Human Capital and Nonseparable Preferences

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Nonseparabilities over time

Competitive equilibrium

- Panel data reject the joint null hypothesis that:
  1. consumer workers maximize expected utility.
  2. they have rational expectations.
  3. the disturbance structure is *iid.*
  4. current utility is CRRA.
  5. current utility is additively separable within and between periods.
  6. goods and labor productivity are additively separable over time.
  7. there are complete markets.
- There is less consensus on which of these factors is instrumental:
  - Some economists believe 7 fails.
  - Others believe 3 through 7 cause the rejections.
  - There are those who believe consumers violate 1 and/or 2.
- The remainder of the course focuses on the failure of complete markets and the incorporation of nonseparable preferences.
- In both cases we justify the extensions with evidence from the data.

Female Wages

Value of marginal product of labor

- Female labor supply receives much more attention than male labor supply from labor economists.
- There are two main reasons. Female labor supply:
  1. exhibits much more variation than male labor supply.
  2. is significantly correlated with variables observed typically observed in panel data (such as household composition and education).
- One noticeable feature of female wage data is that past labor supply decisions significantly and quantitatively affect their current wages.
- This form of human capital accumulation induces nonseparabilities over time within the production function.

- Suppose:

$$\widetilde{w}_{nt} \equiv w_{nt} \exp\left(\varepsilon_{3nt}\right)$$

and:

$$w_{nt} \equiv w_t \upsilon_n \exp\left[x_{nt}B_3 + \sum_{s=1}^{\rho}\left(\gamma_{1s} l_{n,t-s} + \gamma_{2s} d_{n,t-s}\right)\right]$$

where:

- $\widetilde{w}_{nt}$ measured wage rate of n at t
- w_{nt} wage rate of n at t
- ε_{3nt} *iid* measurement error
- w_t wage rate for standardized unit of labor
- v_n household specific fixed effect
- x_{nt} time varying socioeconomic factors
- $l_{nt} \in [0, 1]$ normalized labor time
- $d_{nt} = \begin{cases} 0 \text{ if } l_{nt} = 0 \\ 1 \text{ if } l_{nt} > 0 \end{cases}$

Female Wages

Estimates from the PSID (Table III, Altug and Miller, 1998)

The wage equation†

$$\ln(w_{nt}) = \ln(\omega_t) + \ln(v_n) + \sum_{s=1}^{\rho} (\gamma_{1s} l_{n,t-s} + \gamma_{2s} d_{n,t-s}) + x'_{nt} B_3$$

Variable	Parameter	(i) Estimate	(ii) Estimate	Variable	(i) Estimate	(ii) Estimate
Lags of hours worked				Aggregate wages		
$\Delta l_{n,t-1}$	γ_{11}	0·0002 (0·00001)	0·0002 (0·5E−5)	$\Delta \ln(\omega_7)$	—	0·045 (0·016)
$\Delta l_{n,t-2}$	γ_{12}	0·0001 (0·00001)	0·0001 (0·000006)	$\Delta \ln(\omega_8)$	—	−0·003 (0·021)
$\Delta l_{n,t-3}$	γ_{13}	0·00008 (0·00001)	0·00006 (0·000006)	$\Delta \ln(\omega_9)$	−0·013 (0·022)	−0·038 (0·011)
$\Delta l_{n,t-4}$	γ_{14}	0·00006 (0·00001)	0·00005 (0·000005)	$\Delta \ln(\omega_{10})$	−0·04 (0·02)	0·02 (0·01)
$\Delta l_{n,t-5}$	γ_{15}	0·00002 (0·00001)	—	$\Delta \ln(\omega_{11})$	0·11 (0·02)	0·074 (0·01)
$\Delta l_{n,t-6}$	γ_{16}	0·00002 (0·00001)	—	$\Delta \ln(\omega_{12})$	0·05 (0·02)	0·03 (0·02)
Lags of participation				$\Delta \ln(\omega_{13})$	0·05 (0·02)	0·02 (0·01)
$\Delta d_{n,t-1}$	γ_{21}	−0·11 (0·021)	−0·09 (0·01)	$\Delta \ln(\omega_{14})$	−0·01 (0·02)	−0·03 (0·01)
$\Delta d_{n,t-2}$	γ_{22}	−0·10 (0·021)	−0·07 (0·01)	$\Delta \ln(\omega_{15})$	0·05 (0·02)	0·02 (0·01)
$\Delta d_{n,t-3}$	γ_{23}	−0·10 (0·02)	−0·09 (0·01)	$\Delta \ln(\omega_{16})$	−0·02 (0·02)	−0·01 (0·01)
$\Delta l_{n,t-4}$	γ_{24}	−0·10 (0·02)	−0·07 (0·01)	$\Delta \ln(\omega_{17})$	0·07 (0·02)	0·04 (0·01)
$\Delta d_{n,t-5}$	γ_{25}	−0·05 (0·02)	—	$\Delta \ln(\omega_{18})$	−0·01 (0·02)	−0·02 (0·01)
$\Delta d_{n,t-6}$	γ_{26}	−0·03 (0·02)	—	$\Delta \ln(\omega_{19})$	0·082 (0·02)	0·05 (0·02)
Socioeconomic variables						
ΔAGE_{nt}^2	B_{31}	−0·0005 (0·0001)	−0·0002 (0·00005)			
$\Delta(\text{AGE}_{nt} \times \text{EDU}_{nt})$	B_{32}	0·0001 (0·0004)	0·0002 (0·0001)			

† Standard errors in parentheses.

A Social Planner's Problem

Preferences and resource constraint

- Suppose individual n is uniformly distributed on $[0,1]$ with current consumption c_{nt} and current utility:

$$\begin{aligned} U_{nt} &= (1-d_{nt})\left(x_{nt}B_0+\varepsilon_{0nt}\right)+d_{nt}\varepsilon_{1nt} \\ &\quad +\alpha^{-1}c_{nt}^{\alpha}\exp\left[x_{nt}B_2+\varepsilon_{2nt}\right]+\left[x_{nt}B_1+\textstyle\sum_{s=0}^{\rho}\delta_s l_{n,t-s}\right]l_{nt} \end{aligned}$$

- Aggregate consumption cannot exceed aggregate income, comprising aggregate wages and aggregate nonlabor income, e_t:

$$\int_0^1 c_{nt}dn \leq e_t + \int_0^1 w_{nt}l_{nt}dn$$

- The planner's preferences are given by:

$$E_0\left\{\sum_{t=0}^{\infty}\beta^t\left[\int_0^1 \eta_n^{-1}U_{nt}dn\right]\right\}$$

where β is a subjective discount factor, and η_n is the marginal utility of wealth for n in the corresponding competitive equilibrium.

A Social Planner's Problem

First order conditions

- Let λ_t denote the Lagrange multiplier associated with the aggregate resource constraint.
- The log of the FOC for consumption is then:

$$(\alpha - 1) \ln c_{nt} + (x_{nt} B_2 + \varepsilon_{2nt}) = \ln \eta_n + \ln \lambda_t$$

- Similarly the interior FOC for leisure can be expressed as:

$$\begin{aligned} 0 \quad = \quad & x_{nt} B_1 + 2\delta_0 l_{nt}^o + \sum_{s=1}^{\rho} \delta_s l_{n,t-s} + \eta_n \lambda_t w_{nt} \\ & + \sum_{s=1}^{\rho} E_t \left[(\delta_s + \gamma_{1s} \eta_n \lambda_{t+s} w_{n,t+s}) \, l_{n,t+s}^o \,\middle|\, l_{nt}^o \right] \end{aligned}$$

where we draw on the parameterization of utility and productivity, which imply:

$$\frac{\partial}{\partial l_{nt}} U_{n,t+s} = \delta_s l_{n,t+s}$$

$$\frac{\partial}{\partial l_{nt}} \eta_n \lambda_{t+s} w_{n,t+s} l_{n,t+s} = \gamma_{1s} \eta_n \lambda_{t+s} w_{n,t+s} l_{n,t+s}$$

- Noting the preferences for consumption and leisure are additively separable, the planner:
  1. chooses c_{nt} for all (n, t) to maximize:

$$E_0 \left\{ \alpha^{-1} \sum_{t=0}^{\infty} \beta^t \left[\int_0^1 \eta_n^{-1} c_{nt}^{\alpha} \exp\left[x_{nt} B_2 + \varepsilon_{2nt} \right] dn \right] \right\}$$

subject to the budget constraints for each t:

$$\int_0^1 c_{nt} dn \leq e_t' \equiv e_t + \int_0^1 w_{nt} l_{nt}^o dn$$

  2. chooses l_{nt} for all (n, t) to maximize:

$$E_0 \left\{ \sum_{t=0}^{\infty} \beta^t \left[\begin{array}{l} (1 - d_{nt}) (x_{nt} B_0 + \varepsilon_{0nt}) + d_{nt} \varepsilon_{1nt} \\ + x_{nt} B_1 l_{nt} + \sum_{s=0}^{\rho} \delta_s l_{n,t-s} l_{nt} + \eta_n \lambda_t w_{nt} l_{nt} \end{array} \right] \right\}$$

where λ_t is the Lagrange multiplier associated with the aggregate resource constraint for the consumption allocation problem.

A Social Planner's Problem

Optimal participation

- The exante value function for the labor supply problem of n at t is:

$$
\begin{aligned}
& V\left(l_{n,t-s},\ldots,l_{n,t-1},x_{nt},\lambda_t w_t,\eta_n\right) \\
= \quad & E_t\left\{\sum_{r=t}^{\infty}\beta^{r-t}\left[\begin{array}{c}\left(1-d_{nr}\right)\varepsilon_{0nr}+d_{nr}\left(x_{nr}B_0+\varepsilon_{1nr}\right) \\ +x_{nr}B_1 l_{nr}^o+\sum_{s=0}^{\rho}\delta_s l_{n,r-s}^o l_{nr}^o+\eta_n\lambda_t w_{nr} l_{nr}^o\end{array}\right]\right\}
\end{aligned}
$$

and denote the associated conditional value functions by:

$$
\begin{aligned}
v_{0nt} &= x_{nt}B_0+\int\left[\begin{array}{c}V\left(l_{n,t-s+1},\ldots,0,x_{n,t+1},\lambda_{t+1}w_{t+1},\eta_n\right) \\ \times dF\left(x_{n,t+1},\lambda_{t+1}w_{t+1}\left|x_{nt},\lambda_t w_t\right.\right)\end{array}\right] \\
v_{1nt} &= \left[x_{nt}B_1+\eta_n\lambda_t w_{nt}+\sum_{s=0}^{\rho}\delta_s l_{n,t-s}\right]l_{nt}^o \\
&\quad +\int\left[\begin{array}{c}V\left(l_{n,t-s+1},\ldots,l_{nt}^o,x_{n,t+1},\lambda_{t+1}w_{t+1},\eta_n\right) \\ \times dF\left(x_{n,t+1},\lambda_{t+1}\left|x_{nt},\lambda_t w_t\right.\right)\end{array}\right]
\end{aligned}
$$

- Then optimal participation is given by:

$$
d_{nt}=\begin{cases}0 \text{ if } v_{1nt}+\varepsilon_{1nt}\leq v_{0nt}+\varepsilon_{0nt} \\ 1 \text{ if } v_{1nt}+\varepsilon_{1nt}> v_{0nt}+\varepsilon_{0nt}\end{cases}
$$

A Representation of the Value Function

Telescoping forwards using the nonparticipation choice

- Denote the conditional choice probability of participation by:

$$p_{nt} = E_t \left[d_{nt} \left| l_{n,t-s}, \ldots, l_{n,t-1}, x_{nt}, \eta_n \lambda_t w_t \right. \right]$$

- Suppressing the arguments $\left(l_{n,t-s}, \ldots, l_{n,t-1}, x_{nt}, \eta_n \lambda_t w_t \right)$, previous lectures on discrete choice proved:

$$\begin{aligned} V_{nt} &= \psi_0 \left(p_{nt} \right) + v_{0nt} \\ &= \psi_0 \left(p_{nt} \right) + x_{nt} B_1 + E_t \left[V_{n,t+1} \left| d_{nt} = 0 \right. \right] \end{aligned}$$

- Telescoping forwards:

$$\begin{aligned} V_{nt} &= \psi_0 \left(p_{nt} \right) + x_{nt} B_1 + E_t \left[\psi_0 \left(p_{n,t+1} \right) + x_{n,t+1} B_1 \left| d_{nt} = 0 \right. \right] \\ &\quad + E_t \left[V_{n,t+2} \left| d_{nt} = 0, d_{n,t+1} = 0 \right. \right] \\ &= \sum_{s=0}^{\rho} E_t \left[\psi_0 \left(p_{n,t+s} \right) + x_{n,t+s} B_1 \left| d_{nt} = 0, \ldots, d_{n,t+s} = 0 \right. \right] \\ &\quad + E_t \left[V_{n,t+\rho+1} \left| d_{n,t+1} = 0, \ldots, d_{n,t+\rho} = 0 \right. \right] \end{aligned}$$

A Representation of the Value Function

Finite dependence

- Since:

$$\psi_0(p_{nt}) - \psi_1(p_{nt}) = v_{1nt} - v_{0nt}$$

it now follows that:

$$\begin{aligned}
& \psi_0(p_{nt}) - \psi_1(p_{nt}) \qquad (1) \\
= & \left[x_{nt}B_1 + \eta_n \lambda_t w_{nt} + \textstyle\sum_{s=0}^{\rho} \delta_s l_{n,t-s}\right] l_{nt}^o - x_{nt}B_0 \\
& + E_t\left[V_{n,t+1} \,|d_{nt} = 0\right] - E_t\left[V_{n,t+1} \,| l_{nt} = l_{nt}^o\right] \\
= & \left[x_{nt}B_1 + \eta_n \lambda_t w_{nt} + \textstyle\sum_{s=0}^{\rho} \delta_s l_{n,t-s}\right] l_{nt}^o - x_{nt}B_0 \\
& + \sum_{s=0}^{\rho} E_t\left[\psi_0(p_{n,t+s}) \,| l_{nt} = l_{nt}^o, d_{n,t+1} = 0, \ldots, d_{n,t+s} = 0\right] \\
& - \sum_{s=0}^{\rho} E_t\left[\psi_0(p_{n,t+s}) \,| d_{nt} = 0, \ldots, d_{n,t+s} = 0\right]
\end{aligned}$$

- The previous lecture shows how to estimate how to estimate preferences for consumption from the FOC.
- But how should we treat terms like $E_t\left[\lambda_{t+s} w_{n,t+s} l_{n,t+s} \left| I_{nt} \right.\right]$ and $E_t\left[l_{n,t+s} \left| I_{nt} \right.\right]$, which appear in the Euler equation determining labor supply for those who participate in the workforce?
- We cannot justify substituting:

$$l_{n,t+s} \text{ for } E_t\left[l_{n,t+s} \left| I_{nt} \right.\right]$$

and:

$$\lambda_{t+s} w_{n,t+s} l_{n,t+s} \text{ for } E_t\left[\lambda_{t+s} w_{n,t+s} l_{n,t+s} \left| I_{nt} \right.\right]$$

to equate to zero the sample moment:

$$\frac{1}{N}\sum_{n=1}^{N} z_{nt}\left[\begin{array}{l} x_{nt}B_1 + 2\delta_0 l^o_{nt} + \eta_n \lambda_t w_{nt} \\ +\sum_{s=1}^{\rho}\delta_s\left(l_{n,t-s} + l^o_{n,t+s}\right) + \gamma_{1s}\eta_n\lambda_{t+s}w_{n,t+s}l^o_{n,t+s}\end{array}\right]$$

because λ_{t+s} and w_{t+s} do not average out over the population.

Aggregate Shocks

Assumptions on the price process

- To estimate the model we place assumptions on the $\lambda_t w_t$ process.
- Since the $\lambda_t w_t$ process is endogenous, we must first establish these assumptions are compatible with the social planner's problem. (See Altug and Miller 1998, Appendix.)
- Assume $\lambda_{t+1} w_{t+1} = \Delta_t \lambda_t w_t$ where Δ_t:
  1. is an *iid* random variable with distribution function $F(\Delta, \sigma)$.
  2. has bounded positive support of length $\varsigma \equiv F(\overline{\Delta}, \sigma) - F(\underline{\Delta}, \sigma)$ where $F(\underline{\Delta}, \sigma) = 0$ and $F(\overline{\Delta}, \sigma) = 1$.
- The model has ρ period dependence; to verify this set $l_{n,t+s} = 0$ for all initial choices l_{nt} and note that the labor experience of the state variable is $(0, \ldots, 0)$ after ρ periods.
- We also assume $2\varsigma\rho < \overline{\eta} - \underline{\eta}$ for some $\underline{\eta}$ and $\overline{\eta}$ within the interior of the support of η.

Estimation

A nonparametric estimator of the CCPs

- Decompose any random variable y_n into its conditional expectation function on any x_n and a disturbance ε_n, such that:

$$\begin{aligned} y_n &= E\left[y_n \left| x_n\right.\right] + \varepsilon_n \\ &\equiv E\left[y_n \left| x_n\right.\right] + \varepsilon_n \text{ and hence } E\left[\varepsilon_n \left| x_n\right.\right] = 0 \end{aligned}$$

- Let $J(\cdot)$ denote a multivariate continuous probability density function satisfying $J(0) \neq 0$ and $J(\infty) = J(-\infty) = 0$.
- Suppose $f(x_n)$ is estimated with a weighted average of the other sample y values:

$$\widehat{f(x_n)} \equiv \left[\sum\nolimits_{m=1,m\neq n}^{N} J\left(\frac{x_m - x_n}{\delta_N}\right)\right]^{-1} \sum\nolimits_{m=1,m\neq n}^{N} y_m J\left(\frac{x_m - x_n}{\delta_N}\right)$$

- Then for all x one can show (see for example Prakasa Rao, 1983):

$$\text{If } \delta_N \rightarrow 0 \text{ and } \left(N\delta_N\right)^{-1} \rightarrow 0 \text{ then } \widehat{f(x)} \underset{p}{\rightarrow} f(x)$$

Estimation

Semiparametric behavioral responses (Table V, Altug and Miller, 1998)

Behavioural responses†

Variable	$\eta_n=\mu_\eta+\sigma_\eta;\ v_n=\mu_v$						$v_n=\mu_v+\sigma_v;\ \eta_n=\mu_\eta$					
	$z_1^{(1)}$	$z_1^{(2)}$	$z_1^{(3)}$	$z_0^{(1)}$	$z_0^{(2)}$	$z_0^{(3)}$	$z_1^{(1)}$	$z_1^{(2)}$	$z_1^{(3)}$	$z_0^{(1)}$	$z_0^{(2)}$	$z_0^{(3)}$
p	0·96	0·43	0·24	0·31	0·24	0·23	0·96	0·41	0·23	0·31	0·24	0·24
l	1513	1460	1394	1490	1394	1320	1504	1448	1382	1447	1382	1306
w	7·18	5·71	5·48	5·94	5·38	5·46·	8·80	7·00	6·72	7·28	6·60	6·70
λwl	10877	7803	6311	8666	7028	5950	13250	9493	7670	10543	8542	7224

Variable	$\eta_n=\mu_\eta+\sigma_\eta;\ v_n=\mu_v$						$v_n=\mu_v+\sigma_v;\ \eta_n=\mu_\eta$					
	$z_1^{(1)}$	$z_1^{(2)}$	$z_1^{(3)}$	$z_0^{(1)}$	$z_0^{(2)}$	$z_0^{(3)}$	$z_1^{(1)}$	$z_1^{(2)}$	$z_1^{(3)}$	$z_0^{(1)}$	$z_0^{(2)}$	$z_0^{(3)}$
p	0·96	0·39	0·22	0·29	0·23	0·23	0·96	0·39	0·23	0·30	0·23	0·23
l	1484	1425	1357	1425	1357	1282	1486	1427	1360	1427	1360	1285
w	7·18	5·71	5·48	5·94	5·38	5·46	5·56	4·42	4·24	4·60	4·17	4·23
λwl	10668	7622	6145	8465	6843	5782	8370	5910	4766	6564	5307	4484

† Nonparametrically estimated individual effects.

Corrected key to four panels

$$\begin{bmatrix} (\eta_n+\sigma_\eta, v_n+\sigma_v) & (\eta_n, v_n+\sigma_v) \\ (\eta_n+\sigma_\eta, v_n) & (\eta_n, v_n) \end{bmatrix}$$

- To compute the CCPs required to form an orthogonality condition, we simulate for each (n, t) a future path of aggregate shocks that are specific to the individual, denoted by:

$$\lambda_{t+s+1}^{(n,t)} w_{t+s+1}^{(n,t)} = \lambda_{t+s}^{(n,t)} w_{t+s}^{(n,t)} \exp(\sigma\pi)$$

where $\lambda_{t+s}^{(n,t)} w_{t+s}^{(n,t)}$ are estimates obtained from the consumption and wage equations, π is generated from a $\mathcal{N}(0, 1)$ and σ is a volatility parameter to be estimated within the orthogonality conditions.

- To account for the discreteness in participation, define:

$$p_{knt}^{(s)} = E_\tau \left[d_{ns} \middle| l_{n\tau} = kl_{nt}^{o}, l_{n,t+1} = 0 \ldots, l_{n,s-1} = 0, x_{nt}^{(s)}, \eta_n \lambda_t w_t \right]$$

- To estimate $p_{knt}^{(s)}$ define the indicator function and the weight for each $(m, r) \in N \times T$:

$$d_{mr}^{(s)} = \left[(1-k)(1-d_{m,r-s}) + kd_{m,r-s} \right] \prod\nolimits_{r=1}^{s-1} (1 - d_{n,t-r})$$

$$J_{knt}^{(s)}(m,r) \equiv J_x\left(\frac{x_{mr} - x_{nt}^{(s)}}{\delta_N}\right) J\left(\frac{\eta_m \lambda_r w_r - \eta_n \lambda_t^{(n,s)} w_t^{(n,s)}}{\delta_N}\right) \times d_{knt}^{(s)} J\left(\frac{l_{m,r-s} - l_{nt}}{\delta_N}\right)^k \prod\nolimits_{\tau=s+1}^{\rho} J\left(\frac{l_{m,r-\tau} - l_{n,t+s-\tau}}{\delta_N}\right)$$

- Then the estimated CCPs are:

$$\widehat{p_{knt}^{(s)}} \equiv \left[\sum\nolimits_{(m,r)}^{N \times T} J_{knt}^{(s)}(m,r) \right]^{-1} \sum\nolimits_{(m,r)}^{N \times T} d_{mr} J_{knt}^{(s)}(m,r)$$

- Recall the Type 1 Extreme value assumption implies:

$$\psi_j(p_{nt}) = -\ln p_{jnt} \equiv -\ln p_j(l_{n,t-s}, \ldots, l_{n,t-1}, x_{nt}, \eta_n \lambda_t w_t)$$

- Then from (1):

$$\begin{aligned} \ln p_{1nt} - \ln p_{0nt} &= \left(x_{nt} B_1 + \eta_n \lambda_t w_{nt} + \sum_{s=0}^{\rho} \delta_s l_{n,t-s} \right) l_{nt}^o - x_{nt} B_0 \\ &\quad + \sum_{s=1}^{\rho} E_t \left[\ln \left(p_{0nt}^{(s)} \right) - \ln \left(p_{1nt}^{(s)} \right) \right] \end{aligned}$$

- Given instruments z_{nt} we obtain a estimator from:

$$0 = \sum_{n=1}^{N} z_{nt} \left[y_{0nt} - \left(x_{nt} B_1 + \sum_{s=0}^{\rho} \delta_s l_{n,t-s} \right) l_{nt}^o - x_{nt} B_0 \right]$$

where:

$$y_{0nt} \equiv \sum_{s=0}^{\rho} \left[\ln \left(p_{0nt}^{(s)} \right) - \ln \left(p_{1nt}^{(s)} \right) \right] + \eta_n \lambda_t w_{nt} l_{nt}^o$$

- We could exploit the interior FOC for leisure directly in estimation by simulating future values of labor supply off the price shocks that we draw for each person.
- Alternatively the interior FOC for leisure can be expressed as:

$$\begin{aligned} & x_{nt} B_1 + 2\delta_0 l_{nt}^o + \textstyle\sum_{s=1}^{\rho} \delta_s l_{n,t-s} + \eta_n w_{nt} \\ = \; & \frac{-\partial}{\partial l_{nt}} E\left[V\left(l_{n,t-s+1}, \ldots, l_{nt}^o, x_{n,t+1}, \lambda_{t+1}, \eta_n \right) \right] \\ = \; & \frac{-\partial}{\partial l_{nt}} \sum_{s=1}^{\rho} \beta^s E_t \left[\psi_0 \left(p_{1n}^{(s)} \right) | l_{nt} = l_{nt}^o \right] \end{aligned}$$

where the third line exploits the facts that neither $x_{n,t+s} B_1$ nor $E_t \left[V_{n,t+\rho+1} \middle| d_{n,t+1} = 0, \ldots, d_{n,t+\rho} = 0 \right]$ depend on l_{nt}.

Estimation

A simulation estimator for the interior labor market choices

- Appealing to the Type 1 Extreme Value assumption and defining:

$$y_{nt} \equiv \frac{\partial}{\partial l_{nt}} \sum_{s=1}^{\rho} \beta^s \ln\left(p_{1n}^{(s)}\right) + \eta_n w_{nt}$$

  gives us:

$$y_{nt} = x_{nt} B_1 + 2\delta_0 l_{nt}^o + \sum_{s=1}^{\rho} \delta_s l_{n,t-s} + \varepsilon_{nt}$$

  where for all z_{nt} in the information set of n at t:

$$E\left[\varepsilon_{nt} \,|z_{nt}\right] = 0$$

- An estimator is now obtained from:

$$0 = \sum_{n=1}^{N} z_{nt}\left[y_{nt} - x_{nt} B_1 - 2\delta_0 l_{nt}^o - \sum_{s=1}^{\rho} \delta_s l_{n,t-s}\right]$$

Estimation

Current utility parameter estimates (Table VI, Altug and Miller, 1998)

Hours and participation†

Variable	Parameter	1. $\beta=0{\cdot}9,\ \sigma=0{\cdot}05$ (a)	(b)	(c)	2. $\beta=0{\cdot}9,\ \sigma=0{\cdot}05$ (a)	(b)	(c)	3. $\beta=0{\cdot}9,\ \sigma=0$ (a)	(b)	(c)	4. $\beta=0{\cdot}9,\ \sigma=0$ (c)
1	B_{00}	1257	—	−676	−14	—	−154	−44	—	−277	—
		(566)		(230)	(264)		(115)	(264)		(113)	
$KIDS_{nt}$	B_{01}	31	—	116	204	—	−43	173	—	120	—
		(222)		(110)	(132)		(72)	(132)		(41)	
$KIDS_{nt} \times MAR_{nt}$	B_{02}	−184	—	5·62	−187	—	42	−154	—	−77	—
		(208)		(106)	(129)		(71)	(129)		(25)	
AGE_{nt}	B_{03}	−37	—	42.2	31	—	13	29	—	18	—
		(33)		(16)	(13)		(6·6)	(13)		(6·5)	
AGE^2_{nt}	B_{04}	0·06	—	0·03	−0·03	—	−0·02	−0·03	—	−0·03	—
		(0·03)		(0·02)	(0·01)		(0·01)	(0·01)		(0·01)	
l_{nt}	B_{10}	−11·6	−10·4	−11	−5·4	−5·6	−5·5	−4·8	−5·1	−4·5	−2·7
		(0·51)	(0·04)	(0·25)	(0·24)	(0·02)	(0·12)	(0·24)	(0·02)	(0·11)	(0·12)
$KIDS_{nt} \times l_{nt}$	B_{11}	0·16	0·28	0·22	−0·55	−0·14	−0·40	−0·49	−0·14	0·3E−05	−0·51
		(0·17)	(0·02)	(0·10)	(0·10)	(0·01)	(0·07)	(0·10)	(0·01)	(0·1E−04)	(0·15)
$(KIDS_{nt} \times MAR_{nt})l_{nt}$	B_{12}	0·18	−0·12	0·07	0·60	0·34	0·52	0·54	0·34	−0·05	0·90
		(0·16)	(0·02)	(0·10)	(0·10)	(0·01)	(0·07)	(0·10)	(0·01)	(0·02)	(0·15)
$AGE_{nt} \times l_{nt}$	B_{13}	0·31	0·03	−0·60	−0·52	0·008	−0·20	−0·47	0·003	−0·24	0·19
		(0·49)	(0·003)	(0·26)	(0·17)	(0·001)	(0·01)	(0·17)	(0·001)	(0·01)	(0·005)
$AGE^2_{nt} \times l_{nt}$	B_{14}	0·002	0·002	0·002	0·002	0·002	0·002	0·002	0·001	0·002	0·002
		(0·05E−03)	(0·5E−04)	(0·3E−03)	(0·2E−03)	(0·2E−04)	(0·1E−03)	(0·2E−03)	(0·2E−04)	(0·1E−03)	(0·2E−03)
l^2_{nt}	δ_0	0·002	0·002	0·002	0·001	0·001	0·001	0·001	0·001	0·001	0·3E−04
		(0·1E−03)	(0·2E−04)	(0·6E−04)	(0·6E−04)	(0·1E−05)	(0·3E−04)	(0·6E−04)	(0·8E−05)	(0·3E−04)	(0·1E−03)
$l_{nt}l_{n,t-1}$	δ_1	−0·001	−0·001	−0·001	−0·6E−03	−0·5E−03	−0·6E−03	−0·5E−03	−0·5E−03	−0·6E−03	−0·7E−03
		(0·1E−03)	(0·2E−04)	(0·1E−04)	(0·5E−04)	(0·1E−05)	(0·4E−04)	(0·5E−04)	(0·1E−05)	(0·4E−04)	(0·1E−03)
$l_{nt}l_{n,t-2}$	δ_2	−0·7E−03	−0·7E−03	−0·7E−03	−0·4E−03	−0·4E−03	−0·3E−03	−0·3E−03	−0·4E−03	−0·3E−03	−0·6E−03
		(0·1E−03)	(0·2E−04)	(0·1E−04)	(0·6E−04)	(0·1E−05)	(0·4E−04)	(0·6E−04)	(0·9E−05)	(0·5E−04)	(0·1E−03)
$l_{nt}l_{n,t-3}$	δ_3	−0·7E−03	−0·8E−03	−0·6E−03	−0·3E−03	−0·3E−03	−0·3E−03	−0·2E−03	−0·3E−03	−0·2E−03	−0·5E−03
		(0·1E−03)	(0·2E−04)	(0·1E−04)	(0·5E−04)	(0·1E−05)	(0·4E−04)	(0·5E−05)	(0·9E−05)	(0·4E−04)	(0·1E−03)

† Standard errors in parentheses. a. Participation equation; b. Hours equation; c. Joint estimates.
Column 1: Nonparametric fixed effects. Columns 2, 3 and 4: Time-averaged fixed effects.