Dynamic Skill Accumulation, Education Policies and the Return to Schooling

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Introduction

- **Dynamic Discrete Choice Model of Skill Accumulation (Learning-by-Doing) with Comparative Advantages**
  - Schooling, Labor Supply (intensive and extensive margins), household production
  - Arbitrage between the relative rates at which education and market-work produce skills and Utility (Disutility) of labor supply intensity, schooling, and hometime
  - Not a Free Lunch Model
  - Returns to Schooling:
    - Effect of education on entry earnings
    - Life Cycle Return: effect on earnings dynamics
  - Applied to sample of white males in the 79 NLSY cohort

Ex-Ante Evaluation of Education Policies

- Education Policies targeting
  - High school drop-outs: Compulsory high school graduation policy and a subsidy to high school graduation
  - Broader population: Subsidies to attend higher education acting as a reduction in the cost of attending college (grade 13 to grade 16).
- We use counterfactual policies to generate IV estimates and investigate their meaning

Questions

- Who would be affected by each specific policy ?
- What would be the impact of the policies
  - on accumulated human capital?
  - on early life-cycle earnings?
  - on total labor supply?
- What would IV estimates of the return to schooling based on those same policy interventions reveal?
- Focus on early life-cycle (age 30 or 35)

Motivation and Background Literature

- Bridge gaps between various literatures
  - **Structural Dynamic Schooling Literature** (Keane and Wolpin, 1997)
  - **Treatment Effects (Roy Model)** applied to Returns to Schooling: Imbens and Angrist (1994), Heckman, and Vytlacil (2005)
  - **Earnings Dynamics literature:** debates the validity of the exogenous heterogenous income profile model vs. Persistent Shocks Model
  - **Labor supply and Human capital** (Imai and Keane, 2004)
- Recent literature (estimated) modeling earnings dynamics: Hugget, Ventura and Yaron (2012, AER), Altonji, Smith and Vidangos (ECTA, 2013), Magnac, Pistolesi and Roux (2013)

A Dynamic Skill Accumulation Model

- Individual allocate discrete periods between 5 states between age 16-35.
  - S : Schooling
  - H : Work 2501 hours or more
  - M : Work between 1501 and 2500 annual hours
  - L : work less than 1500
  - H : Household Activities
- Individuals Maximize Lifetime Utility and solve a Bellman equation.
- The Essence of Skill Formation is a **"Learning-by-Doing Model**" (not a Ben Porath model)

Behavioral Model-

Utilities

$$U_{it}^{h} = w_{it} + \varepsilon_{it}^{h}$$

$$U_{it}^{m} = \alpha_i^{m} + \delta_w^{m} \cdot w_{it} + \delta_s^{m} \cdot S_{it} + \delta_1^{m} \cdot age_{it} + \delta_2^{m} \cdot age_{it}^2 + \varepsilon_{it}^{m}$$

$$U_{it}^{l} = \alpha_i^{l} + \delta_w^{l} \cdot w_{it} + \delta_s^{l} \cdot S_{it} + \delta_1^{l} \cdot age_{it} + \delta_2^{l} \cdot age_{it}^2 + \varepsilon_{it}^{l}$$

$$\begin{aligned} U_{it}^{s} &= \alpha_i^{s} + \alpha_1^{s} \cdot I(S_t = 11) + \alpha_2^{s} \cdot I(12 \leq S_t < 14) + \\ \alpha_3^{s} \cdot I(14 &\leq S_t < 16) + \alpha_4^{s} \cdot I(16 \leq S_t) + \alpha_5^{s} \cdot I(d_{t-1,s} = 0) + \varepsilon_{it}^{S} \end{aligned}$$

$$U_{it}^{r} = \alpha_i^{r} + \alpha_s^{r} \cdot S_{it} + \alpha_1^{r} \cdot age_{it} + \alpha_2^{r} \cdot age_{it}^2 + \varepsilon_{it}^{r}$$

Behavioral Model-

Skill Accumulation Technology

$$w_{it} = \lambda_i + \lambda_i^s \cdot S_{it} + \lambda_i^l \cdot L_{it} + \lambda_i^m \cdot M_{it} + \lambda_i^h \cdot H_{it} + \lambda_1^w \cdot age_{it} + \lambda_2^w \cdot age_{it}^2 + \varepsilon_{it}^w$$

$$\lambda_i = \lambda_0 + \lambda_1 \cdot Math_i + \lambda_2 \cdot Verbal_i + \lambda_3 \cdot Conf_i + \lambda_4 \cdot SE_i + \lambda_5 \cdot PA_i$$

$$\lambda_i^s = \exp(\lambda_0^s + \lambda_1^s \cdot Math_i + \lambda_2^s \cdot Verbal_i + \lambda_3^s \cdot Conf_i + \lambda_4^s \cdot SE_i + \lambda_5^s \cdot PA_i)$$

$$\lambda_i^u = \exp(\lambda_0^u + \lambda_1^u \cdot Math_i + \lambda_2^u \cdot Verbal_i + \lambda_3^u \cdot Conf_i + \lambda_4^u \cdot SE_i + \lambda_5^u \cdot PA_i + \lambda_6^u \cdot HS_{it} + \lambda_7^u \cdot CO_{it}) \text{ for } u = h, m, l$$

Behavioral Model-

Information Set/Random Shocks

$$\Omega_t = \{\varepsilon^s_{it}, \varepsilon^r_{it}, \varepsilon^h_{it}, \varepsilon^m_{it}, \varepsilon^l_{it}, S_t, R_t, L_t, M_t, H_t\}$$

- $\{\varepsilon^s_{it}, \varepsilon^r_{it}, \varepsilon^h_{it}, \varepsilon^m_{it}, \varepsilon^l_{it}\}$ are i.i.d. extreme-value distribution (Rust,1987).ε^w_{it}, is assumed to follow a Normal $(0, \sigma^2_w)$

$$V^k_t(\Omega_t) = U^k_t + \beta EV_{t+1}(\Omega_{t+1} \mid d_{kt} = 1) \text{ for } k = s, r, l, m, h$$

$$EV_{t+1}(\Omega_{t+1} \mid d_{kt} = 1, \Omega_t) = E \max_k \{U^k_{t+1}(\Omega_{t+1}) + F(\Omega_{t+2}(\Omega_{t+1}, d_{kt+1}))\}$$

$$F(.) = \textit{ Polynomial in state variables}$$

- Vector of observed outcomes $O_{it} = \{d_{ist}, d_{iht}, d_{imt}, d_{ilt}, d_{irt}, w_{it}\}$ where w_{it} denotes observed wage outcome

$$L_i(.) = \prod^T \Pr(O_{it} \mid Math_i, Verbal_i, Conf_i, SE_i, PA_i)$$

Labor Supply (Intensive and extensive Margins)and School by Age

Empirical Frequencies

	Schooling	**Labor Supply**			**Home**
		Low	**medium**	**High**	
Age					
20	0.41	0.27	0.18	0.07	0.07
25	0.07	0.23	0.43	0.22	0.05
30	0.03	0.18	0.44	0.31	0.04
35	0.01	0.13	0.44	0.35	0.07

Model Fit

Accumulated Choices by Age 30

	Schooling	Employment			Home
		Low	medium	High	
Predicted	13.3	2.9	4.3	2.4	0.5
Actual	13.3	1.6	5.4	2.3	0.7

Skill Formation Technology

Education vs market-based skill formation

	Average	Std. Dev.
Schooling	0.067	0.012
Labor Supply (Low)		
Drop Out	0.033	0.007
High School	0.036	0.008
College	0.033	0.007
Labor Supply (Medium)		
Drop Out	0.085	0.020
High School	0.085	0.020
College	0.105	0.025
Labor Supply (High)		
Drop Out	0.070	0.019
High School	0.074	0.020
College	0.116	0.031

Compulsory High School Graduation, High School and College Subsidies

- *Compulsory High School Graduation*: Attendance for the first x_i periods, where x_i is defined as the difference between 12 (the minimum required) and initial schooling attainment (recorded by age 16) individuals start optimizing at date $t_i = x_i + 1$.

$$d_{s1i} = d_{s2i} = ..d_{sxi} = 1 \forall i$$

- High School Graduation Subsidy: A reward equivalent to increasing δ_{1s} by 1.0
- *Higher Education Subsidies*: A reward conditional on college attendance by increasing δ_{2s} and δ_{3s} (0.25, 0,50 and 1.0)

Policy Effects: High School

	Compulsory	Subsidy
% Δ in human capital		
Overall	4.5%	1.2%
Drop-outs	15.2%	3.7%
% Δ in life-cycle earnings		
Overall	2.6%	0.3%
Drop-outs	6.0%	0.9%
% Δ in total Labor Supply		
Overall	0.6%	-0.2%
Drop-outs	-0.6%	-0.6%
Δ in schooling (years)		
Overall	0.6	0.2
Drop-outs	2.3	0.6

Policy Effects: College

% Δ in human capital	High	Medium	Low
Overall	4.8%	2.8%	1.3%
High school or less	8.7%	4.8%	2.4%
Some college	1.4%	1.0%	0.4%
% Δ in life-cycle earnings			
Overall	-5.8%	-2.9%	-2.0%
High school or less	-4.7%	-1.9%	-1.1%
Some college	-6.8%	-3.8%	-2.8%
% Δ in total labour supply			
Overall	-7.8%	-4.0%	-2.5%
High school or less	-7.3%	-3.3%	-1.8%
Some college	-8.2%	-4.7%	-3.1%
Δ in Schooling			
Overall	1.3	0.7	0.4
High school or less	1.4	0.7	0.3
Some college	1.1	0.7	0.4

Comparing Compulsory Schooling with Higher Education Subsidies

- Compulsory schooling would raise average human capital of drop-outs by 15% without reducing life-cycle earnings
- Higher Education subsidies may be designed so to obtain same effects on human capital but reduce total earnings
- No scope for raising labor supply (intensive and extensive margins) of the more educated
- Much more effective to focus on high school drop outs

What would IV Estimates Reveal?

	Compulsory High school	**Subsidy High School**
	IV (st. error)	IV (st error)
Age 25	0.037 (0.050)	0.039 (0.112)
Age 30	0.058 (0.034)	0.067 (0.083)

	Subsidy High	**Subsidy Medium**	**Subsidy low**
	IV (st. error)	IV (st error)	IV (st error)
Age 25	0.019 (0.015)	0.020 (0.028)	0.018 (0.054)
Age 30	**0.033 (0.011)**	0.035 (0.020)	0.031 (0.037)

IV Estimation

- Compulsory High School Graduation would lead to fundamentally imprecise IV estimates (for with males)
- Subsidies may be manipulated so to obtain an arbitrarily large precision
- IV generated from subsidies are disconnected from the identity of those affected
  - interplay between dynamics and heterogeneity
  - affected by labor supply intensity adjustments
- Impossible to make sense of it.

Concluding Remarks

- We focussed on US white males, but what about other ethnic groups?
- We have analyzed counterfactual reactions to changes in education policies, but what about changes in education and labor supply induced by changes in the skill formation technology
    - how would education and life-cycle labor supply vary with changes in inequality (or wage dispersion)?
    - what would be the effect of a permanent income tax change on education and labor supply?