Authorship and Acknowledgements

GL and RV had full input into all stages of the paper, and both are guarantors. RV is a health economist who has researched extensively on healthcare financing and international health policy. GL is a public health physician whose interests include healthcare system design. Jennifer Dixon, Chris Ham, Nick Mays and Ron Paterson provided helpful comments on an earlier draft. This work was made possible by the Commonwealth Fund, which supported both authors as Harkness Fellows in the United States when this paper was written. The authors' work was independent of the Fund, and the opinions expressed in this article are not necessarily those of the fund.

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（「世代間問題」の研究会）

2009/07/01　一橋大学経済研究所

報告：　**「世代間問題と教育」に関する一つの試論**

報告：　久冨善之（2006～08 研究協力者）
補足報告：　山本宏樹（社会学研究科・博士課程）

0、若干のまえおき

1、「世代現象」と「世代と教育」　（DPの「作業メモ１・２」を参照）

☆ 参考　Karl Mannheim の世代論：　Das Problem der Generationen, 1928 は、後のドイツ時代論文選集版　Karl Mannheim, *Wissenssoziologie, Auswahl aus dem Werk,* Luchterhand: Hermann, 1964 に収録されている。また、邦訳は樺俊男監訳『マンハイム全集』（潮出版 1975-1976）の第３巻に収録されている。

2、戦後日本の教育人口 Data を通した「時代区分」

表1-1、戦後史のなかの「時代区分（2分・4期）」と、それぞれ時期の特徴・諸側面

期	＜ 前期戦後 ＞		＜ 後期戦後 ＞	
	Ⅰ	Ⅱ	Ⅲ	Ⅳ
年代	戦後改革～ 1950年代後半	1960年前後～ 1970年代半ば	1970年代半ば ～1990年代初頭	1990年代半ば ～今日
時代と社会	戦後窮乏から 経済復興へ	高度経済成長 巨大人口移動	安定成長から バブル経済へ	バブル後長期不況 ・「改革」・格差
出生　出生数	270万人→170万人	170万人→200万人	急速な少子化(130万へ)	少子化定着(110万へ)
出生　出生率	4.5人→1.8人	1.8人→2.1人	2.1人→1.5人	1.5人→1.3人
進学率（高校へ）	40%～50%台	58%→90%	90%台前半停滞	90%台後半
進学率（大学へ）	10%	10%→38%	30%台後半停滞	40%→50%
学校と職業社会	学校を通さない回路 「二重構造」格差	進学組・就職組 進路振分けと上昇	高卒安定供給 競争の秩序化	若年失業増加と 非正規雇用の常態
ジェンダーの視点から見た時代と変化	高・大の進学率格差 短大女性化の進行 女性の限定された形での職業進出	高・進学格差の解消 大・進学率急増と格差 女性の短大進学増、職業進出の広がり	大・進学格差解消へ 女性は短大へが多い 女性の職業進出拡大（学卒就職当たり前）	短大・大学の逆転 四大進学に格差残る 高・大からの就職難が女性側でより深刻
中学校の長欠率と不登校率	高長欠率から低下	長欠率更なる低下	長欠率の増加への反転	長欠率の更なる急増
	経済的理由多→減少	経済的理由の3桁台へ	「不登校」の増加	「不登校」更なる急増

○ この区分を考えた、それぞれの教育人口 Data 的根拠

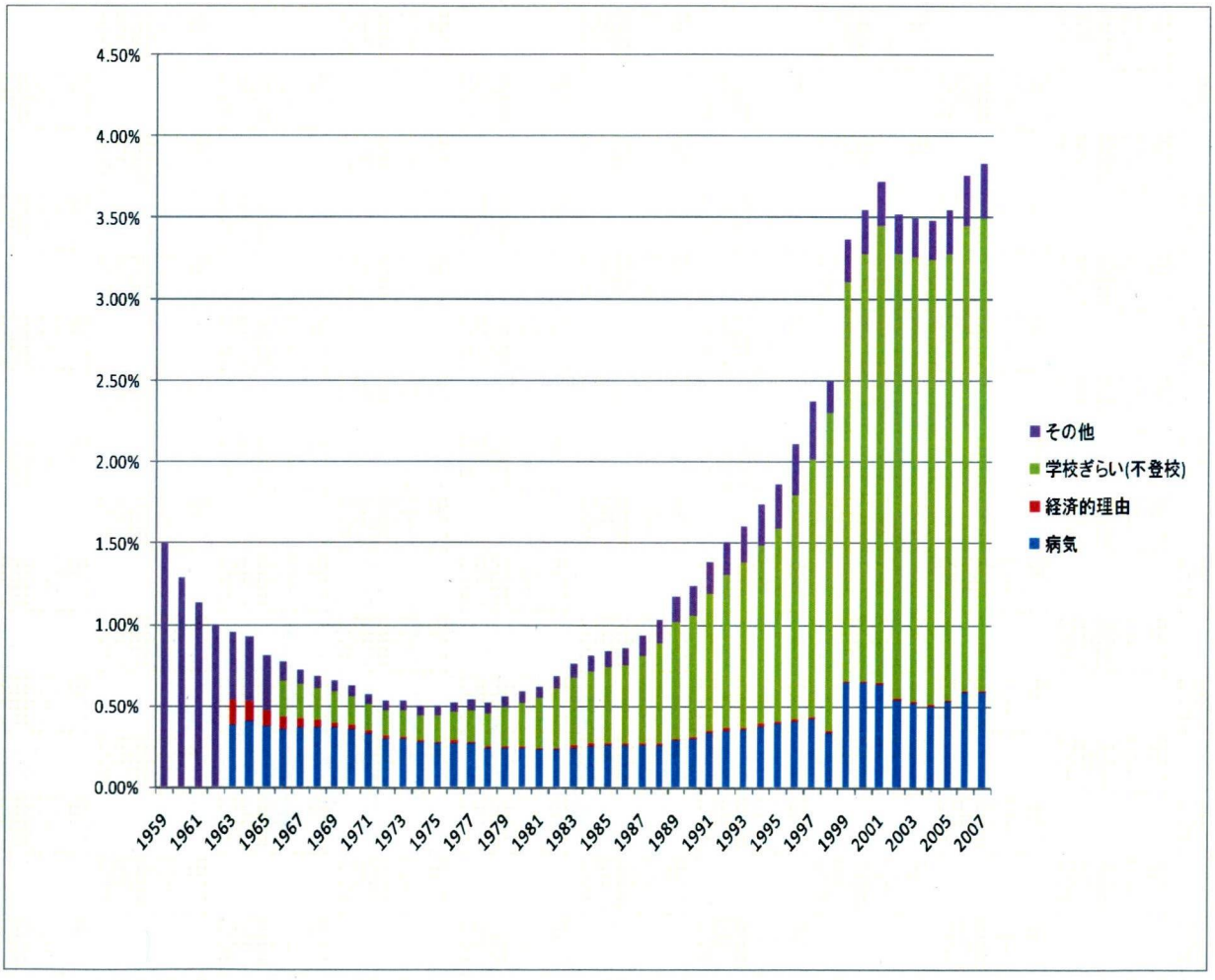
（１）出生数と「１学年人数」（DP, p.6, pp.18-19）

（２）高校・大学への進学率（DP, pp.6-8, pp.24-30）

（３）「長期欠席」と「不登校」の比率（DP, p.8, pp.31-33、下の補足資料）

補足図表　戦後日本の中学校「理由別長期欠席数」

（年間 50 日以上、1999 年から年間 30 日以上）

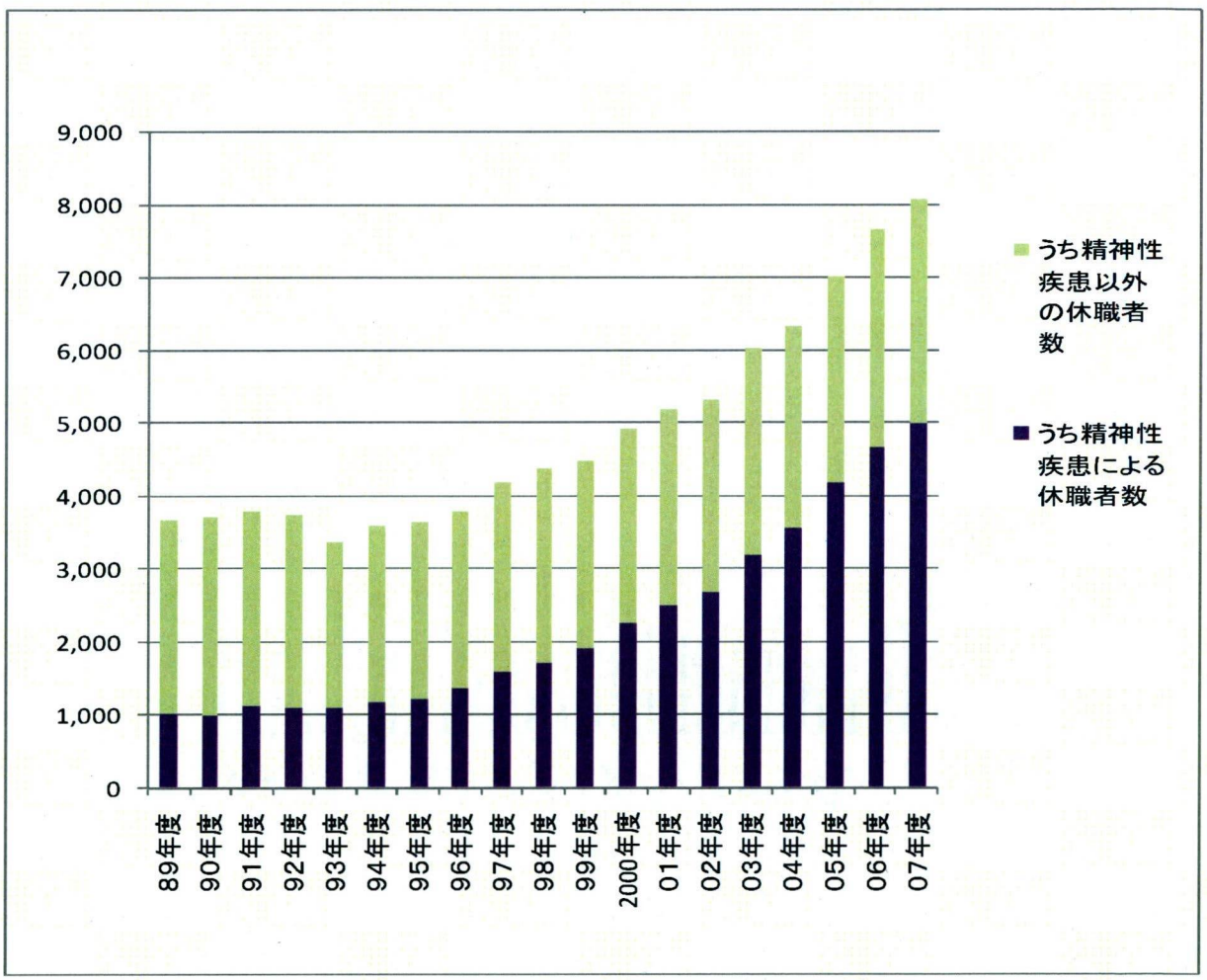


（４）教師の「休職」と「病気休職」（DP, pp.20-24、次ページの補足資料）

補足の図と表：　病気休職者数と、うち精神疾患による休職数等の推移（1989年度～2007年度）

	89年度	90年度	91年度	92年度	93年度	94年度	95年度	96年度	97年度	98年度	99年度	2000年度	01年度	02年度	03年度	04年度	05年度	06年度	07年度
在職者数（A）	997,215	998,112	1,001,432	992,700	984,115	976,220	971,027	964,365	958,061	948,350	939,369	930,220	927,035	925,938	925,007	921,600	919,154	917,011	916,441
病気休職者数（B）	3,671	3,701	3,795	3,730	3,364	3,596	3,644	3,791	4,171	4,376	4,470	4,922	5,200	5,303	6,017	6,308	7,017	7,655	8,069
うち精神性疾患による休職者数（C）	1,037	1,017	1,129	1,111	1,113	1,188	1,240	1,385	1,609	1,715	1,924	2,262	2,503	2,687	3,194	3,559	4,178	4,675	4,995
休職率（%）（B）/（A）	0.37%	0.37%	0.38%	0.38%	0.34%	0.37%	0.38%	0.39%	0.44%	0.46%	0.48%	0.53%	0.56%	0.57%	0.65%	0.68%	0.76%	0.83%	0.88%
精神疾患休職率（%）、C/A	0.10%	0.10%	0.11%	0.11%	0.11%	0.12%	0.13%	0.14%	0.17%	0.18%	0.20%	0.24%	0.27%	0.29%	0.35%	0.39%	0.45%	0.51%	0.55%
休職者中の精神疾患率（%）C/B	28.2%	27.5%	29.7%	29.8%	33.1%	33.0%	34.0%	36.5%	38.6%	39.2%	43.0%	46.0%	48.1%	50.7%	53.1%	56.4%	59.5%	61.1%	61.9%

（注）「在職者数」は、当該年度の「学校基本調査報告書」における公立の小学校、中学校、高等学校、中等教育学校、盲学校、聾学校、及び養護学校の校長、教頭、教諭、助教諭、養護教諭、養護助教諭、講師、実習助手及び寄宿



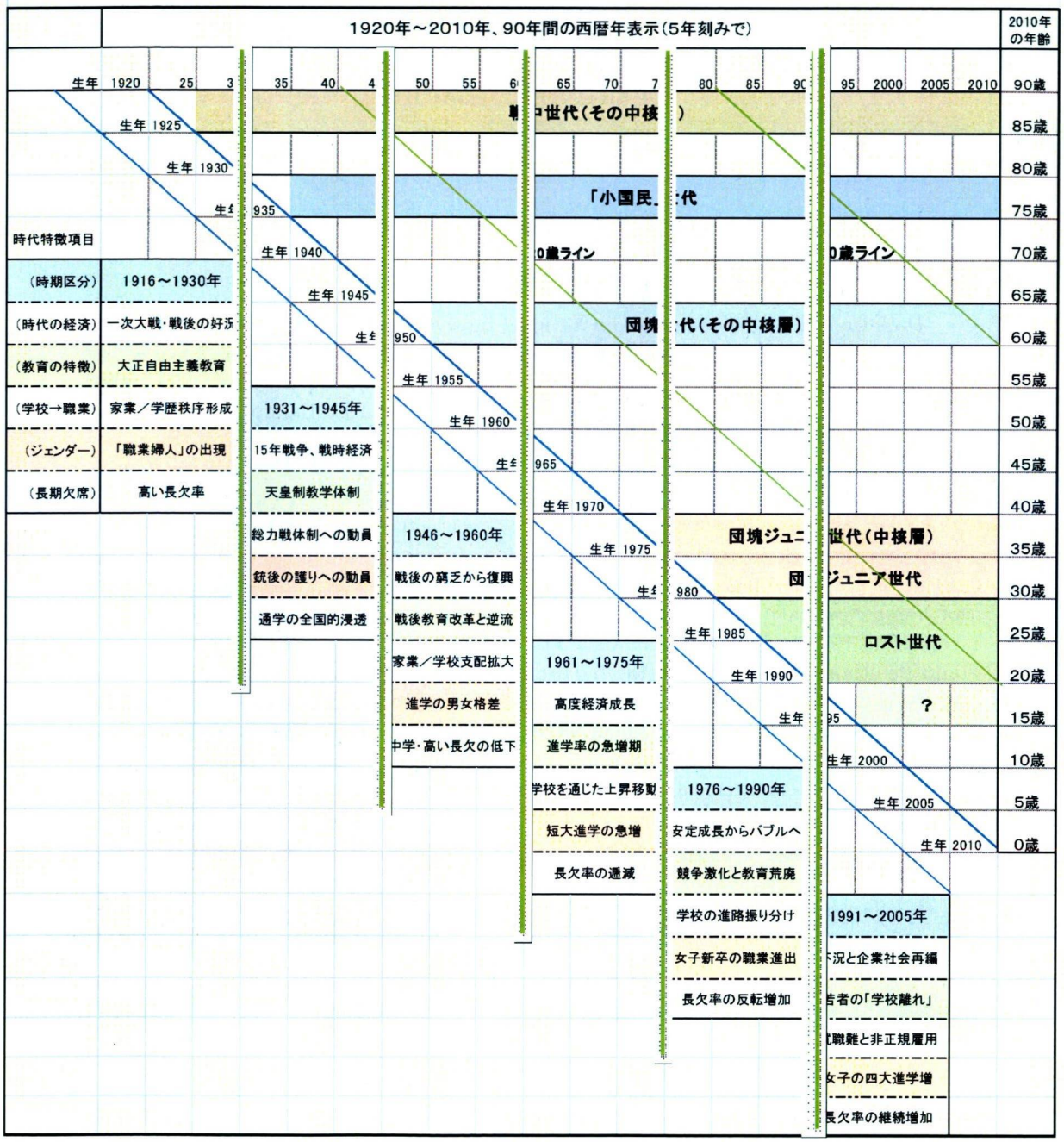
＜注＞この Data は、『教育委員会月報』の各年 12 月号によるものなので、前年度間の教育委員会による「休職」措置数で、DP の pp.21-24 の学校基本調査の数値とは、若干性格が異なっている。

・ ここから想定される「教師受難時代」の到来（？）

3、戦後日本の「世代区分」・「世代体験」についての一つの試み

（DP, pp.10-12, pp.33-35 を参照）

図1-3、戦後日本の「世代」を区分し、表示するに当たっての一つの試み



☆ なお、DP「作業B」（pp.41-50）の「生活困難の再生産問題」は、上の「1・2・3」とつなげて考えられるような、統計 Data の系統的収集と検討がないまま、当事者インタビューでの様相把握とその意味検討になっているので、本日の報告では省いている。

A Life-Cycle Model of Entrepreneurial Choice: Understanding Entry into and Exit from Self-Employment*

TAKANORI ADACHI†

This Version: March 31, 2009

Abstract

Data from the 1979 cohort of the National Longitudinal Survey of Youth (NLSY79) show that self-employment (nonfarm and nonprofessional) accounts for as much as 7% of all yearly labor supplied by young white males (aged 20-39 in the period 1979-2000). On the other hand, nearly 30% of the individuals covered by the data have at least one year of experience as a self-employer in the relevant period. The goal of this paper is to develop a coherent framework that accounts for these two contrasting figures, which together indicate the importance of understanding not only entry into but also exit from self-employment. Specifically, I present and estimate a life-cycle model of entrepreneurial choice and wealth accumulation, using a subsample of white males aged 20 to 39 from the NLSY79. In addition, the model includes two basic components of human capital (educational attainment and labor experience) aimed at a better capturing the observed patterns of labor supply, as well as those of income profiles and wealth accumulation over the life cycle. Counterfactual experiments with the use of the estimated model indicate that relaxation of borrowing constraints increases the average duration of self-employment, especially for the non-college-educated, whereas injections of business capital or self-employment-specific human capital only induce entries into self-employment that are of short duration.

Keywords: Labor Force Dynamics; Self-Employment; Entry and Exit; Human Capital; Borrowing Constraints.

JEL classification: J21 (Labor Force and Employment, Size, and Structure); J24 (Human Capital; Skills; Occupational Choice; Labor Productivity); L26 (Entrepreneurship).

*I am particularly indebted to Kenneth Wolpin and Antonio Merlo for their guidance from the very beginning of this project, and to Petra Todd and Áureo de Paula for invaluable suggestions. I also thank (individual names will be added here) for helpful comments and discussions. The parameter estimates are obtained with the use of the MPI facilities available on TSUBAME Grid Cluster at Tokyo Tech. Any remaining errors are my own.

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1 Introduction

Self-employment constitutes a sizeable portion of the labor force in the United States.[1] Data from the 1979 cohort of the NLSY79 show that self-employment (nonfarm and nonprofessional)[2] accounts for as much as 7% percent of all yearly labor supplied by young white males (aged 20–39 in the period 1979–2000). However, a more noticeable fact is that nearly 30% of individuals included in the data have at least one year of experience as a self-employer in the relevant period. These two contrasting numbers seem to suggest that self-employment is temporary in nature. A natural question that then arises is what determines the duration of self-employment? In this paper, to better understand labor force dynamics, I study this issue of the duration of self-employment by estimating a life-cycle model of entrepreneurial choice and wealth accumulation, using a subsample of white males aged 20 to 39 from the NLSY79, and by conducting counterfactual experiments with the use of the estimated model.[3] The main target of the estimation is to accurately replicate the observed patterns of entry into and exit from self-employment, as well as the patterns of income profiles and wealth accumulation over the life cycle. The counterfactual experiments conducted in this paper involve (i) the relaxation of borrowing constraints, (ii) an injection of business capital and (iii) an injection of self-employment-specific human capital.

My dynamic model is a natural extension of Evans and Jovanovic's (1989) static model of entrepreneurial choice to a competitive labor supply model in a life-cycle framework.[4] In my model, an individual, either non-college- or college-educated, must commence making decisions after he/she finishes schooling. In each period (a calendar year), an individual decides on a mode of employment, after observing shocks to his/her preference and income opportunities, and obtains income from the chosen job. Then he/she determines the amount of

[1] In this study, the empirical counterpart of a person starting a business is that the person becomes his or her own *self-employer* and, therefore, the words "self-employment" and "entrepreneurship" are used interchangeably throughout. The definition of self-employers in US surveys such as the Current Population Survey (CPS) and the National Longitudinal Survey of Youth (NLSY79), which is used in the present study, is "*those who work for profit or fees in their own business, profession, trade or operate a farm.*" I use this definition to describe running a business, instead of an alternative definition that is also widely used (business ownership), because of this paper's emphasis on the labor side of entrepreneurship, as the aim is to highlight the role of human capital in entrepreneurship. In addition, the majority of new businesses are likely to be started by self-employed business owners. Evidence from the Panel Study of Entrepreneurial Dynamics (PSED) indicates that about 75% of business startups involve self-employers: almost half of the nascent entrepreneurs in the PSED plan to start business as the sole legal owner of a new firm, and a quarter of them expect to start partnerships. Only one-fifth of nascent entrepreneurs consider a form of corporation. As the data I use for this study do not contain such information, I may overlook some entrepreneurs who start their business in the form of a corporation, instead counting them as "wage workers". In addition, I may be missing changes in legal status: some successful self-employers may become wage workers when they change the legal form of their firms to a corporation. The data employed in the present study do not include such detailed information.

[2] I exclude professionals (doctors, lawyers and accountants) and farmers from this study. See Subsection 5.1 for details.

[3] One caveat is that no welfare evaluations are provided from these experiments because labor and/or credit market imperfections are not explicitly modeled in the present study. Note also that the analytical framework provided below is a partial equilibrium one: counteractive forces caused by experiments involving changes in market prices are not considered. These are definitely important topics for future research.

[4] I do not explicitly model labor market frictions in a framework of, for example, job search. Rather, the "bare-bones" framework that I adopt is a dynamic model of competitive labor supply, and factors such as possible frictions in the labor market are modeled as unobservable residuals. However, I incorporate financial market "frictions" (in the form of borrowing constraints) into the model (with the word friction placed in double-quotation marks for the reason stated in the previous footnote).

Table 1: Income Differences by Educational Attainment (NLSY79; White Males; Aged 20–39)

	Non-college-educated	College-educated
Mean annual income from self-employment	44978.7	63378.1
(No.Obs.)	(1359)	(720)
Mean annual income from full-time paid employment	28464.6	40500.6
(No.Obs.)	(14019)	(8276)

Note : Monetary values are in terms of year 2000 dollars.

the income from working that is devoted to consumption, and the returns from the accumulated asset. He/she obtains utility from consumption as well as disutility from working. The objective of each individual is to maximize the expected present discounted value of utility over a finite horizon from the first decision period to the last. The main difference between self-employment and paid employment is in the functional forms of the income opportunities. That is, I assume that the functional forms of the individual's income opportunities depend on whether he/she works as a self-employer (that is, "becomes his/her own boss") or is employed by someone else.

A key feature of the proposed life-cycle model, which has not been given much attention in the existing literature, is the addition of *human capital* (*educational attainment* and *labor experience*) to the analysis of self-employment. The main motivation for incorporating *labor experience* into the model is to explain the observed increases in incomes from self-employment and paid employment over the life cycle (see Subsubsection 5.2.3 for details). Significant differences between the experiences of the non-college-educated (high-school graduates and dropouts) and the college-educated (those with some college education) in self- and paid employment motivate me to incorporate a variable for *educational attainment* into the model. Table 1 shows that the "college premium" in annual income is almost the same both for self-employment (40.9%) and full-time paid employment (42.3%).

Table 2 displays the differences, other than income, between the non-college-educated and the college-educated. In comparison with the college-educated, non-college-educated workers are more likely to have self-employment experience up to the age of 39 (27.5% and 31.1%, respectively), which is referred to as *Key Fact* (1). In addition, the non-college-educated spend more years in the labor force before they become self-employers for the first time (for the non-college-(college-) educated, 62.7% (74.6%) of first entries into self-employment take place in the first eight decision periods, which is referred to as *Key Fact* (2)). The third item in Table 2 shows that the non-college-educated are more likely to leave self-employment after the first year (*Key Fact* (3)). These numbers seem to suggest that, for the non-college-educated, self-employment is more likely to be a "transitory" option compared to paid employment, whereas for the college-educated, self-employment is more likely to be a "committed" task. Thus, the inclusion of human capital (education as well as experience) in a model that explicitly considers decisions over the life cycle is expected to enhance the measurement of the gains and the opportunity costs associated with occupational decisions

Table 2: Differences in Self-Employment by Educational Attainment (NLSY79; White Males; Aged 20–39)

	Non-college-educated	College-educated
Ever had experience of self-employment (%)	31.78**	27.48
(No.Obs.)	(1199)	(717)
First entry into self-employment occurs within the first eight decision years or less (%)	62.72***	74.62
(No.Obs.)	(381)	(197)
Exit from self-employment in a year (%)	32.28*	28.57
(No.Obs.)	(550)	(287)

Note 1: The data are constructed from the 1979 cohort of the National Longitudinal Survey of Youth (NLSY79). The sample includes 1916 white males. See Section 5 for details of the data.

Note 2: "Non-college-educated" individuals are high school dropouts and high school graduates, and "College- educated" are individuals with some college education and more.

Note 3: "Experience of self-employment ever or never " is measured at the last periods observed in the data.

Note 4: "Decision years" are calendar years during which individuals are in the labor force.

Note 5: The symbols ***, ** and * indicate statistical difference at the 1%, 5% and 10% levels of significance, respectively.

over the life cycle. The above points constitute the major focus of the present study. In constructing the model, I explicitly consider heterogeneity among individuals that is not observable in the data. More specifically, through the assumption of an exogenously given (discrete) distribution of an unobserved "type" variable, I am able to take into account possible unobserved differences among individuals that may affect decisions on labor supply, as well as wealth accumulation.

Given the richness of the structural life-cycle model presented below, there will be no closed-form solution for the optimal path of decisions over time. Therefore, to empirically implement the model, it is first solved numerically. Using the decision rules described in Section 4, I simulate the data and use the simulated maximum likelihood (SML) method to estimate the model parameters. The empirical data I use for the study are from the NLSY79. The proposed life-cycle model yields plausible parameter estimates and has a good fit to the main empirical patterns of entry into and exit from self-employment, as well as the age profiles of the labor supplies, income and net worth. The estimation results show that nonpecuniary benefits from continuing self-employment are relatively large, which results in the observed persistence of individuals being self-employed. Using the estimates

of the life-cycle model, I perform the three aforementioned counterfactual experiments. As my approach explicitly solves an optimization problem and thus makes predictions about how individuals behave, I can quantify the effects on entrepreneurial decisions as well as the outcomes of the alternative values of the parameters.

The first experiment is to relax the borrowing constraints for all individuals. I find that a moderate relaxation of the borrowing constraints has large impacts on the formulation and continuation of self-employed businesses. Specifically, with $30,000 as a lower bound on asset holdings (compared to the estimated lower bound of between $10,000 and $18,000 for most of the state variables), the average percentage of time over which self-employment accounts for all yearly labor supplies (over the years covered in the actual data) increases by nearly 50% (from 7% to 11%) for individuals in their thirties. At the same time, the corresponding percentage for nonemployment decreases, whereas that for full-time paid employment does not change much. However, for the individuals in their twenties, the results show the opposite effects. Thus, for individuals in their thirties, the indirect effect of the relaxation of borrowing constraints, which makes individuals more likely to choose nonemployment, is dominated by the direct effect that improves consumption smoothing over time and hence makes individuals more eager to become self-employed, despite the fact that it is a riskier choice than wage employment. For individuals in their twenties, in contrast, the indirect effect dominates the direct effect. It is also found that the average duration of self-employment becomes longer as a result of the relaxation of borrowing constraints. Nearly 90% of self-employers continue to be self-employed in the following year, whereas in the actual data, only 78% continue to be self-employed. This is caused by "selection" effects: individuals who are less able as self-employers choose to stay nonemployed instead. Focusing on educational differences, I find that the effects of relaxing the borrowing constraints are larger for the non-college-educated.

The second and the third experiments involve direct forces: injections of business capital and self-employment-specific human capital. I find that both counterfactual changes induce more individuals to enter into self-employment, although they make the average duration of self-employment shorter. The results from the three counterfactual experiments show that the relaxation of borrowing constraints encourages entries into self-employment of longer duration, whereas both types of injection only induce entries of short duration. In conclusion, the relaxation of borrowing constraints would be the most effective means of determining the duration of self-employment.

The rest of this paper is organized as follows. Following the review of the related literature in the next section, Section 3 presents a structural model for entrepreneurial choice and wealth accumulation over the life cycle. Because of the richness of the model, it does not permit an analytical solution. Thus, Section 4 explains how the model is numerically solved. Then, I describe the data used for the estimation in Section 5. After the method of estimation is described in Section 6, Section 7 presents the estimation results, followed by discussions of the model fit and the implications of the parameter estimates. Then, Section 8 outlines the results from the three counterfactual experiments. Section 9 concludes the paper.

2 Related Literature

The literature on self-employment and entrepreneurship is vast. Here, I confine my attention to the studies that are closely related to this paper.[5]

[5]A related area of the literature involves the study of entrepreneurship in the presence of borrowing constraints (and precautionary saving) to better explain the observed heavy right tail of the aggregate

The main focus of the literature has been on examining the significance of borrowing constraints in the formation of business startups. In particular, much effort has been devoted to studying whether borrowing constraints deter entry into self-employment. There are two different (although not necessarily mutually exclusive) approaches to this issue. One is to provide probit estimates of the effect of assets on entry into self-employment, and the other is to explicitly consider a behavioral model of entrepreneurial choice. In both approaches, different specifications and different data are used by different authors. A seminal study by Evans and Jovanovics (1989),[6] which belongs to the second approach,[7] concluded (among other things) that borrowing constraints are significant in preventing some individuals from entering self-employment: a counterfactual experiment showed that the average probability of someone becoming a self-employer would increase by 34% if the borrowing constraints were removed.[8] The study by Evans and Jovanovic (1989) stimulated successive studies. Most of them belong in the category of the first approach (probit models). In many cases, statistically significant positive coefficients for wealth were found, which were interpreted as an indication of the existence of borrowing constraints. Many of the recent studies using the first approach have carefully treated endogeneity of wealth using instrumental variables: the possible correlation between, for example, unobserved ability as a self-employer and wealth accumulation may cause the positive relationship even if there are no borrowing constraints.[9] However, a recent study by Hurst and Lusardi (2004), using data from the Panel Study of Income Dynamics (PSID), challenged this conclusion by finding that the positive effect occurs only for the top percentiles of the wealth distribution, whereas for other percentiles, there is little evidence of a positive relationship between assets and entry into self-employment.[10]

Partly in response to Hurst and Lusardi's (2004) results and partly with the intent of improving on Evans and Jovanovics's (1989) *static* model, two recent studies, belonging to the second approach (behavioral models), by Buera (2008a) and Mondragon-Velez (2006)

wealth distribution in the US. The common idea is that when borrowing constraints are added in a model economy when businesses are starting up, this creates a more skewed wealth distribution than does the precautionary savings motive alone. See, e.g., Quadrini (1999, 2000), Castañeda, Díaz-Giménez and Ríos-Rull (2003), Cagetti and De Nardi (2006) and Terajima (2006). For other issues on self-employment in macro contexts, see, e.g., Li (2002), Fernández-Villaverde, Galdón-Sánchez and Carranza (2003) and Meh (2008). In particular, Li (2002) compared several alternative credit programs, and found that income subsidy programs and programs that target poor and capable entrepreneurs are most effective in promoting entrepreneurial activity. In contrast to the present study, the focus of these papers was not on explaining transitions (entry into and exit from self-employment) at the individual level in a life-cycle framework. Whereas I study entry into and exit from self-employment over the life cycle, this is out of scope for the above papers because they consider stationary equilibriums.

[6]Evans and Leighton (1989) is a companion paper that is the first study reporting empirical findings on the dynamic aspects of self-employment, making use of longitudinal data.

[7]For studies that use behavioral dynamic models with financial market imperfections to analyze different issues from the present study, see, e.g., Rosenzweig and Wolpin (1993) and Fafchamps and Pender (1997) (farmers in developing countries), Keane and Wolpin (2001) (financing for higher education), Redon (2006) (job search), Pavan (2008) (collateralized debt in consumption smoothing) and Schündeln (2006) (small manufacturing firms in developing countries).

[8]In a follow-up paper, Xu (1998) corrected the puzzling finding in Evans and Jovanovic (1989) that (unobserved) entrepreneurial ability and wealth are negatively correlated. Xu (1998) pointed out the negative correlation resulted from a downward bias in the original data, because a positive correlation was found with less biased wealth data.

[9]See, e.g., Holtz-Eakin, Joulfaian and Rosen (1994a,b), Blanchflower and Oswald (1998) and Dunn and Holtz-Eakin (2000).

[10]More specifically, Hurst and Lusardi (2004) documented the nonmonotonic relationship by considering a polynomial of wealth in the probit equation. In addition, they checked the result with changes in housing prices as an instrumental variable.

estimated structural parameters of a *dynamic* model of entrepreneurial choice. In their dynamic models, asset accumulation is endogenously determined (model individuals decide on how much they consume and save in each period). Buera (2008a) involved a synthesis that offered both analytical characterization in a continuous-time setting and structural estimation, motivated the nonmonotonic relationship found by Hurst and Lusardi (2004). First, by assuming (unobserved) heterogeneity of entrepreneurial skill among individuals, Buera (2008a) derived a nonmonotonic (hump-shaped) relationship between the level of net worth and the likelihood of self-employment. This occurs because, if an individual has accumulated a large amount of wealth, it is likely that he/she can earn more as a wage worker than as a self-employer and thus he/she is less motivated to enter into self-employment. Then, using the PSID, Buera found that welfare costs (measured by consumption) are larger for individuals who are able as self-employers but have insufficient amounts of accumulated wealth than they are for the rest of the population, which implied that borrowing constraints are significant in deterring entry into self-employment.

However, in Buera's (2008a) model, as in many studies on self-employment and entrepreneurship, human capital is not incorporated: instead, talent that augments entrepreneurial income is treated as unobserved, determined in the beginning and permanently fixed. Considering that the human capital literature has devoted much effort to studying how education and experience enhance one's market wage in paid employment, it is surprising that most of the literature on self-employment does not focus on human capital, instead treating a pool of current and future self-employers as homogenous (except for unobservable factors).[11] This simplification may cause the effect of entrepreneurial skills on self-employment performance to be overstated. This is because human capital may be correlated with important (unobserved) factors such as borrowing constraints, resulting in omitted variable biases. To capture the effects of observed and unobserved characteristics on entrepreneurial choice and wealth accumulation as precisely as possible, the level of human capital should be considered in relation to earnings opportunities not just from paid employment, but also from self-employment.

With the intent of improving on Buera's (2008a) formulation, Mondragon-Velez (2006) incorporated human capital accumulation into a dynamic framework to better capture the benefits and opportunity costs of self-employment, and then estimated the model to replicate earnings and fractions of self-employers by age–education groups. Mondragon-Velez (2006) augmented Buera's (2008a) nonmonotonic (hump-shaped) relationship between the probability of transition to self-employment and accumulated wealth: because the opportunity cost of self-employment (wage increases owing to the accumulation of human capital) becomes larger as the individual becomes older, a larger scale of business capital is necessary to attract an individual into self-employment. In this way, the relationship between the propensity to be a self-employer and accumulated wealth is nonmonotonic, consistent with Hurst and Lusardi (2004). However, Mondragon-Velez (2006) stated that the significance of borrowing constraints may still hold because tight values for borrowing constraints better replicate the skewness of the wealth distribution observed in many US data sets.

In this paper, adopting the second approach (behavioral models), I focus on an impor-

[11] There are a few exceptions, for example, Bates (1990) and Kawaguchi (2003) focused on the effects of human capital on self-employment. By estimating a logit model, Bates found that owner schooling (years of education) is the most significant human capital variable that explains the longevity of small businesses: businesses owned by college-educated individuals survived longer than businesses owned by other individuals. By considering a two-period model of human capital accumulation under income risk, Kawaguchi (2003) found that experience–earnings profiles are flatter for self-employed workers than for wage workers.

tant aspect of self-employment to which Buera (2008a) and Mondragon-Velez (2006) did not pay attention: *exit* from self-employment.[12] In Buera's (2008a) model, an individual remains a self-employer once he/she becomes one, because the author did not incorporate uncertainty into his model. When he estimated his dynamic model, Buera (2008a) used only cross-sectional information on income and the ratios of entrepreneurs to wage workers. Mondragon-Velez (2006) did not focus much on the dynamic aspects of entrepreneurship, although his model is potentially able to do so. In addition, Mondragon-Velez (2006) used age as a dynamic component in the human capital function rather than (endogenously) accumulated experience, and did not include nonemployment as a labor-supply choice. Hence, he did not distinguish between self-employment experience and wage experience. In the present study, because my life-cycle model allows exit from self-employment, I can examine the dynamic aspects of self-employment over the life cycle and, hence, the effects of borrowing constraints on entry into and exit from self-employment. In addition, I can conduct additional experiments to the relaxation of the borrowing constraints that have not considered by either Buera (2008a) or Mondragon-Velez (2006). Being able to conduct a variety of counterfactual/policy experiments is the main benefit from estimating a behavioral model. To the best of my knowledge, there are no studies using a structural model that investigate entry into self-employment and exit from self-employment. I do not focus on the nonmonotonic (hump-shaped) relationship between net worth and the likelihood of self-employment partly because the data I use are different from the data used by Hurst and Lusardi (2004), Buera (2008a) and Mondragon-Velez (2006).

In a study analogous to the present study, Schjerning (2006) focused on entry into and exit from entrepreneurship by developing and calibrating an infinite-horizon model of occupational choice and wealth accumulation. In addition, his dynamic model incorporated human capital accumulation. Schjerning's (2006) calibration exercises yielded a number of interesting predictions. There are two important differences between his model and the one in the present study. First, whereas Schjerning (2006) assumes the stationarity of the model environment, I employ a finite-horizon (life-cycle) model so that I can consider life-cycle aspects pf labor suppy and wealth accumulation. Second, in my fomulation, switching costs are modeled as nonpecuniary terms in the utility function.

3 Model Strucuture

In this section, I present a life-cycle model of an individual's decisions on entrepreneurial choice and on wealth accumulation. The general structure is a standard one that can been seen as a natural extension of Evans and Jovanovic's (1989) static model of entrepreneurial choice: in each calender year, an individual, after observing shocks to his preference and income opportunities, decides on the mode of employment and obtains income from the job. He then determines the amount of consumption out of the sum of the income from working and the returns from the accumulated asset, obtaining utility from consumption as well as disutility from working. The objective of the individual is to maximize the expected present

[12] Using the 1976–2006 March Current Population Survey (CPS), Rissman (2007) calibrated a model to generate steady-state transition rates across three employment states (self-employment, paid employment and unemployment). Rissman's (2007) results suggested that startup costs are not important determinants of the steady-state level of self-employment because a doubling of business startup costs had very little effect on the simulated transition rates. By its nature, Rissman's (2007) model is not a life-cycle model. In addition, Rissman (2007) abstracted from wealth accumulation and did not incorporate borrowing constraints into his model.

discounted value of utility over a finite horizon from the first decision period to the last. The rest of this section gives a formal description of the model.

3.1 Timeline, Choice and State Variables

The discrete decision periods are assumed to be *calender years*, indexed by t. The individual's sequential decision-making problem begins one year after when he has completed his education ($t = 1$)[13] and ends at $t = T$. I denote his age in decision period t by $age_t \in \{\underline{age}, ..., \overline{age}\}$, where $\underline{age}$ is the first year after he completed schooling[14] and $\overline{age}$ is the last decision period. I assume the retirement age is 65 for all individuals so that I set $\overline{age} = 64$. Two variables that characterize the individual's *permanent* heterogeneity are (i) his level of completed schooling (denoted by *educ*) and (ii) his type (denoted by *type*). Throughout this section, the dependence of variables on *educ* and *type* notionally suppressed.

At the beginning of each decision period t, the individual first observes shocks

$$\widetilde{\epsilon}_t^l = (\widetilde{\epsilon}_t^{ls}, \widetilde{\epsilon}_t^{lw}) \in \mathbb{R}^2$$

to his preference u_t (more precisely to labor disutility; see below) where $\widetilde{\epsilon}_t^l$ is distributed according to $N(0, \Sigma^l)$, and shocks

$$\widetilde{\epsilon}_t^y = (\widetilde{\epsilon}_t^{ys}, \widetilde{\epsilon}_t^{yw}) \in \mathbb{R}^2$$

to his earnings opportunities for the current period y_t (see Subsection 3.3 below for details), where $\widetilde{\epsilon}_t^y$ is distributed according to $N(0, \Sigma^y)$. I assume that $\widetilde{\epsilon}_t^l$ and $\widetilde{\epsilon}_t^y$ are serially uncorrelated and independently distributed.

After observing the shocks and the potential amount of business scale in his self-employment, he decides on the mode of employment (non-employed, paid-employed or self-employed). If he has decided to work for a paid job, he can choose full or part-time. For self-employment, he can only choose to work or not to work.[15] Specifically, a choice element of labor is written by

$$\begin{aligned} l_t = (l_t^s, l_t^w) \in & \{Zero,\ SE\} \\ & \times \{Zero,\ Part\text{-}time\ PE,\ Full\text{-}time\ PE\} \end{aligned}$$

and as a result of labor choice he obtains income from working.[16,17] Since I assume that full-time work is equivalent to working for 2000 hours and part-time work is to 1000 hours,

[13] In this study, I do not model schooling decisions and assume that the individual's education level is exogenously given. This simplifying assumption may lead to overstatement of college premium in self-employment because the schooling decision may be partly motivated by some unobservable factors that relate to productivity in self-employment.

[14] In the data, the starting age varies among individuals as a result of differences in last years of schooling. I excluded those individuals whose first period is 14 years, or 26 years old or older. Following Imai and Keane (2004), I assume that the earliest age when decisions start is 20. So, the first age ranges from 20 to 25 in the constructed data. See B.2 in Appendix B for details.

[15] The reason why I do not distinguish between full- and part-time self-employment is that the number of individuals choosing part-time self-employment in each age is small. See B.4.2 in Appendix B for details. Notice here that by definition I am excluding such issues as "overwork" and "flexibility" on hours worked in self-employment.

[16] Note that he makes a decision, observing a vector of earnings "offer." In other words, the value for all income alternatives have already "realized" when he is making a decision.

[17] Campbell and DeNardi (2007) find that a large proportion of nascent entrepreneurs are employed in the wage and salary sector at the time they are starting their own business.

I occasionally use the alternative notation:

$$l_t = (l_t^s, l_t^w) \in \{0,\ 2000\} \times \{0{,}1000, 2000\}.$$

He also determines how much to save for next period out of the sum of the current income and the accumulated asset (denoted by $\Delta a_{t+1} = a_{t+1} - a_t$, where a_t is the amount of financial net worth in age t). The residual is consumption, c_t. I assume that he chooses an absolute change in financial net worth for next period from a discretized set $\{\underline{\Delta a}, ..., \overline{\Delta a}\}$, that is

$$\Delta a_{t+1} \in \{\underline{\Delta a}, ..., \overline{\Delta a}\}.$$

He obtains per-period utility from consumption as well as gets disutility from working: $u_t = u(c_t, l_t^s, l_t^w; \epsilon_t^{ls}, \epsilon_t^{lw})$. The objective of the individual is to maximize the expected present discounted value of utility over a finite horizon from the first decision age to the last (see next subsection).

Beside age index age_t itself, there are five moving state variables in each decision age t: (i) whether he has ever experienced self-employment until period $t-1$, h_t^s, (ii) how many years he has been a self-employer *in a row*, τ_t^s, (iii) accumulated labor experience in paid-employment, h_t^w, (iv) labor experience in paid-employment in the previous period, l_{t-1}^w,[18] and (v) financial net worth, a_t. The initial values for labor experience, (h_1^s,h_1^w) and for net worth, a_1, are exogenously given.

Any individual before observing shocks and starting decisions is, therefore, characterized by

$$\overline{s}_1 = ((h_1^s,\tau_1^s, h_1^w, l_0^w, a_1),\ (\textit{educ},\ \textit{type},\ \underline{\textit{age}})),$$

where $h_1^s = 0$, $\tau_1^s = 0$, $h_1^w = 0$, $l_0^w = \phi$ (null), and a_1 may be positive or negative (or zero). Regarding experience in self-employment, I employ the following transitions:

$$h_{t+1}^s = \begin{cases} 1 \text{ if } \exists t' \leq t \text{ such that } l_{t'}^s = SE \\ 0 \text{ otherwise} \end{cases}$$

for any $t \in \{1, ..., T\}$, and

$$\tau_{t+1}^s = \begin{cases} \tau_t^s + 1 \text{ if } l_t^s = SE \\ 0 \quad \text{otherwise} \end{cases}$$

for any $t \in \{1, ..., T\}$. Regarding labor experience accumulation in paid-employment, I employ the following transitions:

$$h_{t+1}^w = h_t^w + 0.5 \cdot I(l_t^w = \textit{Part-time PE}) + I(l_t^w = \textit{Full-time PE})$$

for any $t \geq 1$, where $I(\cdot)$ is an indicator function that assigns one if the term inside the parenthesis is true and zero otherwise. Notice that two state variables l_{t-1}^w and a_t are also decision variables.

3.2 The Individual's Problem and Constraints

In each decision period t, the individual is assumed to maximize the present discounted value of lifetime utility from the current period to the terminal age. The subjective discount factor

[18] The reason his work status in the previous period, (τ_{t-1}^s, l_{t-1}^w) is introduced is that the persistence effect in the employment modes is captured to explain better the patterns in the empirical data.

is denoted by $\beta \in (0,1)$. Then, in each period t, he solves

$$\max_{\{l_{t'},\ \Delta a_{t'+1}\}_{t'=t}^{T}} E\left[\sum_{t'=(\underline{age}-19)}^{(\overline{age}-19)} \beta^{t'-t} u_t\right]$$

where $u_t = u(c_t, l_t^s, l_t^w; \epsilon_t^{ls}, \epsilon_t^{lw})$, subject to the budget and borrowing constraints, which are specified in the rest of this subsection.

First, letting y_t denote the earned income, the *budget constraint* is given by

$$c_t + a_{t+1} = y_t + (1-\delta)k_t + (1+r)(a_t - k_t)$$

where $y_t = y_t^w + y_t^s$ and k_t is the amount of business capital invested in the self-employed business, which is positive *if and only if* he worked as a self-employer (see next subsection for details), $\delta \in (0,1)$ is the rate of capital depreciation of business capital, and $r > 0$ is the rate of return from savings, which is assumed to be the same as the unit cost of business capital.[19] The opportunity cost for k_t arises because he could have saved k_t in a bank. Here I assume, as in the standard neoclassical growth model, that business capital, k_t, can be completely divested (cashed out) after production and that there is no additional adjustment cost other than depreciation.[20] In addition, consumption in any period t cannot be below some level, which is called consumption floor and is denoted by $c_{\min}$ (implicitly assumed is the existence of such (unmodeled) public welfare systems as unemployment insurance and bankruptcy protection), so that

$$c_t \geq c_{\min}.$$

Second, he (*as a consumer*) faces the *borrowing constraint* due to (unmodeled) imperfections in the financial market. That is, in each period t, (unmodeled) creditors impose a lower bound that prevents the individual's net financial asset a_{t+1} from falling below a lower bound, $\underline{a}_t$:[21,22]

$$a_{t+1} \geq \underline{a}_{t+1}.$$

Because of this borrowing constraint the individual *cannot always perfectly smooth consumption.*

3.3 Earnings Opportunities

Differences between self-employment and paid-employment are expressed as those in functional forms of earnings opportunities: I assume that functional forms of someone's earnings opportunities depend on whether he works independently ("becomes his own boss") or is

[19] Notice here that the interest rate is not dependent on t. If one wants to consider the time dependency of the interest rate in a consistent manner to a dynamic model, she needs to introduce the individual's forecasting rule in the model. In this paper, I just assume that the individual in the model regards the interest rate as some constant during his life. Hence, I do not consider macro schocks from the aggregate economy, either. For an analysis of the macro effects on self-employment, see Rissman (2003, 2006).

[20] Such papers as Quadrini (2000), Cagetti and De Nardi (2006), Buera (2008a,b), Mondragon-Velez (2006) and Schjerning (2006) that study the role of borrowing constraints in entrepreneurship also employ the same assumption and thus business capital does not constitute a state variable in their models.

[21] The lower bound, $\underline{a}_t$, can be negative. This is motivated by the empirical observations: in most of ages that are covered by the data for estimation, the lower 10% have negative net worth.

[22] I do not allow the individual to default. See Pavan (2008) and Herranz, Krasa and Villamil (2007) for estimable dynamic models that allow for default.

employed by someone else.[23] I begin with the case of paid-employment because it uses a familiar formulation from the existing literature on human capital.

3.3.1 Income from Paid-Employment

Hourly Market Wages Following the literature on human capital (e.g. Ben-Porath (1967) and Mincer (1974)), I assume that the market hourly wage for effective labor is the product of the *rental price* of human capital (R^f for full-time paid-employment and R^p for part-time paid-employment) and the level of (sector-specific) human capital for paid-employment, Ψ_t^w. I assume that $\Psi_t^w$is the product of the deterministic part of the human capital ($\overline{\Psi}_t^w$) and the idiosyncratic productivity shock ($\exp(\epsilon_t^{yw})$):

$$\begin{aligned} w_t^j &= R^j \cdot \Psi_t^w \\ &= R^j \overline{\Psi}_t^w \exp(\epsilon_t^{yw}) \ (\equiv w^j(\overline{\Psi}_t^w, \epsilon_t^{yw})) \end{aligned}$$

which leads to the following *Mincerian wage equation*:

$$\ln w_t^j = \ln R^j + \ln \overline{\Psi}_t^w + \epsilon_t^{yw},$$

for $j = f, p$.

Annual Income Annual income from paid-employment, y_t^w, is then the hourly market wage multiplied by hours worked. Specifically, it is given by

$$y_t^w = \begin{cases} w_t^f \cdot 2000 \text{ if } l_t^w \text{ is "full-time"} \\ w_t^p \cdot 1000 \text{ if } l_t^s \text{ is "part-time"} \\ 0 \quad \text{if } l_t^s \text{ is "zero"}, \end{cases}$$

where the variation in income reflects only the variation in hourly market wages.[24]

3.3.2 Income from Self-Employment

Entrepreneurial Production Function I assume that production contribution by the individual as a self-employer separable from that by other individuals who work with him (if any). The individual's production ability when he works as a self-employer is assumed to be captured by following the Harrod-Neutral Cobb-Douglas *entrepreneurial production function*:

$$\begin{aligned} y_t^s &= f([\overline{\Psi}_t^s l_t^s], k_t, \epsilon_t^{ys}; \alpha) \\ &= [\overline{\Psi}_t^s l_t^s]^{1-\alpha} {k_t}^{\alpha} \exp(\epsilon_t^{ys}), \end{aligned}$$

which leads to

$$\ln y_t^s = (1-\alpha) \ln[\overline{\Psi}_t^s l_t^s] + \alpha \ln k_t + \epsilon_t^{ys},$$

[23] In the present study, I assume away one important difference that a self-employed worker has to pay fringe benefits out of his earnings while a wage worker receives these as part of earnings, but they are not added into the earnings data of the wage worker. I also do not consider business transfers. See Holmes and Schmitz (1990,1995) for this issue.

[24] This is also the way of constructing data on income from paid-employment. See Appendix B.4.4.

where $\overline{\Psi}_t^s$ is the (deterministic) value of human capital for self-employment, l_t^s is hours worked for self-employment, k_t is business capital, and $\alpha \in (0,1)$ is a constant.[25] Following the human capital literature on *heterogenous skills* (e.g. Willis and Rosen (1979), Heckman and Sedlacek (1985), and Keane and Wolpin (1997)) I distinguish the (deterministic) value of human capital for self-employment ($\overline{\Psi}_t^s$) and that for paid-employment ($\overline{\Psi}_t^w$). The difference is, however, that, I assume that there does not exist a price of human capital for self-employment (such R^f and R^p as in the case of paid-employment) because the lack of the market for it.[26] Notice also that different from paid employment, the idiosyncratic productivity shock ($\exp(\epsilon_t^{ys})$) is not multiplied by deterministic part of the human capital ($\overline{\Psi}_t^s$) only but by the component including the scale of business, k_t.

Now, I assume, following Evans and Jovanovic (1989), Buera (2008a,b), Mondragon-Velez (2006) and many others in the literature on entrepreneurship, that the individual (*as a self-employer*) faces the following *borrowing constraint*:

$$0 \leq k_t \leq a_t - \underline{a}_t.$$

Notice here that if the borrowing constraint is binding, then accumulated net worth a_t determines the level of business capital (together with the lower bound for financial net worth, $\underline{a}_t$). Or, anticipating this, he may be able to overcome the borrowing constraint by accumulating enough amount of wealth beforehand. This is the mechanism of how wealth accumulation may affect entrepreneurial choice *through the presence of the borrowing constraint.* Even if an individual anticipates that the borrowing constraint is not likely to bind, wealth accumulation may matter to entrepreneurial choice *though precautionary saving motive*: if income from self-employment fluctuates more than from paid-employment, then it gives potential and current self-employers.

Annual Income Since I have judged that information on business capital k_t is not reliable enough[27] due to the small number of observations in the NLSY79 and the ambiguity of the definition of "business capital" in early processes of business formation, I follow Evans and Jovanovic (1989) to substitute the chosen k_t into the entrepreneurial production function in the following way. When he has decided works as a self-employer with $l_t^s = 2000$ hours worked, he chooses his business capital k_t by solving

$$\max_{k_t \in [0, a_t - \underline{a}_t]} \exp(\epsilon_t^{ys})[\overline{\Psi}_t^s l_t^s]^{1-\alpha} k_t^{\alpha} - (1+r)k_t,$$

subject to the borrowing constraint above, so that the chosen amount of business capital is

$$k_t^{\$} = k_t^{\$}(2000, \epsilon_t^{ys}, a_t) = \min\{k_t^*(2000; \epsilon_t^{ys}), a_t - \underline{a}_t\}.$$

[25] In the present study, when estimating the model, I capture heterogeneity in α by considering differences in the level of schooling. This is because, as Mondragon-Velez (2007) points out in other dataset, there are significant differences in industries of self-employers by the level of schooling. See A.4 in Appendix A for details.

[26] An alternative modeling for the entrepreneurial production function would be to assume homegenous human capital ($\overline{\Psi}_t \equiv \overline{\Psi}_t^s \equiv \overline{\Psi}_t^w$) and thus

$$\begin{aligned} y_t^s &= f([\overline{\Psi}_t l_t^s], k_t; \omega, \alpha) \\ &= \omega \cdot [\overline{\Psi}_t l_t^s]^{1-\alpha} {k_t}^{\alpha} \end{aligned}$$

where ω is assumed to be related to *entrepreneurial/managerial talent* (see e.g. Lucas (1978)). Notice that in my model, "entrepreneurial/managerial talent" is incorporated in $\overline{\Psi}_t^s$.

[27] Evans and Jovanovic (1989) reached the same judgement, stating that "[s]ince our data do not contain precise enough information on how much is invested, ... " (p.814)

where

$$k_t^*(2000, \epsilon_t^{ys}) = \left(\frac{\alpha \cdot \exp(\epsilon_t^{ys})}{1+r}\right)^{\frac{1}{1-\alpha}} [\overline{\Psi}_t^s \cdot 2000]$$

is derived from the first-order condition for the optimal value without the borrowing constraints.[28]

Annual income from self-employment, y_t^s, is thus given by

$$y_t^s = \begin{cases} \exp(\epsilon_t^{ys})[\overline{\Psi}_t^s \cdot 2000]^{1-\alpha}[k_t^{\$}(2000, \epsilon_t^{ys}, a_t)]^{\alpha} & \text{if } l_t^s \text{ is "work"} \\ 0 & \text{if } l_t^s \text{ is "zero"}, \end{cases}$$

where, because of the borrowing constraint, the realization is affected by the current net worth, a_t.

4 Solving the Model

Although its structure is not conceptually complicated, the life-cycle model described above does not seem to permit an analytical solution for the optimal decision rule that yields the path, $\{(l_t)^*, (\Delta a_{t+1})^*\}_{t=1}^T$, even if parametric forms for the functions are given. In this section, I explain how my life-cycle model becomes computationally solvable.

4.1 Descretization

Notice that the structural model is presented as a *discrete choice problem*.[29] In the current formulation, the number of grids for absolute change in net worth for next period is 12,[30] so that the choice set contains 72 ($= 6 \times 12$) elements.

Variables that characterize the individual's permanent heterogeneity (*educ*, and *type*) are also discretized. First, education level takes one of two values. That is, $educ = 0$ if the individual is a high-school dropout (his year of schooling is less than 12) or a graduate (his year of schooling is 12), $educ = 1$ if he obtained some college degree (his year of schooling is equal to or greater than 13 and equal to or less than 15) or if he is a college graduate (his year of schooling is equal to or greater than 16). I also assume that *type* takes value 0 or 1.

[28] This operation is justified because I assume that k_t does not appear in a transition equation or it is not a state variable. In Schündeln (2006), who considers adjustment costs of capital but assumes away human capital accumulation, does the same operation for labor input.

[29] Another formulation would allow savings choice to be *continuous*. See, e.g, Cagetti (2003), Imai and Keane (2004), and van der Klaauw and Wolpin (2008), who numerically solve the Euler equation for the optimal consumption/savings path. Obviously, this formulaion would be more demanding in computation.

[30] The set of the actual grids that are used in the current formulation is

$$\{\underline{\Delta a}, ..., \overline{\Delta a}\} = \{\pm\{20000, 10000, 7500, 5000, 1500\}, +500, +40000\}.$$

In constructing the asset space for each period, Starting with $t = 1$ (with 5 grids), I recursivelly expand grids for next period by adding all $\Delta a \in \{\underline{\Delta a}, ..., \overline{\Delta a}\}$ to all the grids in the current period, starting with the initial period. For those who start working at age 20 the initial grids are set to be $\{-4240, 704, 2424, 6136, 96496\}$, and for others they are $\{-19154, 1840, 5932, 12492, 296400\}$.