Early Childhood Development, Earnings Inequality and Social Mobility in an Education Signaling Model

Professor Lakshmi K. Raut
Visiting Fellow, University of Chicago,
and
Visiting Professor,
Indian Institute of Management – Udaipur
lakshmiraut@gmail.com

Outline and summary

- Many factors are responsible for growing income inequality around the world
  - capital outflow, relocation of jobs, declining labor union, i.e., declining bargaining power of the labor, poor regulation of financial institutions, corruption, and all-encompassing globalization (Bourguignon, 2015; Piketty, 2014; Stiglitz, 2015).
- For the 99% population, the main source is earnings.
- Determinants of earnings-effects of labor market phenomena
  - Earlier literature: Cognitive abilities -> IQ, schooling
  - Recent literature: Adds emotion (affect) dysregulation-> personality skills
- Where are they produced?
  - Home, neighborhood, role of early childhood inputs from primary caretaker (generally mother) -- (Bowlby (1982), NICHD Early Childhood Network (2004)
  - More recent neuroscience research on Brain Development.
- Show empirical evidence from Heckman and Raut[2016]
- Asymmetric information and labor market education signaling model

Important Skills: Cognitive and Personality traits

- Cognitive Skills:
  - Intelligence, schooling level →Bell Curve controversy etc.
- Emotion or Affect regulation -> Big Five Personality skills
  - Self-control, Executive Function (EF), Social and Motivational skills

- Evidence
  - Stanford Marshmallow Test (see Walter Mischel, 2014 book)
  - Perry Preschool (see Schweinhart, 2002,Online Res. Bulletin)
  - U.S.Census Bureau interviewed 3,000 employers (1 to 5 very important): skill crentials - 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)

Emotion or Affect Dysregulation: Neuroscience Approach

- Human brain develops between age 0-8 and almost at the speed of light between age 0-2.
- Poor quality interaction of the primary care-taker -> affect dysregulation with long-term effects on cognition and emotion
- Apart from quality of parenting, prenatal care, post natal care, and home environments, Other effects of poor SES on neural development.
  - Toxin exposure: higher levels of lead affect IQ and reading ability.
  - Nutrition: low intakes influence cognition and emotion.
  - Stress: stress in family leads to affect dysregulation and language

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

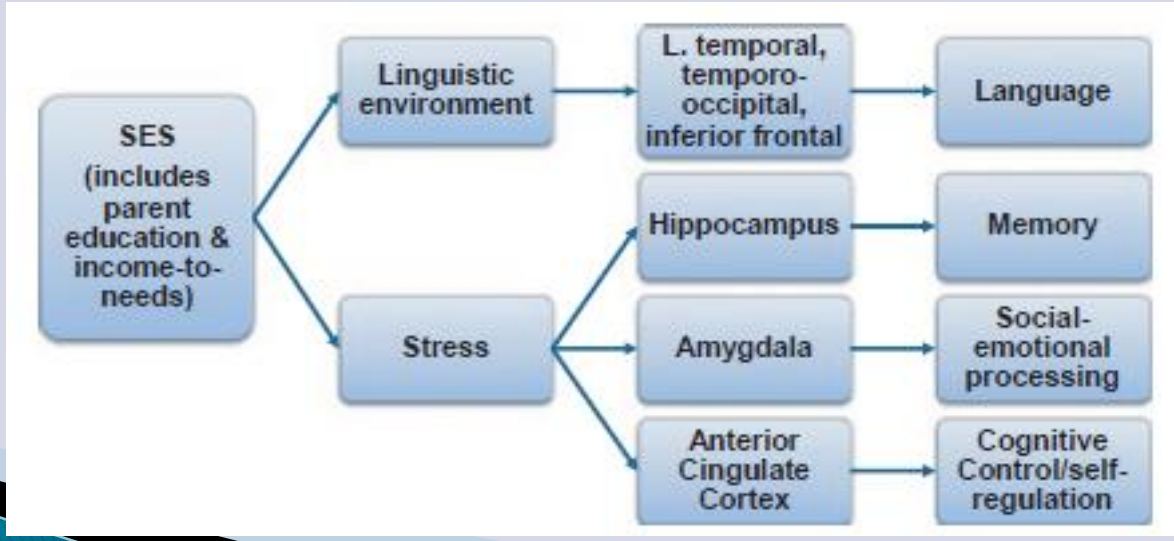

Table 1: Determinants of earnings -- role of cognitive and non-cognitive skills

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

Variables	Basic	Extended	Augmented
Intercept	1.7137 (28.22)	2.3440 (36.36)	1.6978 25.12
Grade*	0.1112 (82.59)	0.0694 (37.93)	0.0595 (31.93)
Age	0.3363 (82.66)	0.3277 (77.00)	0.3279 (76.77)
Age Square	-0.0040 (60.79)	-0.0039 (56.45)	-0.0039 (56.30)
Mother's grade		-0.0022 (1.61)	-0.0050 (3.59)
Father's Grade		0.0079 (7.00)	0.0065 (5.67)
Dummy variable for Female		-0.5187 (81.19)	-0.5137 (79.70)
Dummy Variable for non-Black and non-Hispanic		0.0545 (7.21)	0.0794 (10.39)
τ : Revised AFQT Score		0.0059 (36.76)	0.0048 (28.90)
s : Socialisation			0.0111 (1.68)
μ : Motivation - Job Aspiration			0.0261 (3.57)
η : Self-Esteem (Rosenberg Scale)			0.0193 (18.24)
ϕ : Internal Self-Control (Pearlin Scale)			0.0251 (22.97)
n	118,477	95,253	93,166
R^2	0.3083	0.3752	0.3839

Notes: Absolute values of t-statistics are in parentheses.

Table 2: Determinants of schooling

Variables	OLS model of years of completed schooling	Logit model of completing college
Intercept	9.1570 (421.47)	-7.9304 (117.45)
Mother's grade	0.0817 (35.79)	0.1145 (23.76)
Father's Grade	0.0430 (22.84)	0.0705 (19.59)
Preschool	0.4999 (35.89)	0.5800 (24.72)
τ : Revised AFQT Score	0.0384 (169.00)	0.0472 (104.15)
σ : Socialisation	0.0776 (7.00)	0.1332 (6.80)
μ : Motivation - Job Aspiration	0.4890 (40.69)	0.9446 (34.09)
η : Self-Esteem (Rosenberg Scale)	0.3551 (21.39)	0.3781 (14.66)
ϕ : Internal Self-Control (Pearlin scale)	0.4399 (31.32)	0.7299 (20.62)
n	108,565	108,636
R^2 *	0.4263	0.3436

* Notes: The R^2 in the second column is the McFadden's-R^2.

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
	(41.76)	(20.80)	(17.02)	(32.42)	(32.61)	(33.60)
τ	1.4300	0.1508	-0.0713	-0.5082	-0.4989	2.1359
	(23.99)	(2.47)	(1.19)	(6.99)	(6.69)	(26.38)
τ'		0.9459	1.2590	0.2423	0.1800	
		(16.78)	(22.85)	(4.18)	(3.04)	
σ		0.2414	0.1940	0.1209	0.1044	0.3041
		(5.64)	(4.62)	(2.54)	(2.14)	(3.92)
μ		0.1005	-0.0211	-0.0449	-0.0312	0.7126
		(2.26)	(0.48)	(0.89)	(0.61)	(6.78)
η		0.2581	0.2577	0.2863	0.2542	0.5727
		(5.82)	(5.91)	(5.90)	(5.13)	(7.31)
ϕ		-0.0177	-0.0466	0.1294	0.1333	0.6198
		(0.41)	(1.11)	(2.66)	(2.68)	(7.72)
s	0.8456	0.5096	0.4588	1.5443	1.6694	1.4013
	(11.92)	(10.64)	(9.60)	21.21	(21.38)	(15.49)
a : Preschool	0.8766	0.7972	0.0496	-0.0731	-0.0647	0.6569
	(16.75)	(18.58)	(1.16)	(1.53)	(1.33)	(7.13)
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: A variable x without a $'$ refers to the parent and with a $'$ refers to his child.

τ : Revised AFQT Score
σ : Socialisation
μ : Motivation - Job Aspiration
η : Self-Esteem (Rosenberg Scale)
ϕ : Internal Self-Control (Pearlin Scale)

Education Signaling Model of Income Inequality

- At time t, individuals (τ_t, s_{t-1})

$$\sigma_t(\tau_t, s_{t-1}) = \arg\max_{s_t \in \mathcal{S}} u\left(w_t(s_t) - \theta(s_t, \tau_t, s_{t-1})\right) \tag{1}$$

$$\frac{w_t'(s_t)}{\theta_1'(s_t)} = \theta_2(\tau_t, s_{t-1}) \tag{5}$$

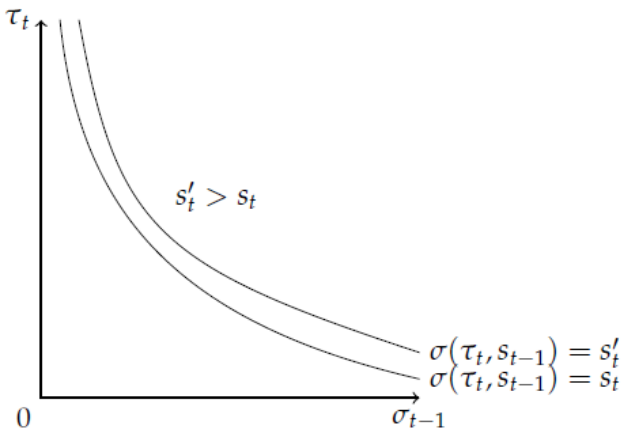

Figure 1: Set of individuals $(\tau_t, st-1)$ for whom s_t is the optimal schooling level.

Signaling Equilibrium

we can solve s_{t-1} as a function of (s_t, τ_t), $s_{t-1} = s_t^{*-1}(\tau_t, w_t'(s_t)/\theta_1'(s_t))$

- Given the distribution of education in period $\pi_{t-1}(s_{t-1})ds_{t-1}$ and the distribution of cognitive ability $g(\tau_t)$ assumed to be independent of s_{t-1}, and the above equation,

the joint pdf of s_t, τ_t is given by

$$f_{(s_t,\tau_t)}(s_t,\tau_t) = g(\tau_t).\pi_{t-1}\left(s_t^{*-1}\left(\tau_t, \frac{w_t'(s_t)}{\theta_1'(s_t)}\right)\right)\left|\frac{\partial(\tau_t, s_{t-1})}{\partial(s_t,\tau_t)}\right|$$

A period-t signaling equilibrium is a wage schedule $w_t(s_t)$ such that

$$\begin{aligned} w_t(s_t) &= \int_T e(s_t,\tau_t) f_{\tau_t|s_t}(\tau_t)\, d\tau_t = \frac{\int_T e(s_t,\tau_t) f_{X_t}(s_t,\tau_t)\, d\tau_t}{\int_T f_{X_t}(s_t,\tau_t)\, d\tau_t} \\ &= \frac{\int_T e(s_t,\tau_t) g(\tau_t) \pi_{t-1}\left(s_t^{*-1}\left(\tau_t, \frac{w_t'(s_t)}{\theta_1'(s_t)}\right)\right)\left[\frac{\partial\theta_2}{\partial s_{t-1}}\left(\tau_t, s_t^{*-1}\left(\tau_t, \frac{w_t'(s_t)}{\theta_1'(s_t)}\right)\right)\right]^{-1} d\tau_t}{\int_T g(\tau_t)\pi_{t-1}\left(s_t^{*-1}\left(\tau_t, \frac{w_t'(s_t)}{\theta_1'(s_t)}\right)\right)\left[\frac{\partial\theta_2}{\partial s_{t-1}}\left(\tau_t, s_t^{*-1}\left(\tau_t, \frac{w_t'(s_t)}{\theta_1'(s_t)}\right)\right)\right]^{-1} d\tau_t} \\ &= \Psi(w_t'(s_t), s_t) \text{ say} \end{aligned}$$

Two Lognormal economies

$$\begin{aligned} s_{t-1} &\sim \Lambda\left(\mu_{s_{t-1}}, \sigma^2_{s_{t-1}}\right) \\ \tau_t &\sim \Lambda\left(\mu_\tau, \sigma^2_\tau\right) \\ e(s_t, \tau_t) &= s_t^\rho . \tau_t,\ \rho > 0. \end{aligned}$$

$$\theta_2\left(\tau_t, s_{t-1}\right) = \tau_t^{-\alpha} \cdot s_{t-1}^{-\gamma}, \text{ where, } \alpha, \gamma > 0$$

$$w'_t(s_t) = \left[\frac{s_t^\rho \tilde{\mu}}{w_t(s_t)}\right]^{1/\beta^*}, \text{ where } \tilde{\mu} = \exp(d) = \exp\left([1-\alpha\beta^*]\mu_\tau - \gamma\beta^*\mu_{s_{t-1}} + \sigma^{*2}/2\right)$$

$$\beta^* = \frac{\alpha\sigma^2_\tau}{\gamma^2\sigma^2_{s_{t-1}} + \alpha^2\sigma^2_\tau}, \quad \text{and} \quad \sigma^{*2} = \frac{\gamma^2\sigma^2_\tau\sigma^2_{s_{t-1}}}{\gamma^2\sigma^2_{s_{t-1}} + \alpha^2\sigma^2_\tau}$$

$$s_t \sim \Lambda\left(\left[\frac{\ln\left(\tilde{\mu}\frac{\rho+\beta^*}{1+\beta^*}\right)}{1-\rho} + \frac{(1+\beta^*)}{1-\rho}\left(\alpha\mu_\tau + \gamma\mu_{s_{t-1}}\right)\right], \frac{(1+\beta^*)^2}{(\rho-1)^2}\cdot\left[\alpha^2\sigma^2_\tau + \gamma^2\sigma^2_{s_{t-1}}\right]\right) \quad (12)$$

and

$$w_t s \sim \Lambda\left(\mu_{w'}\left[\frac{\rho+\beta^*}{1+\beta^*}\cdot\frac{(1+\beta^*)}{1-\rho}\right]^2\left[\alpha^2\sigma^2_\tau + \gamma^2\sigma^2_{s_{t-1}}\right]\right) \quad (13)$$

For this economy, the Gini-coefficient for schooling inequality in period t is

$$\begin{aligned} G'_{s_t} &= 2\Phi\left(\frac{1}{\sqrt{2}}\frac{1+\beta^*}{1-\rho}\sqrt{\alpha^2\sigma^2_\tau + \gamma^2\sigma^2_{s_{t-1}}}\right) - 1. \\ G'_{w_t} &= 2\Phi\left(\frac{1}{\sqrt{2}}\frac{\rho+\beta^*}{1+\beta^*}\cdot\frac{1+\beta^*}{1-\rho}\sqrt{\alpha^2\sigma^2_\tau + \gamma^2\sigma^2_{s_{t-1}}}\right) - 1. \end{aligned} \quad (14)$$

Conclusions

- Given asymmetric information about cognitive ability, education is used as a signal for ability. If education cost depends on family background, we have pooling equilibrium ➔ lower within generation earnings inequality and lower social mobility
- Reducing inequality in schooling level of parents will reduce schooling (and hence earnings) inequality of their children. Have not worked out the effect on social mobility yet.
- The channel for the above relationship is from the dependence of education cost (i.e., signaling cost) on family background (i.e., schooling levels of parents) under the assumption that cognitive ability of a child is independent of family background and parents' cognitive ability.
- More realistically, when cognitive ability of a child depends on parents' cognitive ability and family background as the neuroscience and child development literature suggest, we expect the effects to be stronger. I am doing the analytical derivations for this general case.

Thank you…