *increasingly unlikely* to observe individuals at such wealth levels in each subsample.[32] Moreover, given the accumulation of wealth over the life course documented in Sect. 3 and the increasing skewness of the distribution for older cohorts, while the level of wealth at which confidence bands start widening is increasing in age, the age-education wealth percentile at which this happens decreases with age. For example, while confidence bands start widening above the 95th percentile for the youngest cohort for both education groups (above $100,000-$150,000 in wealth); this happens at some point between the 75th and 90th percentile for the oldest cohort (above $250,000 in wealth). Therefore, in the same way the hump-shaped profiles start trending upwards and peak at levels of wealth that increase with age, the point at which the probability falls due to the lack of observations within the sample also increases with age. In sum, this suggests that the hump-shaped function characterizing a given cohort of individuals shifts (relative to wealth levels) over the life course.

When one compares the profiles across estimation methods some important differences arise. When the functional form of wealth is constrained, the probability is monotone increasing along the distribution of wealth. In contrast, the semi-parametric approach tends to predict an initial flatter profile that starts increasing at some specific wealth level as mentioned above. Further analysis of the data provides further evidence in favor of the semi-parametric approach. While more than 80% of the observed transitions occur above the 25th (age-education specific) wealth percentile; in most cases between $2/3$ and $3/4$ of the transitions occur above the 50th percentile. As for the starting probability at the zero wealth level, the semi-parametric approach tends to show higher values (that tend to increase with age as well) than the probit estimates for both education groups. Finally, confidence bands for all the estimations presented in this and the previous sections tend to show higher levels of confidence for the semi-parametric estimates along longer ranges of wealth.

5 Conclusions

This paper revisits the empirical relationship between the probability of transition to entrepreneurship and wealth, by focusing on education and life-cycle effects. In particular, given that wealth is correlated with education and age (as the facts presented in Sect. 3 suggest), these observable characteristics cannot be assumed to be independent covariates in the estimation of interest. In addition, the facts documented in Sect. 2 suggest that entrepreneurs differ across education and age (among them,

[32] This is the main intuition behind the decreasing portion of the hump-shape derived in Buera (2008).

as well as relative to workers) in important dimensions such as earnings, wealth and business industry. Therefore, this paper documents the transition probability profile relative to wealth across education and age-education groups, using parametric and non -parametric specifications in wealth; based on the same data used by Hurst and Lusardi (2004) for the estimation of the transition profile at the aggregate level.

The main finding in this paper is that the transition probability profile tends to be hump-shaped in wealth across age-education cohorts, consistent with the model in Buera (2008). Furthermore, these profiles seem to shift along wealth with education and age, and to have different locations relative to the age-education group specific wealth distribution. *These results imply that the aggregate transition probability profile estimated by Hurst and Lusardi (2004), and interpreted as evidence against the importance of liquidity constraints for potential entrepreneurs, is not representative at the micro level*. In addition, I show education effects alone are fundamentally linked with probability levels and wealth-level relative location of the transition profiles, rather than shape.

Thus, this study not only contributes to the debate of the importance of liquidity constraints for potential entrepreneurs, but opens new directions for future research. The most relevant to the results of this paper is to explain the dynamics of the transition profile and their implications in regards to liquidity constraints, along the life-course. Additional issues motivated by the transition probability estimations and the facts provided in Sect. 2 include the relationship between entrepreneurial earnings (relative to paid work) and the transition profile; potential differences and drivers of the rationale behind the occupational decision across education levels; and the relationship between education, business industry, experience, entry costs and occupational choice.

Appendix A: Semi-parametric estimation of the transition probability to entrepreneurship

The regression of interest is

$$y = x\beta + g(w) + \xi \tag{A.1}$$

where $g(w)$ is an unknown function of wealth w. This implies:

$$y - E[y \mid w] = (x - E[x \mid w])\,\beta + \xi \tag{A.2}$$

According to Yatchew (1998), the OLS estimate of β on Eq. A.2 is asymptotically normal. Thus, this equation is estimated as follows:

1. Estimate $E[y|w]$ and $E[x|w]$ using nonparametric kernel regressions. I use a Normal kernel with variable bandwidth. The window width varies with each point w_i in the wealth grid such that at least $\sqrt{N}$points around w_i are within the window. Variable bandwidths are necessary given the right-skewness in the observed wealth distribution.
2. Estimate β through ordinary least squares on Eq. A.2.
3. Construct point estimates $\widehat{y}$ using $\widehat{\beta^{\mathrm{OLS}}}$, mean values for the covariates in x and the kernel density estimate of w for all points in the wealth grid.

4. Confidence bands were estimated as follows:

$$\widehat{y_{\mathrm{CB}i}} = \widehat{y_i} \pm \lambda_{1\pm 2.5\%} \left[\frac{\widehat{\sigma_i^2}}{2N\sqrt{\pi}\,\widehat{f}\,(w)\,h_i} \right]$$

where $\widehat{\sigma_i^2} = \widehat{y_i} * (1 - \widehat{y_i})$ given that $y_i \tilde{} bernoulli$ and $\widehat{f}\,(w)$ is the kernel density estimate of the observed wealth distribution.[33]

Appendix B: Sample size for estimations and (transition–no transition) covariate means (Tables 8, 9)

Table 8 Sample size by age and education groups

Age group	High school or less	Some college or more	Total
21–30	1,293	867	2,160
31–40	1,721	1,505	3,226
41–50	869	977	1,846
51–60	582	320	902
Total	4,465	3,669	8,134

Table 9 Other covariates (dummies) sample means by age and education

	Non college	College	Age group				Total
			21–30	31–40	41–50	51–60	
Gender							
No transition	0.76	0.80	0.75	0.80	0.79	0.69	0.77
Transition	0.94	0.95	0.93	0.95	0.96	0.90	0.94
Race							
No transition	0.44	0.26	0.38	0.39	0.32	0.32	0.36
Transition	0.19	0.1	0.14	0.16	0.12	0.1	0.14
Marital status							
No transition	0.56	0.63	0.46	0.63	0.67	0.6	0.59
Transition	0.75	0.75	0.64	0.75	0.76	0.85	0.75
Unemployment							
No transition	0.09	0.03	0.1	0.07	0.05	0.05	0.07
Transition	0.06	0.04	0	0.09	0.04	0.05	0.05
Past unemployment							
No transition	0.24	0.13	0.25	0.2	0.14	0.14	0.19
Transition	0.17	0.12	0.18	0.13	0.16	0.1	0.14
Past business owner							
No transition	0.15	0.25	0.18	0.19	0.21	0.19	0.19
Transition	0.53	0.73	0.54	0.61	0.67	0.85	0.65

Gender: Male = 1; Race: Black = 1; Marital Status: Married = 1; Unemployed = 1; Past Business Ownership = 1

[33] See Yatchew (1998) for further details.

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