Appendix B Details on the Construction of the Data

The aim of this appendix is to show how the data for estimation,

$$\begin{aligned} X &= \{X_i\}_{i=1}^N \\ &= \{((l_{i,t}^s, l_{i,t}^w),\ (y_{i,t}^s, w_{i,t}),\ a_{i,t+1},\ k_{i,t},\ age_{i,t})_{t=1}^{\widehat{T}_i},\ a_{i1},\ educ_i\}_{i=1}^N, \end{aligned}$$

is constructed from the original 1979 cohort of the National Longitudinal Survey of Youth (NLSY79).[69] The first and last calender years for which information from data is utilized are 1979 and 2000.[70]

Remember that the decision period in my life-cycle model is a *calender year* (job durations, for example, are measured in terms of years), while various information is available on a weekly or monthly basis. So, the original data must be arranged to match the length of the decision period in the model. Other modifications are necessary to accommodate the data to the life-cycle model.

After showing the construction of the age variable in B.1, I show my rules on how to determine the first decision period for each individual in B.2. B.3 explains the restriction on the person dimension. I then give details on the construction of the main variables in B.4. For the sake of presentations, these processes are explained in order, but the actual process of data construction was not implemented in this order because, for example, the restriction on the person dimension needs some information on variables constructed in B.4.

B.1 Constructing Age Variable, $age_{i,t}$

Respondent's data of birth was asked twice: in survey years 1979 and 1981. Although it is suspicious that there are some misreportings of birth year,[71] I simply use the 1979 information. First, I calculate an individual's age in months at each interview date by

interview date (month/year) - DOB (month/year) in the 1979 survey.

Then, I compute his age in months as of January of the interview year simply by

age at interview date (in months) - (interview month -1) (in months).

B.2 Determining Age in the First Decision Period

Remember that schooling decision is not modelled in the life-cycle model. The individual in the model starts decisions one year after when he completed schooling. His year of schooling is taken as an exogenous variable in the dynamic model, and it does not change over time. To follow each individual in the data from his first decision period, I need to determine when he is considered to have finished schooling. Again, note that the decision period of my choice

[69] All the original data was retrieved online at the "NLS Investigator" (http://www.nlsinfo.org/web-investigator/).

[70] While I use the survey rounds up to 2002, I do not take 2002 as the final year because the year 2002 survey did not collect information on assets. The reason why I also use the year 2002 survey is that it covers weekly labor status information after the interview date in 2000.

[71] I found 14 observations (out of the core while male sample; 2,439 observations) are suspected to have misreported his birth year. The number is small, so this problem should be minor. Also note that all original 2439 respondents answered the question in 1979. For details, see the documation attched to the data (will be available in due course).

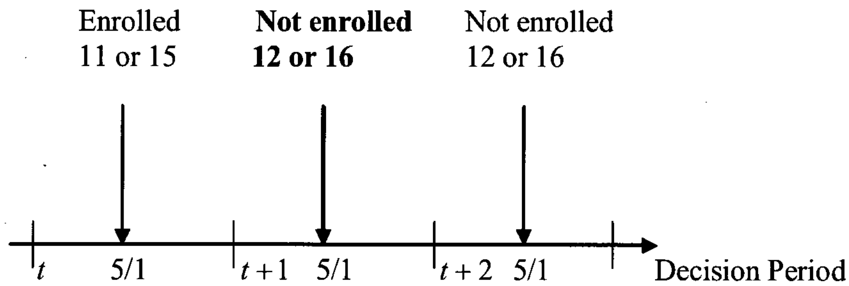

Figure 28: Typical Pattern of Transition from Schooling to Work/Non-Work

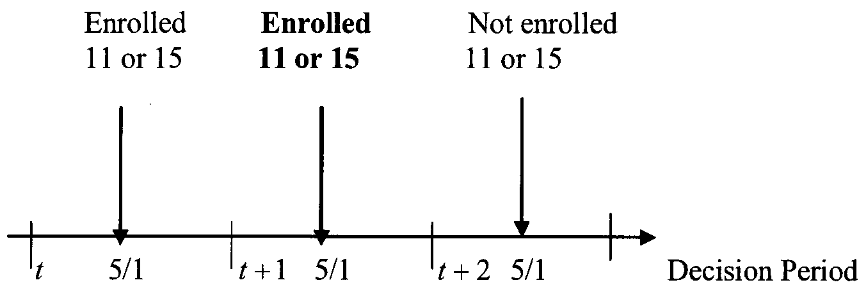

Figure 29: An Ambiguous Case of Transition

is a *calender* year. I must therefore be careful about the differences between calender years and *school* years, because it matters to the transition from schooling to work/non-work.

At each survey round, each respondent's school enrollment status as of May 1 of each year is available. I collapse the four categories in the original data into two as follows:

$$\begin{cases} \text{Enrolled} \leftarrow \text{"Enrolled in high school" or "Enrolled in college"} \\ \text{Not Enrolled} \leftarrow \text{"Not enrolled, completed less than 12th grade"} \\ \qquad\qquad\qquad\text{or "Not enrolled, high school graduate."} \end{cases}$$

Using this information on "school enrollment status as of May 1st" (denoted by "$enrollment_{i,t}$"), however, alone may not be precise. This problem is depicted as follows.

In most cases, we expect to observe patterns as shown in Figure 28. The horizontal arrow shows the timeline, and each partition corresponds to one period (t, $t+1$ and $t+2$). For each period, the status of school enrollment (the first row) and the accumulated year of schooling (the second row) are observed. The story that would be the most plausible to the information in this figure is the following. The individual graduated from school at some point after May 1st of period t, obtaining one more year of schooling. This is found by the information in period $t+1$: he is not enrolled in school and his year of schooling increased from the one in the previous year If that is the case, it is natural to assume that year $t+1$ is the first decision period.

Now, suppose that we observe a pattern as in Figure 29. In this case, it would be natural to assume that he stopped schooling in year t, even though he was reportedly enrolled in school year $t+1$ because he did not obtain one more year of schooling.

To avoid this type of ambiguity, I need to look at *changes* in his "Highest Degree Completed as of May 1st" (denoted by variable "$completed_{i,t}$") to determine the first decision period. Essentially, I want to find when his $completed_{i,t}$ stopped to increase. The first decision period should be one year after the year when his $completed_{i,t}$ firstly stopped to increase.

When I see an individual's $completed_{i,t}$ go up again after years of constant $completed_{i,t}$, I judge whether or not he is considered to have temporary left for additional schooling (see Restriction PD-4 in B.3). More formally, I adopt the following rules to determine when the first decision period is.

Rule 1. If individual i is not enrolled in school as of May 1st of year t ($enrollment_{i,t} = 0$), then I say he is not enrolled in school in year t ($in\_school_{i,t} = 0$).

Rule 2. If individual i is enrolled in school as of May 1st of year t ($enrollment_{i,t} = 1$), then I say he is enrolled in school in year t ($in\_school_{i,t} = 1$) if

$$completed_{i,t+1} > completed_{i,t},$$

and he is not enrolled in school year t ($in\_school_{i,t} = 0$) if

$$completed_{i,t+1} \leq completed_{i,t}.$$

In this way, for each individual, any calender year is categorized into "1" (attended school) or "0" (did not attend school), as long as "school enrollment status as of May 1" and "highest grade completed as of May 1" are available for that year. For most of individuals, "1"s appear in a row when young and "0"s in subsequent years. This case has no difficulty in determining the first decision period. For other individuals, I decided whether or not he is judged to have temporary left for additional schooling by looking at the computed hours worked and the monthly information on school enrollment.[72]

B.3 Restriction on the Person Dimension, N

I employ the following steps to restrict on the person dimension (PD) for the data used for this study.

- Restriction PD-1. I extract the *white male* part in the *core random* sample.[73] This reduces the initial sample size 12,686 to 2,439.
- Restriction PD-2. Next, to drop individuals who have served in the *military*, I look at the "Weekly Labor Force Status" Section (from Week 0 in 1978 to Week 52 in 2000).[74] If an individual's labor force status is "military" in any week since January 1, 1978, then he is excluded from the sample. I find 268 observations have ever been in the military (10.99%). This reduces the sample size 2,439 to 2,171.
- Restriction PD-3. Using the defined occupation for individual i in year t (see B.4.1. below), I exclude *professionals* and *farmers*. First, I exclude individuals who experienced any of the following occupations in any year t: "Accountants and auditors," "Lawyers and judges," "Health diagnosing occupations," and "Farming, forestry & fishing occupations." I then find, among the nonmilitary experienced, 361 observations have ever experienced professional or farmer.[75] I put 259 of them back to the sample if they were

[72] Monthly attendance record is available after January, 1980.

[73] One can retrive all necessary data online by filitering "R0173600 $\leq$ 2" ("R0173600" is the sample identification code).

[74] The 1979 year survey covers weekly labor status in 1978 as well.

[75] Among those already excluded in Restriction CS-2, 26 observations have ever experienced professional or farmer.

a professional or a farmer before the first decision period, if they are judged to have temporally worked for such jobs, or if they were in such occupations as pharmacist and registered nurse. The number of excluded individuals is now 102 (4.70%). This process reduces the sample size 2,171 to 2,069.

- Restriction PD-4. I drop individuals who are judged to have temporary left for adult schooling (24 individuals),[76] to have started working late (26 years old or older; 80 individuals) as well as 2 individuals whose first decision period is judged 14 years old. I also exclude individuals if it is difficult to determine the first decision period (6), or if no survey years are covered when working (41). The number of excluded individuals is 153 (7.39%), and this process reduces the sample size 2,069 to 1,916.

My final sample consists of 1,916 white males with a total of 32,166 person-year observations.

B.4 Construction of the Main Variables

Here I show how the main variables are constructed from the NLSY79. First, I utilize the weekly information is available whether or not someone was self-employed.

B.4.1 Defining Self-Employment and Wage-Employment

To obtain information on whether an individual is a self-employer or a wage worker in a year, I look at the "Class of Worker" Section (up to 2002 survey year). For each "job"[77] (up to five jobs for each survey year) a respondent reports whether he[78]

(1) worked/works for a private company or individual for wages, salary, or commission,
(2) was/is a government employee,
(3) was/is *self-employed* in his/her own business, professional practice or farm, or
(4) was/is working without pay in a family business or farm,

for that job. In the NLSY79, the respondent is classified (by his/her answers to the job classification questions) as *self-employed* if[79]

> "he or she owned at least 50 percent of the business,
> was the chief executive officer or principal managing partner of the business, or
> was supposed to file a form SE for Federal income taxes"

or he or she identifies himself or herself as

> "an independent contractor, independent consultant, or free-lancer."

Using this information, I associate each job with information on whether the respondent worked as a self-employer or as a paid-worker for that job. Specifically, a job is attached

[76] I made judgment by looking at calculated hours worked, changes in the highest degree completed, and the monthly school enrollment information.

[77] All references to a "job" should be understood as references to an employer.

[78] Category (1) includes individuals working for pay for settlement houses, churches, unions, and other private nonprofit organizations until 1994 when these begun to be independently coded.

[79] See ftp://www.nlsinfo.org/pub/usersvc/NLSY79/NLSY79%202004%20User%20Guide/79text/cow.htm.

to *self-employment* if it is categorized as (3), and is attached to *paid-employment* if it is categorized as (1) or (2). Category (4) will not be considered as "worked/works."

Not all the jobs listed in the NLSY79 can be identified either as self-employed or as paid-employed. This is because the "Class of Worker" information is collected only for the current (the CPS item) jobs[80] and ones for which the respondent worked for more than 10 (after 1988) or 20 (prior to 1988) hours a week and for more than 9 weeks since the last interview. This limited form of information should be innocuous for this study, however, because in the actual estimation these "temporary" jobs will not be counted as worked due to the discretization of the variable "hours worked." in B.4.2.[81]

For each job, we also have information (if provided) on labor market opportunities (the weekly average of hours worked[82] and the weekly average of hourly rate of pay). These items are used in the following calculation of the actual hours worked and the diecretization.

One caveat is that owners of incorporated businesses may or may be excluded if they draw a salary from their businesses and interpret this behavior as the one of a wage worker. Thus, the above definition of self-employers refers essentially to sole proprietors and partners of unincorporated businesses.

B.4.2 Mode of Employment and Work Intensity, $(l^s_{i,t}, l^w_{i,t})$

I look at the "Weekly Labor Force Status" Section and the "Dual Jobs" Section (1979-2000)[83] and the job characteristics information obtained above. For each individual, information on weekly labor force status is available up to the date that the last interview that he responded covers. So, the last year when the information is available is the one right before the year when "0" ("no info reported for week") appears in an array.

For each individual $i \in \{1, ..., N\}$, I know (if information is provided) whether job j ($j = 101$, ..., 105, 201, ..., 1905, 2001, ..., 2005)[84] is attached to self-employment or to paid-employment. I compute i's total hours worked for job j in calender year t, $total\_hours\_worked^j_{i,t}$, by

$$total\_hours\_worked^j_{i,t} = weekly\_hours\_worked^j_i \times weeks^j_{i,t},$$

where $weekly\_hours\_worked^j_i$ is individual i's weekly average of hours worked and $weeks^j_{i,t}$ is the number of weeks he worked for job j in year t. Both of them are available in the NLSY79.

I then aggregate jobs according to whether they are attached to self- or to paid-employment. I calculate total hours worked for m-mode employment ($m \in \{self, paid\}$) in year t,

[80] In 1994, the occupation, industry and class of worker information for 353 CPS employers were not collected. This error would be innocuous for my study because these CPS employers were either less than 9 weeks in duration since the last interview, or were employers for whom the respondent worked less than 10 hours per week. For more information on this editing error, see http://www.nlsinfo.org/nlsy79/nlsy79_errata.php3.

[81] Note that week-by-week information on hours worked and hourly rate of pay is collected for almost all jobs appearing in the data. So, if we do not care about the class of worker, we can well grasp total hours worked and wage earnings in any week.

[82] In the 1988 survey round, the NLSY79 started asking hours worked at home separately for each job. By hours worked, I mean the sum of hours worked at workplace home and those at home.

[83] "Weekly Labor Force Status" information is available (since January 1, 1978) on whether a respondent was (a) working, (b) associated with an employer, (c) unemployed, (d) out of the labor force, (e) not working, or (f) in active military duty.

[84] Remember each calender year covers up to 5 jobs and we have 20 calender years; the first one or two digits correspond to survey years and the last digit to the job number.

$total\_hours\_worked^{l}_{i,t}$, by

$$total\_hours\_worked^{m}_{i,t} = \sum_{j \in m} total\_hours\_worked^{j}_{i,t}.$$

Remember that I assume that the individual in the model chooses descretized hours worked. Specifically, I employ the following descretization that allows natural interpretation: in year t, individual i

$$\begin{cases} \text{did } \textit{not} \text{ work as a self-employer if } 0 \leq total\_hours\_worked^{self}_{i,t} < 700 \ (= 20 \text{ hours} \times 35 \text{ weeks}), \\ \textit{worked} \text{ as a self-employer if } total\_hours\_worked^{self}_{i,t} \geq 700. \end{cases}$$

and he

$$\begin{cases} \text{did } \textit{not} \text{ work as a wage earner if } 0 \leq total\_hours\_worked^{paid}_{i,t} < 700, \\ \text{worked as a } \textit{part-time} \text{ wage earner if } 700 \leq total\_hours\_worked^{paid}_{i,t} < 1400 \\ \qquad (= 40 \text{ hours} \times 35 \text{ weeks}), \text{ and} \\ \text{worked as a } \textit{full-time} \text{ wage earner if } total\_hours\_worked^{self}_{i,t} \geq 1400. \end{cases}$$

I do not consider the possibility that an individual decides on how many hours he works, and assume that if he works in self-employment or in full-time paid-employment, his hours worked is 2000, and if he works as a part-time wage worker they are 1000.[85]

The reason why I do not distinguish between full-time and part-time self-employment is that the number of individuals who choose part-time self-employment is very small for each age that is covered in the data. I say that he was *non-employed* in year t if he did work in both modes of employment. Note that as Table 4 in the main text shows, "dual-employment" (worked as a self-employer and as a wage earner in the same year) is observed with small fractions. One reason why one is self-employed and is a wage worker in the same year would be that he works for an employer during the day and runs his own business in the evenings. Another possible reason is that he worked as a wage worker early in the year and worked as self-employer late in the year.

B.4.3 Net Worth, $a_{i,t}$

Collecting information on assets began in survey year 1985,[86] with exceptions of survey years 1991 and 2002. Assets are measured at interview dates. To calculate financial net worth, I follow Keane and Wolpin (2001), Imai and Keane (2004) and many others who use asset information in the NLSY79: I first add up the following variables to construct total positive assets:[87],[88]

(1) "Market value of residential property the respondent or his spouse (R/S) owns"
(2) "Total market value of vehicles including automobiles R/S owns"
(3) "Total amount of money assets like savings accounts of R/S"
(4) "Total market value of all other assets each worth more than $500" and
(5) "Total market value of farm/business/other property the R/S owns".

[85] Under this categoralization, the mean hours worked for self-employment, for full-time paid-employment, and for part-time paid-employment over the ages covered in the data (20-39) are, 2056.2, 2315.5, and 1061.4, respectively. The hours worked for and for full-time paid-employment increase moderately over age, and the ones for part-time paid-employment are stable. This assumption thus seems innocuous.

[86] Remember that this implies that the earliest age at which I have information on assets is essentially 20.

[87] For Item (3), the total market value of stocks/bonds/mutual funds became distinguishable in 1988, and the total amount of money holdings like IRA/Keogh, 401k/403b and CDs became distinguishable in 1994.

[88] If the respondent does not report at least one of the items, I set the assets variable to "missing." I do the same to the debts items.

Then, to construct total debts, I add up the following items:

$$\begin{cases} \text{(1) "Amount of mortgages \& back taxes R/S owes on residential property"} \\ \text{(2) "Amount of other debts R/S owes on residential property"} \\ \text{(3) "Total amount of money R/S owes on vehicles including automobiles"} \\ \text{(4) "Total amount of other debts over \$500 R/S owes" and} \\ \text{(5) "Total amount of debts on farm/business/other property R/S owes".} \end{cases}$$

I subtract the total debts from the total assets and call it *net worth.* I exclude top and bottom 1% of financial net worth (greater than $653,755.7 and less than -72,600, respectively). The numbers of excluded observations are 181 and 180, respectively.

B.4.4 Income in Self-Employment and Wage in Paid-Employment, $(y^s_{i,t}, w_{i,t})$

Difficulties in measuring and interpreting income from self-employment are well known. If an individual i works for self-employment ($l^s_{i,t} > 0$) with a positive amount of business capital ($k_{i,t} > 0$), then his income both from his entrepreneurial production function should be a combination of income from labor and from capital. The issue is whether or not the self-reported income from self-employment includes the returns to business capital, $k_{t,t}$. In the following, I explain the problem and how I mitigate it.

First, there are two sources of information on income in the NSLY79:

(1) Information on "wage/salary" is obtained from the event history (in the Employer Supplement Section) on reported jobs. For each reported job, the respondent is asked wage and the time unit of the wage.

(2) In addition, the NLSY79 has global questions on the amounts of various types of "annual income" in the previous year. These are summarized in the Income Section. In particular, the Income Section asks separately about "wage/salary income" and "business or farm income (after expense)."

At first, it would seem that information source (2) works better than source (1) because the distinction between "wage/salary income" and "business or farm" is explicit in (2) while it is obscure in (1). So, suppose that I use information source (2). It is unclear, however, what corresponds to $y^s_{i,t}$. It seems safe to assume neither "wage/salary income" nor "business or farm" contains the depreciated capital, $(1-\delta)k_t$. The reason is shown in Table B-3 for my final person-year observations: "(Business income)/k_t" does not seem constant over changes in percentiles.

Some respondents are still likely to mix the returns to labor and the returns to capital, even though the Income Section asks about both income sources separately. As Fairlie (2005, pp.43-44) points out, and as is verified with my final sample, about half of the self-employed with positive earnings report wage/salary income, but do not report business income. Fairlie (2005) ascribes this problem to the ordering of questions. In the NLSY79, respondents are asked, (1) "How much money did you get from the military?"; (2) "Excluding military pay, how much money did you get from wages, salary, commissions, or tips?"; and (3) "Excluding anything you already mentioned, did you receive any business income?" Some of the self-employed thus may have reported their income in the second question and did not correct their mistake.[89]

[89] Another issue is on the accuracy or the reliability of the question. The exact sentence of the question is: "How much did you receive *after expences* from your farm or business in the past calender year?" One odd thing is that we have no observations with negative business income.

To overcome this issue, I decided to use *the sum of "salary/wage income" and "business income" in the Income Section as income from self-employment,* $y^s_{i,t}$. I trim outliers of the income observations to remove their effects on the results. Note here that I do not drop entire persons with outliers from the sample, but in estimation I treat outliers as missing values. Specifically, if the sum of wage/salary and business incomes from the Income Section exceeds \$1,000,000, I treat *both* wage/salary and business incomes as missing. The number of such observations is 16.

For wage from paid-employment, $w_{i,t}$, I use information source (1).

B.4.5 Education ($educ_i$)

Each respondent's highest grade completed as of May 1 of each year is also available.[90] I keep an individual's year of education constant through his decision periods.[91] After imputation, I collapse "Highest Grade Completed" into:

$$\begin{cases} \text{High-school Dropout } (HD)\text{: education } < 12 \\ \text{High-school Graduate } (HG)\text{: education } = 12 \\ \text{Some College } (SC)\text{: } 13 \leq \text{ education } \leq 15 \\ \text{College Graduate } (CG)\text{: education } \geq 16. \end{cases}$$

In the actual implementation, I consider two levels of schooling: schooling H (HD or HG) and schooling C (SC or CG). I define the education dummy by

$$educ_i = \begin{cases} 0 & \text{if } i \text{ is a high-school dropout or graduate} \\ 1 & \text{otherwise.} \end{cases}$$

Appendix C Details on the Construction of the Log Likelihood

C.1 Classification Error for Hours Worked, E^s and E^w (2 Parameters)

The classification error for self-employment is characterized by parameter E^s in the following way:

$$\Pr((l^s_{i,t})^{obs} = 1 | \widetilde{l^s}^{sim}_{i,type,t} = 1) = E^s + (1 + E^s)\widehat{\Pr}((l^s_{i,t})^{obs} = 1)$$
$$\Pr((l^s_{i,t})^{obs} = 1 | \widetilde{l^s}^{sim}_{i,type,t} \neq 1) = (1 - E^s)\widehat{\Pr}((l^s_{i,t})^{obs} = 1)$$

where

$$E^s = \frac{\exp(E^s_0)}{1 + \exp(E^s_0)}$$

[90] I do not use AFQT in this study because among the 1916 individuals in the Restriction CS-4, scores of 154 individuals are missing.

[91] It is known that there are issues of inconsistencies on information on the highest grade completed in the NLSY79. For example, we sometimes observe an individual's "Highest Grade Completed" suddenly jumps even if his "School Enrollment Status"s are zero around that year. See the NLSY79 User's Guide (p.143) for details. I used my own judgment to determine one's highest grade completed when I saw inconsistensies.

and

$$\widehat{\Pr}((l_{i,t}^s)^{obs} = 1) = \frac{1}{N}\sum_{i=1}^{N} I((l_{i,t}^s)^{obs} = 1).$$

Note here that

$$\begin{aligned}
&\Pr((l_{i,t}^s)^{obs} = 1) \\
&= \Pr((l_{i,t}^s)^{obs} = 1 | \widetilde{l^s}_{i,type,t}^{sim} = 1)\widehat{\Pr}((l_{i,t}^s)^{obs} = 1) + \Pr((l_{i,t}^s)^{obs} = 1 | \widetilde{l^s}_{i,type,t}^{sim} \neq 1)[1 - \widehat{\Pr}((l_{i,t}^s)^{obs} = 1)],
\end{aligned}$$

which is equal to $\widehat{\Pr}((l_{i,t}^s)^{obs} = 1)$. The classification error for full-, part- and zero-time paid employment, E^w, is constructed similarly. That is,

$$E^w = \frac{\exp(E_0^w)}{1 + \exp(E_0^w)}.$$

C.2 Measurement Error for the Continuous Variables, $\sigma_{\xi,\cdot}^2$ (4 Parameters)

First, the measurement error in *financial net worth* is modeled as

$$(a_{i,t})^{obs} = \widetilde{a}_{i,type,t}^{sim} + \xi_t^a$$

where $\xi_t^a \sim N(0, \sigma_{\xi,a}^2)$ and $\sigma_{\xi,a} = \sigma_{\xi,a,0} + \sigma_{\xi,a,1}|(a_{i,t})^{obs}|$. Similarly, the measurement error in *income* from self-employment is modeled in

$$\exp(\xi_t^{y^s}) = |(y_{i,t}^s)^{obs} - \widetilde{y^s}_{i,type,t}^{sim}|$$

where $\xi_t^{y^s} \sim N(0, \sigma_{\xi,y^s}^2)$, and the the one from j-time paid-employment is modeled in

$$\exp(\xi_t^{y^w}) = |(y_{i,t}^w)^{obs} - \widetilde{y^w}_{i,type,t}^{sim}|$$

where $\xi_t^{y^w} \sim N(0, \sigma_{\xi,y^w}^2)$.

C.3 Parametric Form of the Likelihood Contribution

With the given specification of classification/measurement errors, the actual expression for the likelihood contribution for individual i in mth simulation is given by

$$
\begin{aligned}
&\Pr(X_i|\widetilde{X}^{sim}_{i,type},\theta) \\
&= \left[\frac{1}{\sqrt{2\pi\sigma^2_{\xi,a}}}\exp\left[-\frac{[(a_{i,t})^{obs}-\widetilde{a}^{sim}_{i,type,1}]^2}{2\sigma^2_{\xi,a}}\right]\right] I(a_{i,1} \textit{ is observed}) \\
&\times \prod_{t|l^s_{i,t}=1 \text{ is observed}} \Pr((l^s_t)^{obs} \textit{ is self-employment}) \\
&\times \prod_{t|l^s_{i,t}=0 \text{ is observed}} \Pr((l^s_t)^{obs} \textit{ is zero self-employment}) \\
&\times \prod_{t|\text{``}l^s_{i,t}=\text{full-time'' is observed}} \Pr((l^s_t)^{obs} \textit{ is full-time paid-employment}) \\
&\times \prod_{t|\text{``}l^s_{i,t}=\text{ part-time'' is observed}} \Pr((l^s_t)^{obs} \textit{ is part-time paid-employment}) \\
&\times \prod_{t|\text{``}l^s_{i,t}=0\text{'' is observed}} \Pr((l^s_t)^{obs} \textit{ is zero paid-employment}) \\
&\times \prod_{t|y^s_{i,t} \text{ is observed}} \left[\frac{1}{|(y^s_{i,t})^{obs}-\widetilde{y^s}^{sim}_{i,type,t}|\sqrt{2\pi\sigma^2_{\xi,y^s}}}\exp\left[-\frac{[\log((y^s_{i,t})^{obs})-\log(\widetilde{y^s}^{sim}_{i,type,t})]^2}{2\sigma^2_{\xi,y^s}}\right]\right] \\
&\times \prod_{t|y^w_{i,t} \text{ is observed}} \left[\frac{1}{|(y^w_{i,t})^{obs}-\widetilde{y^w}^{sim}_{i,type,t}|\sqrt{2\pi\sigma^2_{\xi,y^w}}}\exp\left[-\frac{[\log((y^w_{i,t})^{obs})-\log(\widetilde{y^w}^{sim}_{i,type,t})]^2}{2\sigma^2_{\xi,y^w}}\right]\right] \\
&\times \prod_{t|a_{i,t+1} \text{ is observed}} \left[\frac{1}{\sqrt{2\pi\sigma^2_{\xi,a}}}\exp\left[-\frac{[(a_{i,t+1})^{obs}-\widetilde{a}^{sim}_{i,type,t+1}]^2}{2\sigma^2_{\xi,a}}\right]\right].
\end{aligned}
$$

Appendix D Parameter Estimates

All the parameter estimates are presented below. The number of estimated parameters is 64. Numerical values in parentheses are standard errors.[92] The maximized value for the log likelihood is −4886.575.

D.1 Preference: Time Discount Factor, β, and the Utility Function, $u(\cdot;\mu)$ (16 Parameters)

D.1.1 Time Discount Factor (β)

- (Parameter #1) $\beta = \underset{(0.0061353226)}{0.9755769}$

[92] Standard errors of the parameters that are transformed from the estimated parameters are calculated by the delta method.

D.1.2 CRRA Constant (μ_0)

- (#2) $\mu_{00} = \underset{(0.0002139242)}{0.4826716}$
- (#3) $\mu_{01} = \underset{(0.0038772353)}{-0.0125118}$ (dummy for Type 2)

$$\rightarrow \text{(CRRA constant)} \begin{cases} \mu_0(type = 1) = \mu_{00} = 0.4826716 \\ \mu_0(type = 2) = \mu_{00} + \mu_{01} = 0.4701598 \end{cases}$$

D.1.3 Labor Disutility (μ_1 and μ_2)

- (#4) $\mu_{10,s} = \underset{(0.0000680669)}{317.2780}$
- (#5) $\mu_{11,s} = \underset{(0.0002151270)}{17.59601}$
- (#6) $\mu_{12,s} = \underset{(0.8354703000)}{-3.305609}$

$$\rightarrow \begin{cases} \mu_{1,s}(type = 1, \tau_t^s) = \mu_{10,s} + \mu_{12,s} \cdot \tau_t^s = 317.2780 - 3.305609 \cdot \tau_t^s \\ \mu_{1,s}(type = 2, \tau_t^s) = \mu_{10,s} + \mu_{11,s} + \mu_{12,s} \cdot \tau_t^s = 334.87401 - 3.305609 \cdot \tau_t^s \end{cases}$$

- (#7) $\mu_{10,w} = \underset{(0.0024144244)}{164.8727}$
- (#8) $\mu_{11,w} = \underset{(0.0003711260)}{14.99203}$

$$\rightarrow \begin{cases} \mu_{1,w}(type = 1) = \mu_{10,w} = 164.8727 \\ \mu_{1,w}(type = 2) = \mu_{10,w} + \mu_{11,w} = 179.86473 \end{cases}$$

- (#9) $\mu_{10,w,part} = \underset{(0.0000569326)}{0.5377413}$

$$\rightarrow \begin{cases} [\mu_{1,w}(type) + \epsilon_t^{lw}] \cdot [I(l_t^w \text{ is } \textit{full-time}) + \mu_{1,w,part} \cdot I(l_t^w \text{ is } \textit{part-time})] \\ = 0.5377413 \cdot [\mu_{1,w}(type) + \epsilon_t^{lw}] \end{cases}$$

- (#10) $\mu_{20,full} = \underset{(0.0001590083)}{1822.401}$
- (#11) $\mu_{21,full} = \underset{(0.0018489889)}{220.5993}$

$$\rightarrow \begin{cases} \mu_{2,full}(type = 1) = \mu_{20,full} = 1822.401 \\ \mu_{2,full}(type = 2) = \mu_{20,full} + \mu_{21,full} = 2043.0003 \end{cases}$$

- (#12) $\mu_{20,part} = \underset{(0.0494701270)}{1424.098}$
- (#13) $\mu_{21,part} = \underset{(0.0009061550)}{197.5852}$

$$\rightarrow \begin{cases} \mu_{2,part}(type = 1) = \mu_{20,part} = 1424.098 \\ \mu_{2,part}(type = 2) = \mu_{20,part} + \mu_{21,part} = 1621.6832 \end{cases}$$

D.1.4 Benefits from Staying in the Same Mode of Employment (μ_3)

- (#14) $\mu_{40,s\to s} = \underset{(0.0003087667)}{159.9276}$
- (#15) $\mu_{41,s\to s} = \underset{(0.0025971585)}{23.56863}$
- (#16) $\mu_{42,s\to s} = \underset{(0.0098452289)}{9.834752}$

$$\rightarrow \begin{cases} \mu_{4,s\to s}(type = 1, \tau_t^s) = \mu_{40,s\to s} + \mu_{42,s\to s} \cdot \tau_t^s = 159.9276 - 9.834752 \cdot \tau_t^s \\ \mu_{4,s\to s}(type = 2, \tau_t^s) = \mu_{40,s\to s} + \mu_{41,s\to s} + \mu_{42,s\to s} \cdot \tau_t^s = 183.49623 - 9.834752 \cdot \tau_t^s \end{cases}$$

D.2 Lower Bound for Net Worth, $\underline{a}(\cdot;\zeta)$, and the Consumption Floor, $c_{\min}$ (8 Parameters)

D.2.1 Lower Bound for Net Worth ($\underline{a}(\cdot;\zeta)$)

- (#17) $\zeta_0 = \underset{(0.0008765895)}{9.256721}$ (constant term)
- (#18) $\zeta_1 = \underset{(0.0002339659)}{-0.001713}$ (dummy for the college-educated)
- (#19) $\zeta_2 = \underset{(0.0002433008)}{0.353281}$ (dummy for experience of self-employment)
- (#20) $\varsigma_3 = \underset{(0.0006186087)}{0.060926}$ (accumulated years of paid-employment)
- (#21) $\zeta_4 = \underset{(0.0000981532)}{-0.358549}$ (accumulated years of paid-employment squared, divided by 100)
- (#22) $\zeta_5 = \underset{(0.0009014859)}{-0.029473}$ (age)
- (#23) $\zeta_6 = \underset{(0.0003437550)}{0.205846}$ (age squared, divided by 100)

D.2.2 Consumption Floor ($c_{\min}$)

- (#24) $c_{\min} = \underset{(0.0003918820)}{129.3269}$

D.3 Human Capital, $\overline{\Psi}^m(\cdot;\gamma^m)$, $m = w, s$, and the Rental Price for Part-time Paid-Employment, R^p (17 Parameters)

D.3.1 Paid-Employment ($\overline{\Psi}^w(\cdot;\gamma^w)$)

- (#25) $\gamma_0^w = \underset{(0.0000893260)}{2.311925}$ (constant term)
- (#26) $\gamma_1^w = \underset{(0.0004235156)}{0.240281}$ (dummy for the college-educated)
- (#27) $\gamma_2^w = \underset{(0.0001987118)}{0.006273}$ (dummy for Type 2)

- (#28) $\gamma_3^w = \underset{(0.0005028620)}{0.086725}$ (accumulated years of paid-employment)
- (#29) $\gamma_4^w = \underset{(0.0010253931)}{-0.272293}$ (accumulated years of paid-employment squared, divided by 100)
- (#30) $\gamma_5^w = \underset{(0.0000324085)}{-0.003291}$ (dummy for experience of self-employment))
- (#31) $\gamma_6^w = \underset{(0.0013710919)}{0.007934}$ (age)

D.3.2 Rental Price for Part-time Paid-Employment (R^p)

- (#32) $R^p = \underset{(0.0002607080)}{1.1647760}$

D.3.3 Self-Employment ($\overline{\Psi}^s(\cdot;\gamma^s)$)

- (#33) $\gamma_0^s = \underset{(0.0021833163)}{2.444152}$ (constant term)
- (#34) $\gamma_1^s = \underset{(0.0004054129)}{0.280044}$ (dummy for the college-educated)
- (#35) $\gamma_2^s = \underset{(0.0000675430)}{0.008961}$ (dummy for Type 2)
- (#36) $\gamma_3^s = \underset{(0.0001483043)}{0.008406}$ (dummy for experience of self-employment)
- (#37) $\gamma_4^s = \underset{(0.0017562581)}{0.096725}$ (accumulated years of self-employment in a row)
- (#38) $\gamma_5^s = \underset{(0.0012691955)}{-0.170103}$ (accumulated years of self-employment in a row squared, divided by 100)
- (#39) $\gamma_6^s = \underset{(0.0291003160)}{0.028571}$ (accumulated years of paid-employment)
- (#40) $\gamma_7^s = \underset{(0.0040131691)}{-0.110880}$ (accumulated years of paid-employment squared, divided by 100)
- (#41) $\gamma_8^s = \underset{(0.0000230824)}{0.0655306}$ (age)

D.4 Entrepreneurial Production Function, $f(\cdot;\alpha)$ (2 Parameters)

- (#42) $\alpha_0 = \underset{(0.0007083222)}{0.1744350}$ (capital returns)
- (#43) $\alpha_1 = \underset{(0.0000490642)}{-0.0123996}$ (dummy for the college-educated)

$$\rightarrow \text{(capital returns)} \begin{cases} \alpha(educ = non\text{-}college) = \widehat{\alpha_0} = 0.1744350 \\ \alpha(educ = college) = \widehat{\alpha_0} + \widehat{\alpha_1} = 0.1620354 \end{cases}$$

D.5 Type Proportions, $\Pr(\cdot;\eta)$ (4 Parameters)

- (#44) $\eta_{0,2} = \underset{(0.0022314987)}{-0.8543712}$ (constant term)
- (#45) $\eta_{1,2} = \underset{(0.0000527258)}{0.4519807}$ (dummy for the college-educated)
- (#46) $\eta_{2,2} = \underset{(0.0443405550)}{0.0000025}$ (net worth)
- (#47) $\eta_{3,2} = \underset{(0.0000398636)}{0.6448548}$ (dummy for age when started working being greater than or equal to 23)

$$\rightarrow \begin{cases} \Pr(type = 1) = 0.3658664 \\ \Pr(type = 2) = 0.6341336 \end{cases}$$

D.6 Variances and the Covariances of the Period-by-Period Disturbance, $\sigma^2_{\epsilon,\cdot}$ (6 Parameters)

- (#48) $\sigma_{\epsilon,ls} = \underset{(0.0002412930)}{136.69850}$ (disutility from self-employed work)
- (#49) $\sigma_{\epsilon,lw} = \underset{(0.0128387660)}{47.039350}$ (disutility from paid-employed work)
- (#50) $\sigma_{\epsilon,(ls,lw)} = \underset{(0.3296192000)}{2.6065150}$ (disutility correlation between self- and paid-employed)
- (#51) $\sigma_{\epsilon,ys} = \underset{(0.0000738572)}{0.6260160}$ (income from self-employed work)
- (#52) $\sigma_{\epsilon,yw} = \underset{(0.0001690397)}{0.2127060}$ (income from paid-employed work)
- (#53) $\sigma_{\epsilon,(ys,yw)} = \underset{(0.0013701618)}{0.0823533}$ (income correlation between self- and paid-employed)

D.7 Quasi-Terminal *Emax* Function, $Emax_{T^*}(\cdot;\kappa_{T^*})$ (5 Parameters)

- (#54) $\kappa_{T^*,1} = \underset{(0.0920327680)}{0.0218159}$ (net worth)
- (#55) $\kappa_{T^*,2} = \underset{(0.0000859060)}{-0.0004184}$ (net worth squared, divided by 10000)
- (#56) $\kappa_{T^*,3} = \underset{(0.0001891246)}{13662.890}$ (dummy for college-educated)
- (#57) $\kappa_{T^*,4} = \underset{(0.0021382151)}{4946.5890}$ (dummy for experience of self-employment)
- (#58) $\kappa_{T^*,5} = \underset{(0.0000701953)}{306.77500}$ (accumulated years of paid-employment)

D.8 Measurement Error (6 Parameters)

- (#59) $E_0^s = \underset{(0.0003832295)}{2.0010930}$ (whether self-employed or not)
- (#60) $E_0^w = \underset{(0.0003898737)}{2.8493010}$ (whether paid-employed or not)
- (#61) $\sigma_{\xi,a,0} = \underset{(0.0015494599)}{0.9165500}$ (net worth)
- (#62) $\sigma_{\xi,a,1} = \underset{(0.0011238761)}{0.8819036}$ (coefficient for the absolute value of net worth)
- (#63) $\sigma_{\xi,y^s} = \underset{(0.0063716951)}{28.736100}$ (income from self-employment)
- (#64) $\sigma_{\xi,y^w} = \underset{(0.0077598407)}{26.189700}$ (income from paid-employment)

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なぜ年齢別所得格差の拡大は観察されないのか？*

四方理人
慶應義塾大学先導研究センター

駒村康平
慶應義塾大学経済学部

* 本研究は、厚生労働科学研究費『格差と社会保障のあり方に関する研究』（主任研究者：駒村康平、平成 20～21 年度）の研究成果の一部です。また、本研究の使用データは、一橋大学経済研究所附属社会科学統計情報研究センターで提供している全国消費実態調査（2004 年）の秘匿処理済ミクロデータを用いて行いました。関係者各位に厚く御礼申し上げます。なお、本稿は未定稿となっておりますので、引用はお控えください。