Intergenerational Long Term Effects of Preschool -Estimates from a Structural Dynamic Programming Model

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Based on Heckman and Raut[2016, J. Econometrics,191:164-175, NBER 2013}, Raut{2003]

Disclaimer

- Dr. Lakshmi K. Raut is an Economist at the Social Security Administration (SSA). This paper is prepared at his personal time, and the analysis and conclusions expressed are those of the authors and not necessarily those of SSA.

Summary

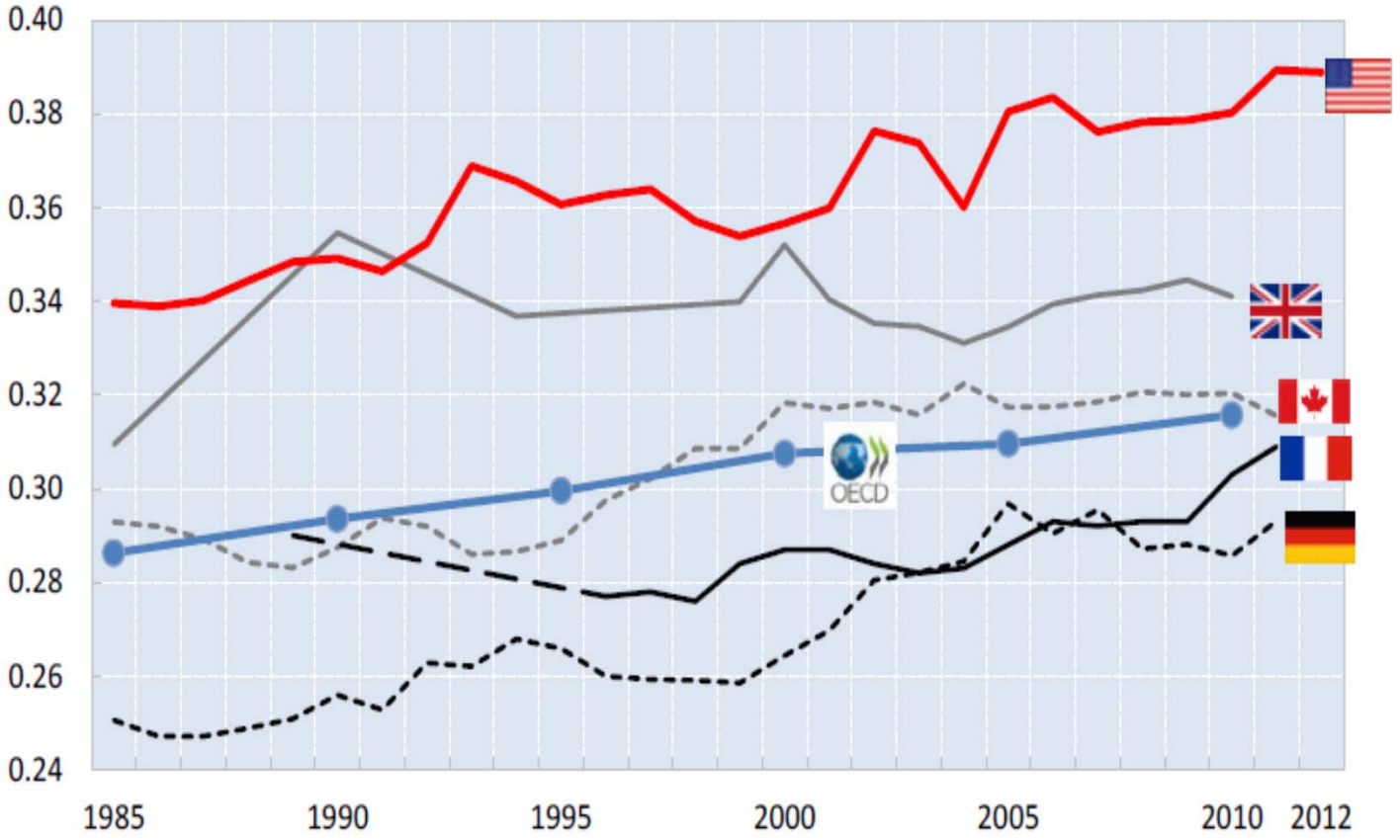
- Economic Issues:
  - Skills such as social, motivational and cognitive skills are important for school and labor market success. Inequality in these skills could be an important source of inequality and social mobility.
  - Where are they produced? Role of preschool inputs.
  - Children of poor SES lack those skills, leading to lack of demand for higher education.
- Methodology:
  - Equilibrium Markov Process arising from an altruistic model of parental preschool investment within a structural dynamic programming framework, featuring stochastic production processes of various skills and individual choices. Use nationally representative survey dataset NLSY79
- Policy: We estimate the effect of a publicly provided preschool to disadvantaged children as a "social contract" for every generation, especially
  - Within generation effect: educational and labor market achievements, earnings distribution
  - Intergenerational effect: Social (lifetime earnings) mobility and schooling mobility.
  - Estimate general equilibrium tax burden of such a social contract policy.
- Findings:
  - Preschool has significantly positive effects on production of social, motivational and cognitive skills.
  - These skills have significantly positive effects on school and labor market outcomes.
  - The conventional estimate of the rate of returns to schooling without including the other skills overestimates it by around one percent.
  - The gains to the society exceed the cost of such a policy.
  - The positive effects on social mobility, college mobility and income inequality are not dramatic but significant. The estimates are based on the qualities of preschools in the sixties. Higher economy-wide returns expected from better quality preschool programs such as Perry and Abecedarian preschool programs.

Outline

- First I show a few stylized facts about growing inequality and low social mobility, high premium for college graduation in the labor market. **Questions**:
  - In spite of high premiums for college, why children from poor SES do not complete college?
  - What skills are important for labor market and school success?
- <u>Then I will show that personality skills</u> such as Big Five including social, motivational and cognitive skills are important for school and labor market success.
- Sources of Inequality: Globalization, Labor market practices, our focus is on inequality at birth in terms of development in health, and human capital including cognitive and non-cognitive skills.
- We formulate the production process of these skills, parental choice problem and estimation method and the results.

Figure 2. Income inequality has been rising over the past three decades

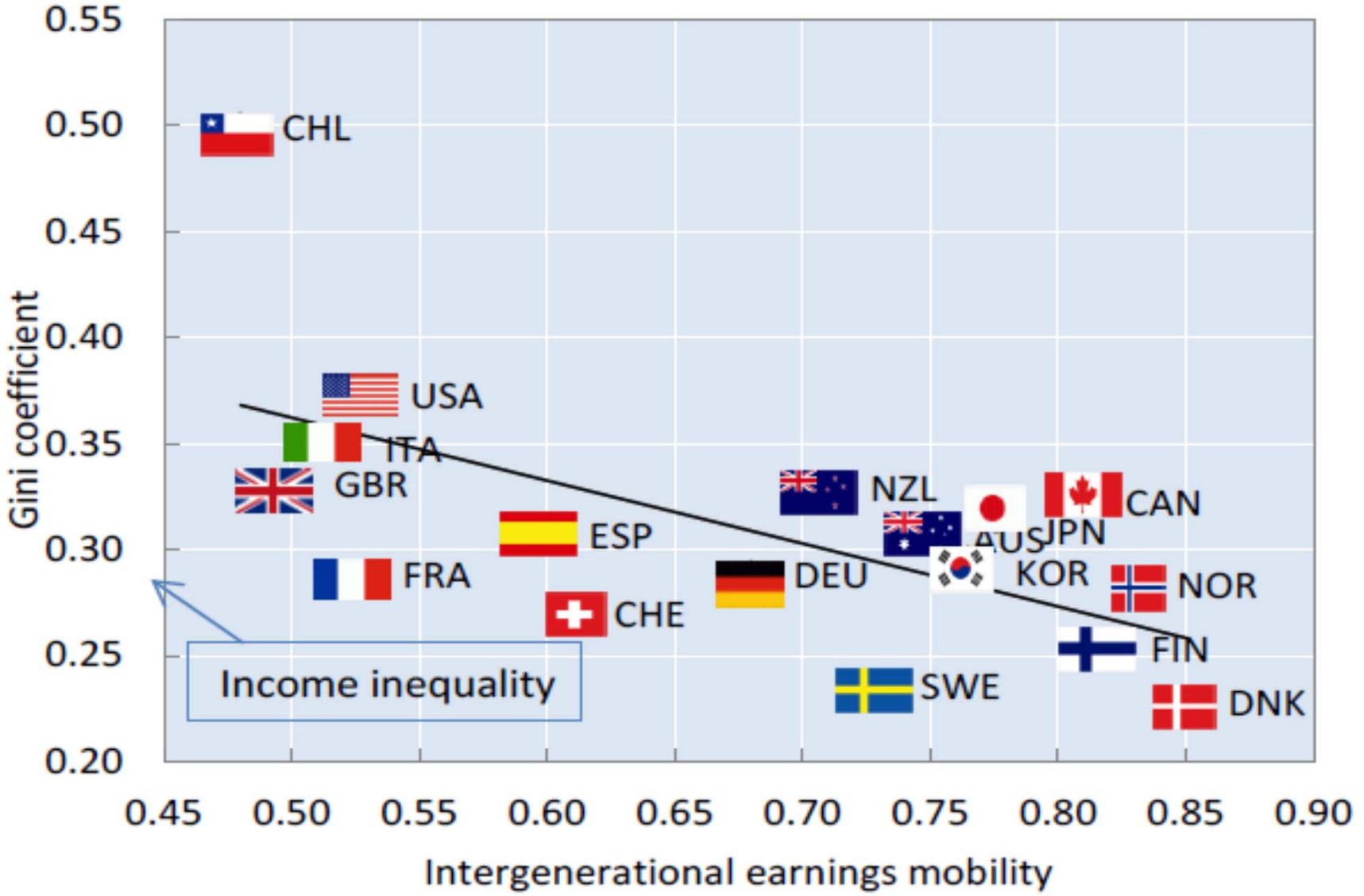
Trends in inequality (Gini coefficient) 1985 – 2012, total population

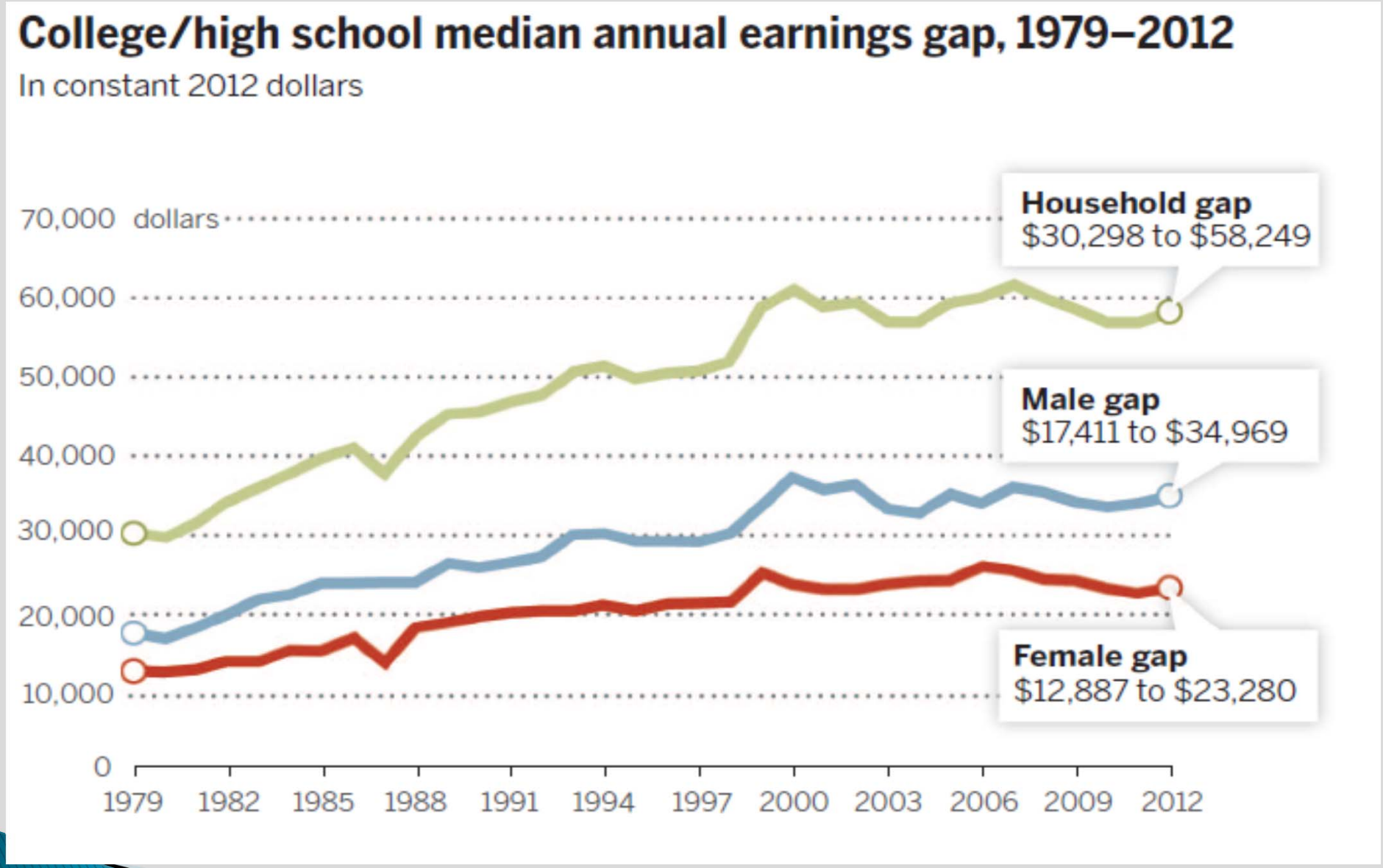


Note: OECD average: un-weighted and based on 12 countries for which data are available at all points (Canada, Denmark, France, Germany, Israel, Italy, Netherlands, New Zealand, Spain, Sweden, United Kingdom and United States). Data for 2011 and 2012 are provisional.

Source: OECD Income Distribution Database (2013), www.oecd.org/social/income-distribution-database.htm

Income inequality and intergenerational earnings mobility, mid-2000s





Source: Autor [2014, Science]

Important Skills: Cognitive and Personality traits

- Cognitive Skills:
  - Intelligence, schooling level
- Big Five Personality skills :
  - Self-control, Executive Function (EF), Social and Motivational skills
- Evidence on the effects of these skills
  - Stanford Marshmallow Test (see Walter Mischel, 2014 book)
  - U.S.Census Bureau interviewed 3,000 employers (1 to 5 very important): skill credentials - 3.2, years of schooling - 2.9, scores on employer given test and academic performance- each 2.5, **attitude - 4.6 and communication - 4.2.**(see Bowles et al (2001, JEL)
  - Our empirical evidence using the NLSY 79 data

Table 1: Determinants of earnings – role of cognitive and non-cognitive skills (from the parent sample)

Variables	Basic	Extended	Augmented
Intercept	1.7137***	2.3440***	1.6978***
Grade	0.1112***	0.0694***	0.0595***
Age	0.3363***	0.3277***	0.3279***
Age Square	-0.0040***	-0.0039***	-0.0039***
Mother's Grade		-0.0022	-0.0050***
Father's Grade		0.0079***	0.0065***
Dummy Variable for Female		-0.5187***	-0.5137***
Dummy Variable for Non-Black and Non-Hispanic		0.0545***	0.0794***
τ : AFQT Score		0.0059***	0.0048***
σ : Socialization			0.0111*
μ : Motivation - Job Aspiration			0.0261***
η : Self-Esteem (Rosenberg Scale)			0.0193***
ϕ : Internal Self-Control (Pearlin Scale)			0.0251***
n	118,477	95,253	93,166
R^2	0.3083	0.3752	0.3839

Note: Parameter estimates with *, **, and *** are significant at $p \leq 0.10$, $p \leq 0.05$ and $p \leq 0.01$ respectively.

Table 2: Determinants of grade and College completion – role of cognitive and non-cognitive skills (from the parent sample)

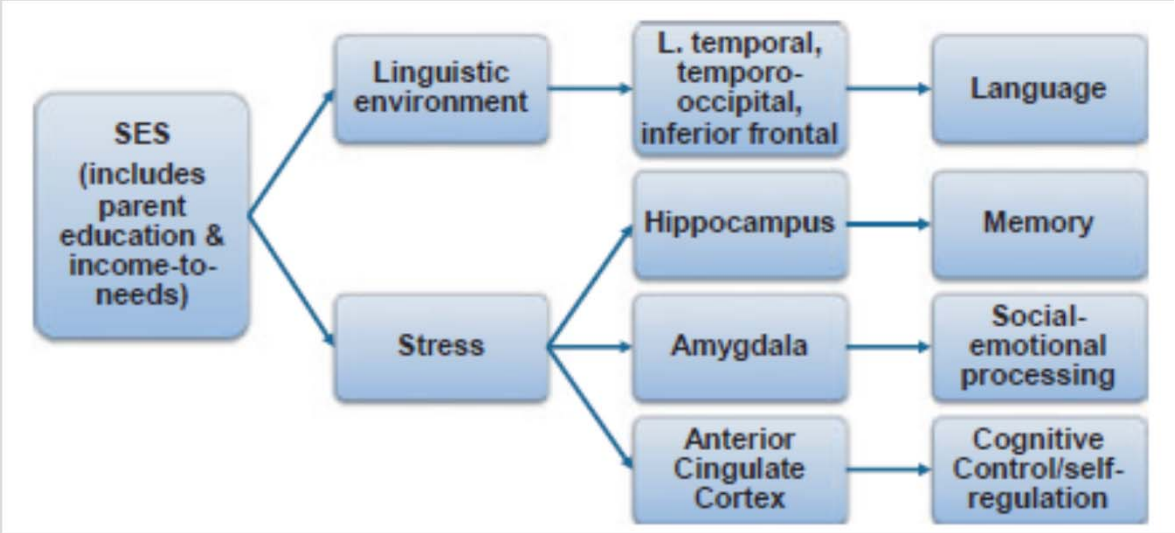
Variables	OLS model of years of completed schooling	Logit model of completing college
Intercept	9.1570***	-7.9304***
Mother's Grade	0.0817***	0.1145***
Father's Grade	0.0430***	0.0705***
Preschool	0.4999***	0.5800***
τ : AFQT Score	0.0384***	0.0472***
σ : Socialization	0.0776***	0.1332***
μ : Motivation - Job Aspiration	0.4890***	0.9446***
η : Self-Esteem (Rosenberg Scale)	0.3551***	0.3781***
ϕ : Internal Self-Control (Pearlin Scale)	0.4399***	0.7299***
n	108,565	108,636
$R^{2\,a}$	0.4263	0.3436

Notes: Parameter estimates with *, **, and *** are significant at $p \leq 0.10$, $p \leq 0.05$ and $p \leq 0.01$ respectively.
a The R^2 in the second column is McFadden's R^2.

Boosting personality and cognitive skill formations with preschool intervention

- Brain Development is a dynamic process – Interaction of genetic programs and experience-dependent plasticity, see, Noble et al (2012, Developmental Science

fMRI shows effects of language & stress on development of regions of prefrontal cortex



- Perry Preschool (see Schweinhart, 2002,Online Res. Bulletin)
- The Mind Tools Program (see Diamond et al, 2007)
- Evidence from NLSY, I present the findings from our paper, Heckman and Raut [2016] and my earlier paper Raut[2003].

Table 3: Logit model of cognitive and non-cognitive skills.

Variables	τ'	σ'	μ'	η'	ϕ'	s
Intercept	-2.8005***	-1.1219***	-0.8990***	-2.5222***	-2.7063***	-3.9698***
τ	1.4300***	0.1508**	-0.0713	-0.5082***	-0.4989***	2.1359***
τ'		0.9459***	1.2590***	0.2423***	0.1800***	
σ		0.2414***	0.1940***	0.1209**	0.1044**	0.3041***
μ		0.1005**	-0.0211	-0.0449	-0.0312	0.7126***
η		0.2581***	0.2577***	0.2863***	0.2542***	0.5727***
ϕ		-0.0177	-0.0466	0.1294***	0.1333***	0.6198***
s	0.8456***	0.5096***	0.4588***	1.5443***	1.6694***	1.4013***
a : Preschool	0.8766***	0.7972***	0.0496	-0.0731	-0.0647	0.6569***
n	11,428	11,428	11,428	11,428	11,428	7,732
McFadden's R^2	0.109	0.0911	0.0623	0.0681	0.0705	0.2205

Notes: Parameter estimates with *, **, and *** are significant at $p \leq 0.10$, $p \leq 0.05$ and $p \leq 0.01$ respectively.
A variable x without a $'$ refers to the parent and with a $'$ refers to his child.
τ : AFQT Score
σ : Socialization
μ : Motivation - Job Aspiration
η : Self-Esteem (Rosenberg Scale)
ϕ : Internal Self-Control (Pearlin Scale)

An altruistic Model of parental preschool investment, Raut[2003] and Heckman and Raut[2016]

- Observable states of an individual:
- x = (τ, σ, μ, η, φ, s)
  - τ : *talent*,
  - σ : *socialization*,
  - μ : *motivation*,
  - η : *Self-esteem (Rosenberg measure)*,
  - φ : *Internal self-control (Perlin measure)*
  - *S : Schooling level*
- z = (x, ε), ε : *taste shifter and random factors affecting permanent income, school outcome given observable inputs.*

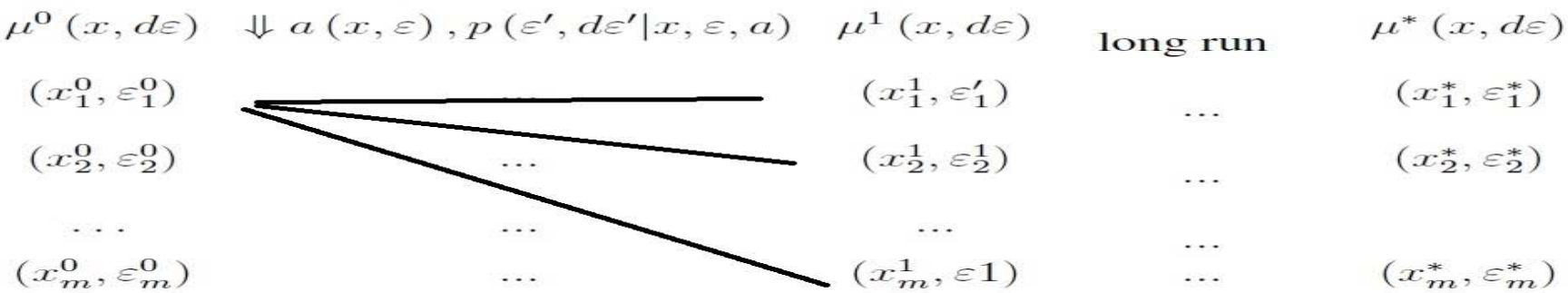
Structural Dynamic Programming Model

- Parent of type (x, ε), earns w (x, ε), decides preschool investment a *in* A(x). -> Determines
- Consumption c (w, a) = w - θ *a*, a = 0, 1.
- Transition probability : p(x',dε'|*x, ε,a)*
- Bellman equation of the choice problem:

$$V(x,\varepsilon) = \max_{a \in A(x)} u(x,\varepsilon,a) + \beta \sum_{x' \in X} \int V(x',\varepsilon')\, p(x', d\varepsilon' | x,\varepsilon,a)$$

- *Optimal solution: a(x, ε).*
- *Structural Parameters:* $\zeta = \{u(.), \xi_p, \beta\}$ *where* ξ_p : parameters characterizing transition probabilities
- Data: $y = \{(x_i, x_i'), a_i\}_{i=1}^{n}$

Equilibrium Dynamics
Controlled Markov Process



optimal choice $a(x,\varepsilon)$ is the solution of the Bellman Equation:

$$V(x,\varepsilon) = \max_{a(x,\varepsilon))\in A(x)} u(x,\varepsilon,a) + \beta \sum_{x'\in X} \int V(x', d\varepsilon')\, p(\varepsilon', d\varepsilon'|x,\varepsilon,a)$$

observavle states: $x = (\tau, \sigma, \mu, \eta, \phi, s)$, permanent income: $w(\tau, \sigma, \mu, \eta, \phi, s)$ and $s' = (\tau', \sigma', \mu', \eta', \phi', \varepsilon', a)$, $->$ Random utility model giving a Logit representation for optimal $a(x,\varepsilon)$ and can derive equilibrium dynamics over the observable states below:

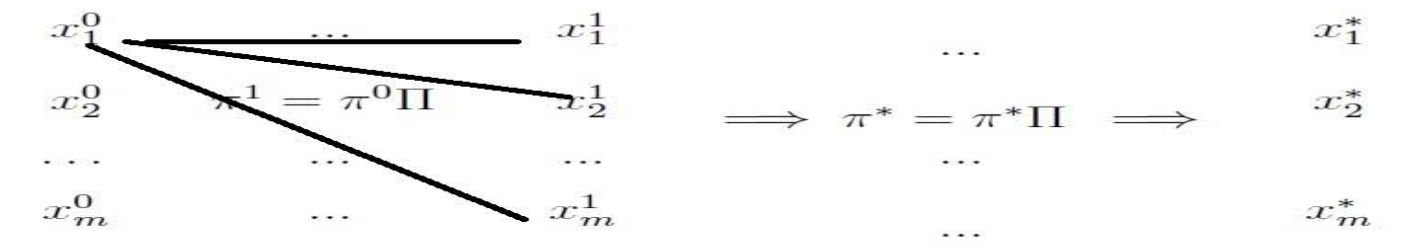


Table 4: Maximum likelihood parameter estimates of $\xi = (\theta, \beta)$ and other derivd macroeconomic parameters, given two different estimates of $f_\gamma(x'|x,a)$

	Given estimates of $f_\gamma(x'|x,a)$ with	
	only significant x	all x
Cost $(\hat{\theta})$ of preschool (in '000 dollars)	1.222***	1.224***
Degree of altruism: $\hat{\beta}$	0.443**	0.486***
Long-run Equibrium Tax Rate: τ (in percent)	5.94	5.83
Percent of population in poor SES:		
Before the policy introduction ($\tau = 0$)	36.22	35.71
After the policy introduction	29.64	29.14
Per capita after tax annual earnings:		
Before the policy introduction ($\tau = 0$)	5621.85	5640.08
After the policy introduction	5734.93	5759.38
gains in per capita income	113.09	119.30
log-likelihood	-7424.97	-7429.575

Note: Parameter estimates with *, **, and *** are significant at $p \leq 0.10$, $p \leq 0.05$ and $p \leq 0.01$ respectively.

Intergenerational Effects of Free preschool to children of poor SES

- From estimated optimal transition probability matrix p(x'|x,a(x)), x in X, calculated Intergenerational mobility measure: 1- $\lambda_{max:}$ Invariant population distribution
- **College Mobility**:
  - Before:
  - After Policy:

$$Q_b^s = \begin{bmatrix} 0.93287 & 0.06713 \\ 0.59380 & 0.40620 \end{bmatrix}, p_b^s = [\ 0.8984 \quad 0.1016\ ], 1 - \lambda_{\max,b}^s = 0.6609$$

$$Q_a^s = \begin{bmatrix} 0.90553 & 0.09447 \\ 0.59184 & 0.40816 \end{bmatrix}, p_a^s = [\ 0.8624 \quad 0.1376\ ], 1 - \lambda_{\max,a}^s = 0.6863$$

- **Social mobility**:
  - before the policy: 0.5945
  - After the policy: 0.6465
- **Income Inequality (Gini Coefficient):**
  - Before the policy:0.2363, percent in poor SES: 36 , w = 5622
  - After the policy: 0.2335, percent in poor SES: 30, w = 5735
- **Tax Burden of the Social Contract**

  Per capita gain in average after tax earnings == $113

Thank you...