

# The Economics of Human Development

James J. Heckman  
University of Chicago

October 7, 2014  
First Yukichi Fukuzawa Lecture  
Keio University



The Human Capital and Economic Opportunity Global Working Group

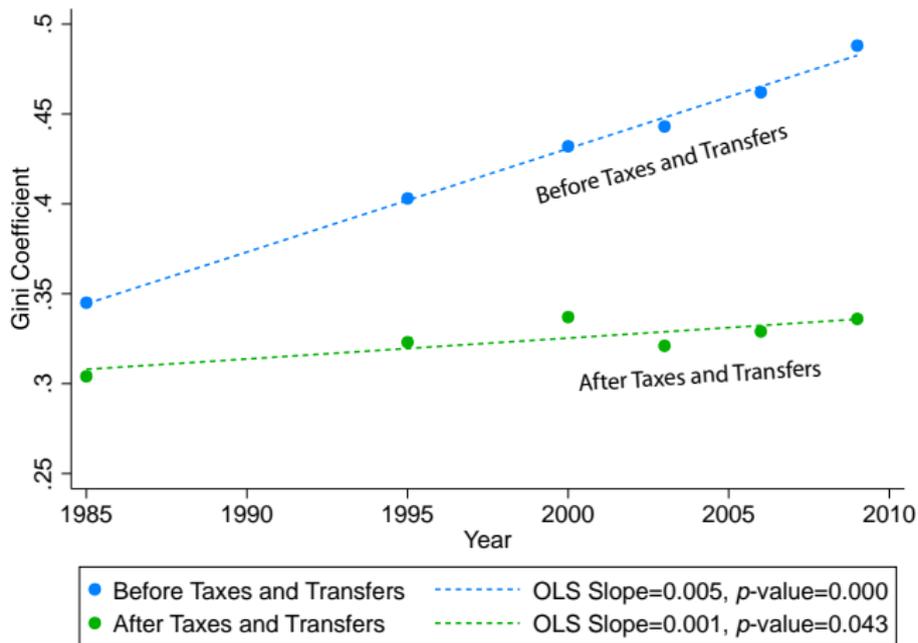


# Institute for New Economic Thinking



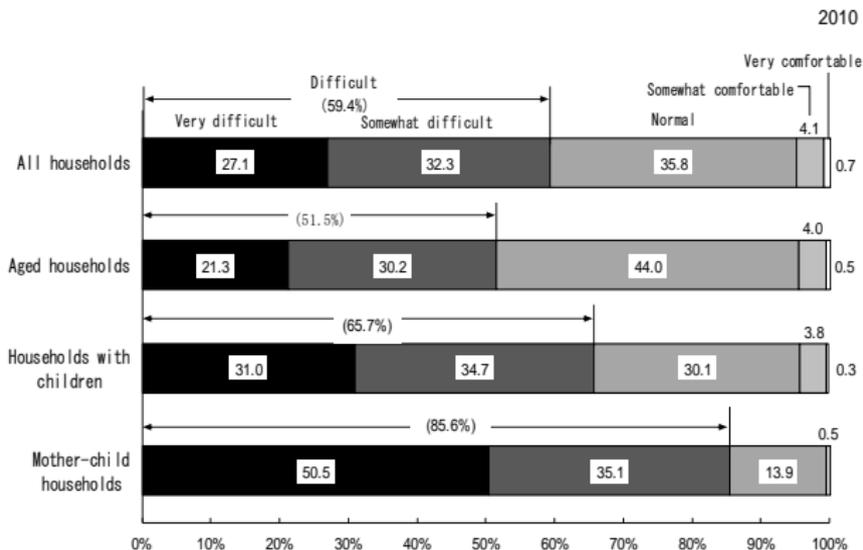
*“It is said that heaven does not create one man above or below another man. Any existing distinction between the wise and the stupid, between the rich and the poor, comes down to a matter of education.” – Fukuzawa Yukichi*

Figure 1: Trends in Family Income Inequality in Japan



Source: Bradley J. Setzler (2014)

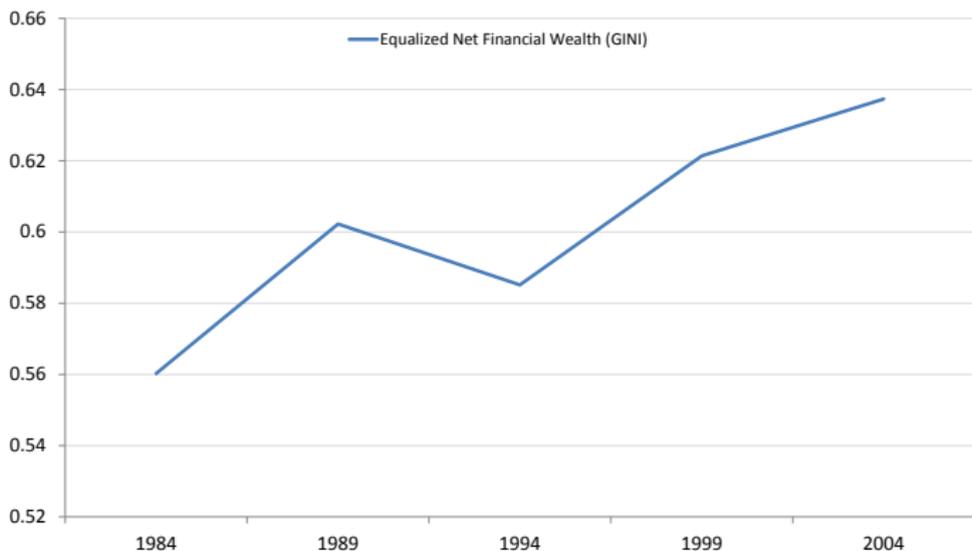
**Figure 2:** Percentage distribution of the number of households by self-assessed living-conditions, for all the households and specific households



Source: From Ministry of Health, Labour, and Welfare

Source: From Ministry of Health, Labour, and Welfare.

## Measures of Wealth Inequality (NSFIE)

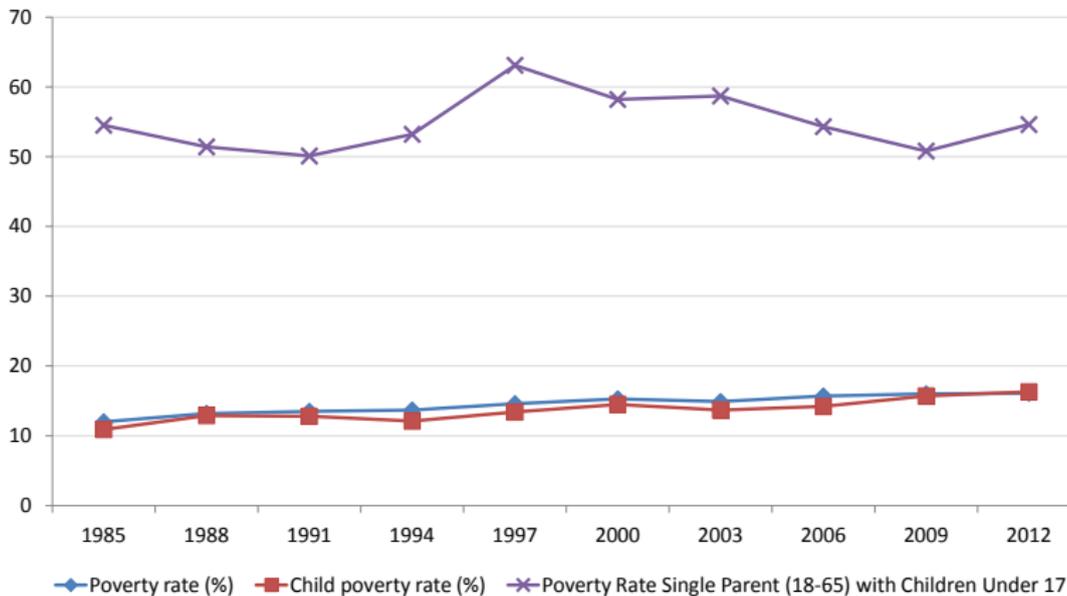


Source: Lise et al., 2014

Data: National Survey of Family Income and Expenditure (NSFIE)

Source: Lise et al., 2010

## Poverty Rates in Japan



Source: Comprehensive Survey of Living Conditions

Note: Poverty rate is calculated according to OECD guideline (The poverty rate is the ratio of the number of people who fall below the poverty line and the total population; the poverty line is here taken as half the median household income)

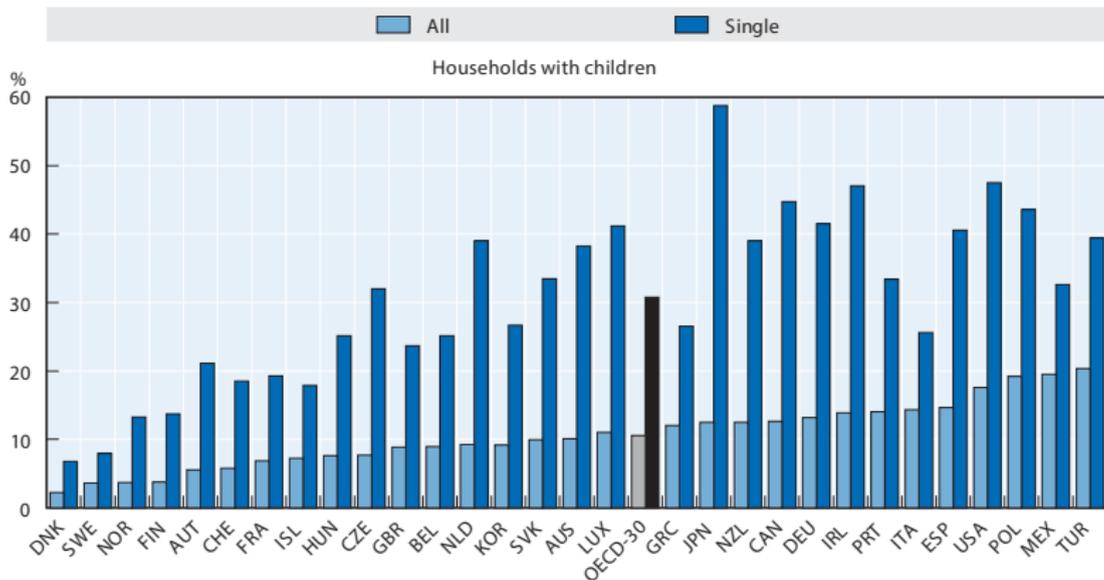
## A Basic Fact on Gender Inequality in Hourly Wage in Japan

**Table 1:** Gender Inequality in Employment Status and Hourly Wage (2006 Wage Census in Japan)

		Fulltime regular	Fulltime irregular	Parttime regular	Parttime irregular	Total(prop.) Mean(wage)
Proportion of Employees	Men	0.840	0.075	0.003	0.082	1.000
	Women	0.474	0.146	0.009	0.371	1.000
Hourly wage (in yen)	Men	2,094	1,324	1,342	1,059	1,949
	Women	1,462	1,041	1,068	939	1,203
Wage Ratio (W/M)		0.698	0.786	0.796	0.887	0.617

Source: Yamaguchi (2014).

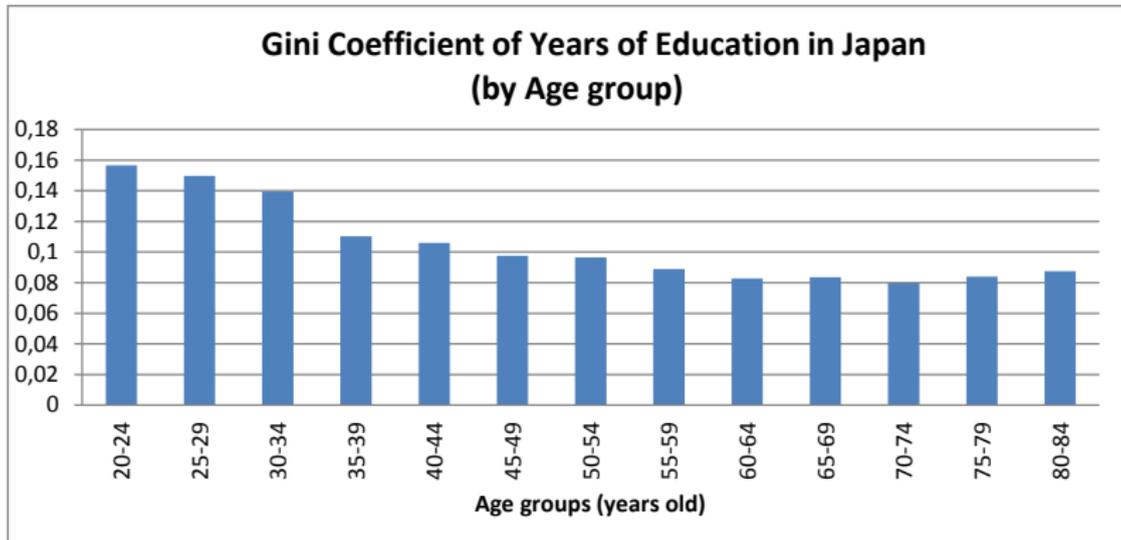
Figure 3: Poverty rates by household type, mid-2000s



Source: "Growing Unequal? Income Distribution and Poverty in OECD Countries," OECD, 2008

Note: Countries are ranked, from left to right, in increasing order of the poverty rate of households without children (in the top panel) and of those with children (in the bottom one). Data refer to all households, irrespectively of the age of the household head. **Poverty thresholds are set at 50% of the median income of the entire population.**

Figure 4: Educational Inequality Among Age Groups

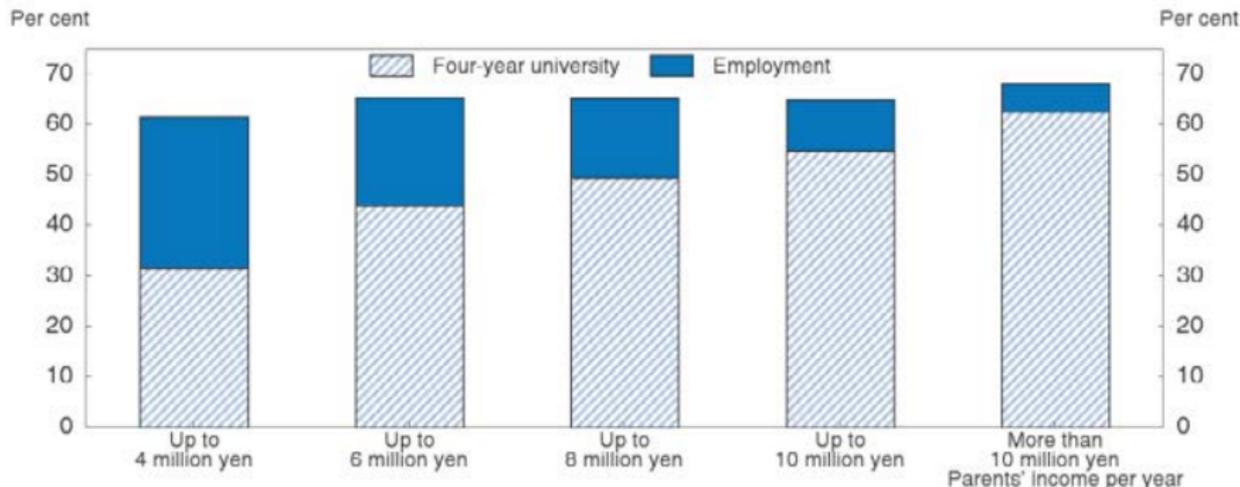


Source: Figure from Ohtake et al., 2013. International Social Survey Programme (Mechi and Scervini (2010): A new dataset on educational inequality).

Note: Gini coefficients of years of education are listed separately by birth cohort. The weighted average of Gini coefficients over all age groups is 0.103677, where the weight is the population in each age group.

**Figure 5:** Family income plays a key role in determining students' path following high school graduation

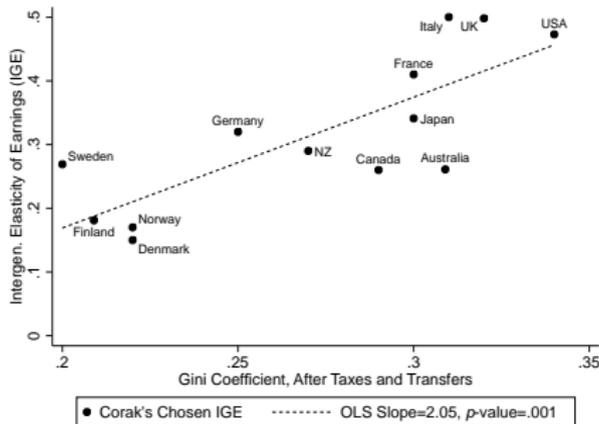
## Percent of High School Graduates



Source: Ministry of Education, Culture, Sports, Science and Technology (2009).

# Intergenerational Mobility and Inequality: The “Gatsby Curve”

$$\text{IGE: } \underbrace{\ln Y_1}_{\text{Income in current generation}} = \alpha + \beta \underbrace{\ln Y_0}_{\text{Income of parents}} + \varepsilon$$



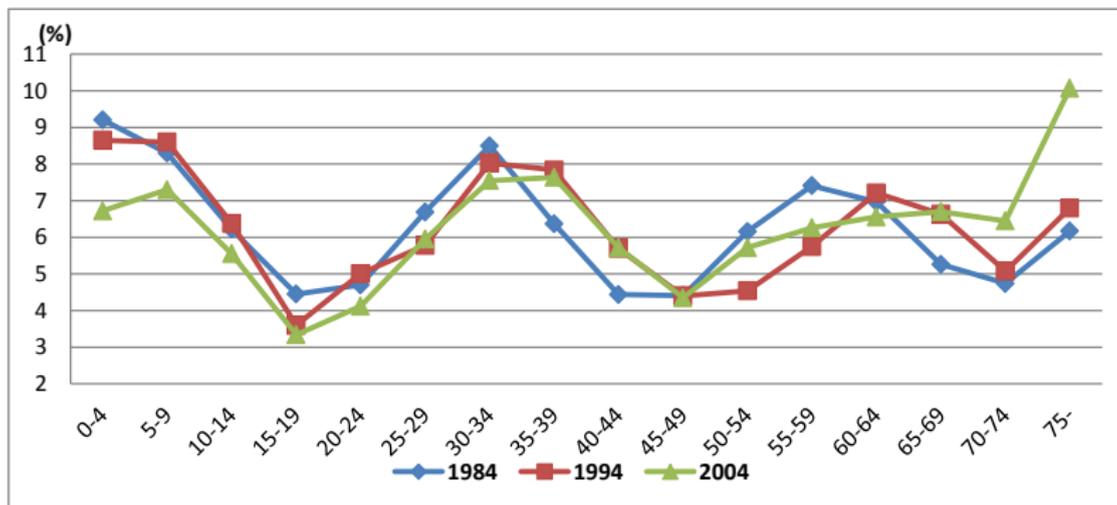
Source: Bradley J. Setzler (2014)

Note:

- Inequality is measured **after-taxes and transfers**.
- Gini index defined on **household** income.
- IGE measured by **pre-tax and transfer** income of **individual** fathers and sons.



**Figure 6:** Age Distribution of the Poor: Percentage of Poor within Age Group



*Source:* Figure from Ohtake et al., 2013. Authors calculations using micro data taken from the NSFIE.

*Note:* The figure shows the percentage of “the poor” within each age category. The poor includes those whose income is less than or equal to the national median income, after taking equivalent scale of income (household income is divided by the square root of the number of household members).

- (a) Should there be policies that attempt to lower the IGE?**
- (b) If so, what form should they take?**

## **Becker-Tomes-Solon** (Basic Framework used in Literature)

Heritability  $\uparrow \beta \uparrow$

Efficiency of parental investment  $\uparrow \beta \uparrow$

Inequality in wages  $\uparrow \beta \uparrow$

Inequality of public provision of investment  $\uparrow \beta \uparrow$

## Main Findings of the Literature

## 1. Multiple Skills

Multiple skills vitally affect performance in life across a variety of dimensions. A large body of evidence shows that cognitive and noncognitive skills affect labor market outcomes, the likelihood of marrying and divorcing, the likelihood of receiving welfare, voting, and health.

## 2. Gaps in Skills

Gaps in skills between individuals and across socioeconomic groups open up at early ages for both cognitive and noncognitive skills. Many measures show near-parallelism during the school years across children of parents from different socioeconomic backgrounds, even though schooling quality is very unequal.

### 3. Capabilities Can Be Created by Investment

The early emergence of skill gaps might be interpreted as the manifestation of genetics: Smart parents earn more, achieve more, and have smarter children. A body of strong experimental evidence shows the powerful role of parenting and environments, including mentors and teachers in shaping skills.

Genes are important, but skills are not solely genetically determined. The role of heritability is exaggerated in many studies and in popular discussions. Genes need sufficiently rich environments to fully express themselves. There is mounting evidence that gene expression is itself mediated by environments. Epigenetics informs us that environmental influences are partly heritable.

## 4. Critical and Sensitive Periods in the Technology of Skill Formation

There is compelling evidence for critical and sensitive periods in the development of a child. Different capacities are malleable at different stages of the life cycle. For example, IQ is rank stable after age 10, whereas personality skills are malleable through adolescence and into early adulthood. A substantial body of evidence from numerous disciplines shows the persistence of early life disadvantage in shaping later life outcomes. Early life environments are important for explaining a variety of diverse outcomes, such as crime, health, education, occupation, social engagement, trust, and voting.

## 5. Family Investments

Gaps in skills by age across different socioeconomic groups have counterparts in gaps in family investments and environments. Children from disadvantaged environments are exposed to a substantially less rich vocabulary than children from more advantaged families. At age three, children from professional families speak 50% more words than children from working-class families and more than twice as many compared to children from welfare families. There is a substantial literature showing that disadvantaged children have compromised early environments as measured on a variety of dimensions. Recent evidence documents the lack of parenting knowledge among disadvantaged parents. Parenting styles in disadvantaged families are much less supportive of learning and encouraging child exploration.



## 6. Resilience and Targeted Investment

Although early life conditions are important, there is considerable evidence of resilience and subsequent partial recovery. To our knowledge, there is no evidence of full recovery from initial disadvantage. The most effective adolescent interventions target the formation of personality, socioemotional, and character skills through mentoring and guidance, including providing information. This evidence is consistent with the greater malleability of personality and character skills into adolescence and young adulthood. The body of evidence to date shows that, as currently implemented, many later life remediation efforts are not effective in improving capacities and life outcomes of children from disadvantaged environments. As a general rule, the economic returns to these programs are smaller compared to those policies aimed at closing gaps earlier.



However, workplace-based adolescent intervention programs and apprenticeship programs with mentoring, surrogate parenting, and guidance show promising results. They appear to foster character skills, such as increasing self-confidence, teamwork ability, autonomy, and discipline, which are often lacking in disadvantaged youth. In recent programs with only short-term follow-ups, mentoring programs in schools that provide students with information that improves their use of capacities have also been shown to be effective.

## 7. Parent-child/Mentor-child Interactions Play Key Roles in Promoting Child Learning

A recurrent finding from the family influence and intervention literatures is the crucial role of child-parent/child-mentor relationships that “scaffold” the child (i.e., track the child closely, encourage the child to take feasible next steps forward in his or her “proximal zone of development,” and do not bore or discourage the child). Successful interventions across the life cycle share this feature. The child as an “*emergent*” system.

## 8. High Returns to Early Investment

Despite the generally low returns to interventions targeted toward the cognitive skills of disadvantaged adolescents, the empirical literature shows high economic returns for investments in young disadvantaged children. There is compelling evidence that high-quality interventions targeted to the early years are effective in promoting skills. This is a manifestation of **“dynamic complementarity”**.

Children enter school with “meaningful differences” in vocabulary knowledge.

### 1. Emergence of the Problem

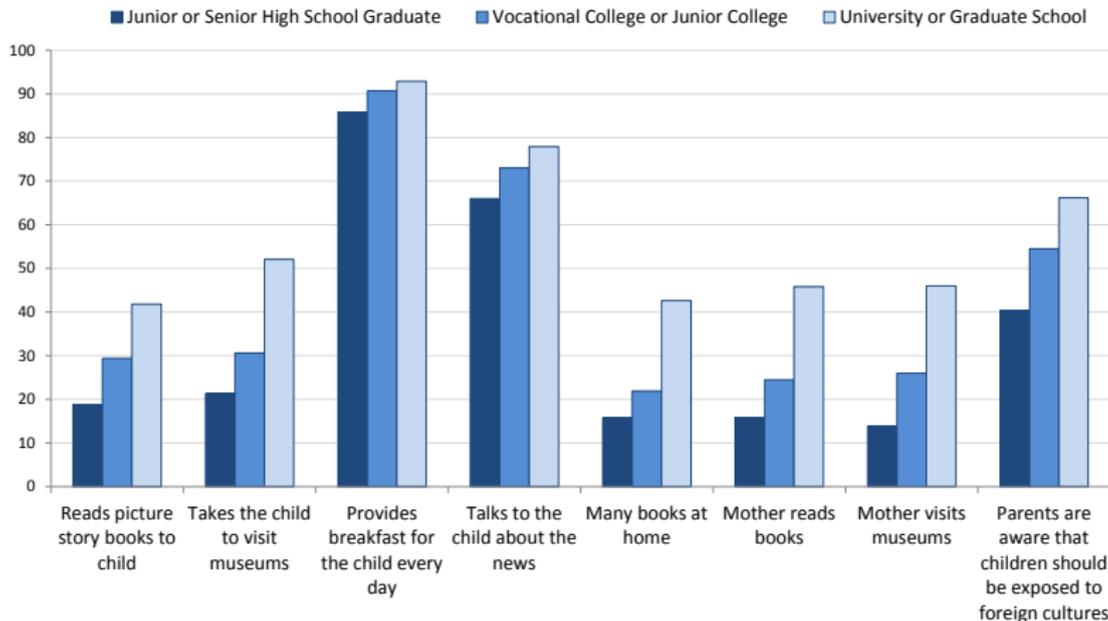
In a typical hour, the average child hears:

Family Status	Actual Differences in <u>Quantity</u> of Words Heard	Actual Differences in <u>Quality</u> of Words Heard
Welfare	616 words	5 affirmatives, 11 prohibitions
Working Class	1,251 words	12 affirmatives, 7 prohibitions
Professional	2,153 words	32 affirmatives, 5 prohibitions

### 2. Cumulative Vocabulary at Age 3

Cumulative Vocabulary at Age 3	
Children from welfare families:	500 words
Children from working class families:	700 words
Children from professional families:	1,100 words

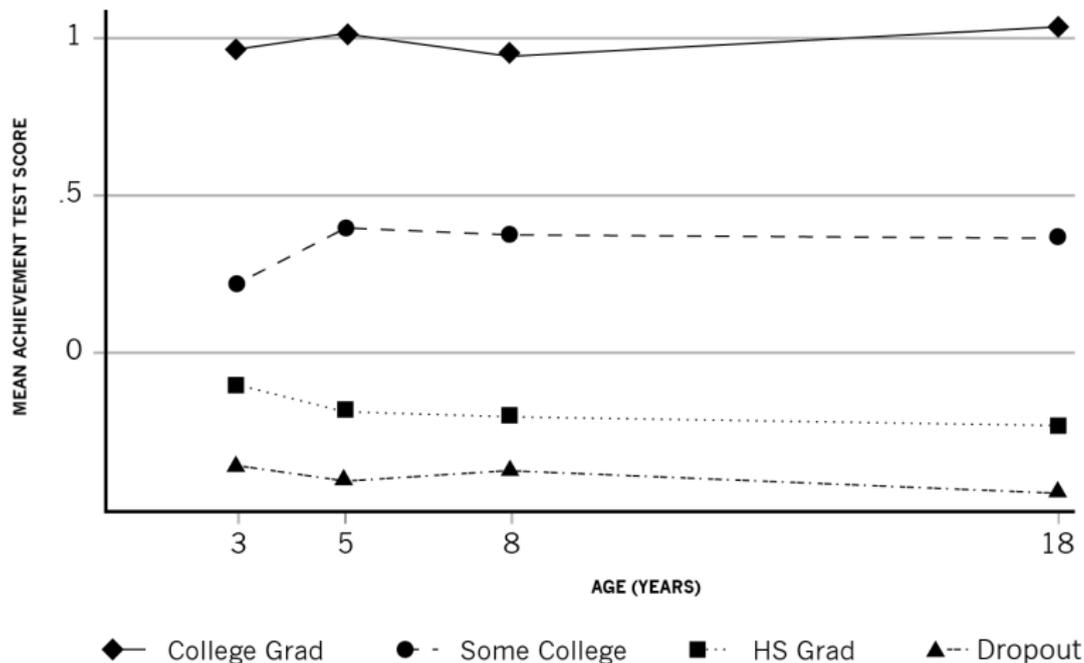
**Figure 7:** Relation between the mother's educational background and her educational awareness and behavior (%)



Source: Takashi HAMANO, 2010

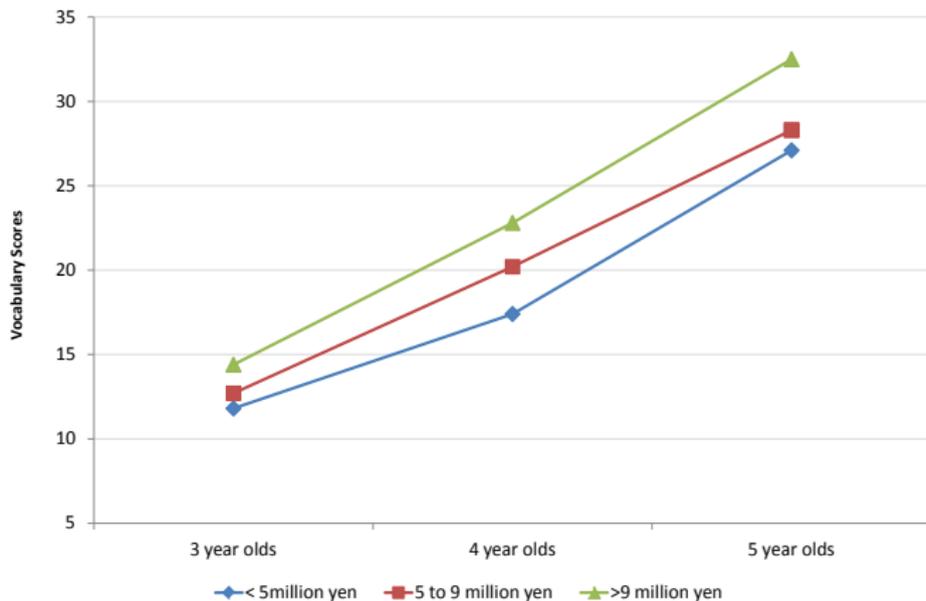
## Gaps Open Up Early

Figure 8: Mean Achievement Test Scores by Age by Maternal Education



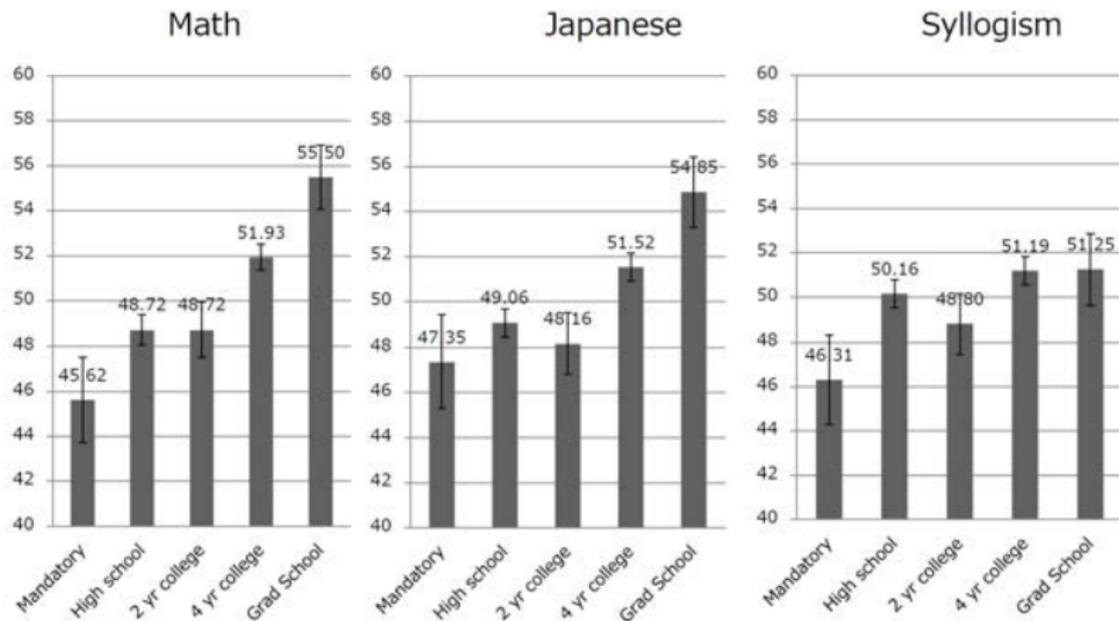
Each score standardized within observed sample. Using all observations and assuming data missing at random. Source: Brook-Gunn et al. (2006).

## Lexical Ability of Children by Annual Household Income



**Note:** Lexical Ability is measured by Picture Vocabulary Test (PVT). PVT measure the degree of development of language comprehension, in particular, basic “vocabulary comprehension.” The test is used internationally and asks children to perform such tasks as choosing the most appropriate picture from a set of four for a word given by the examiner.

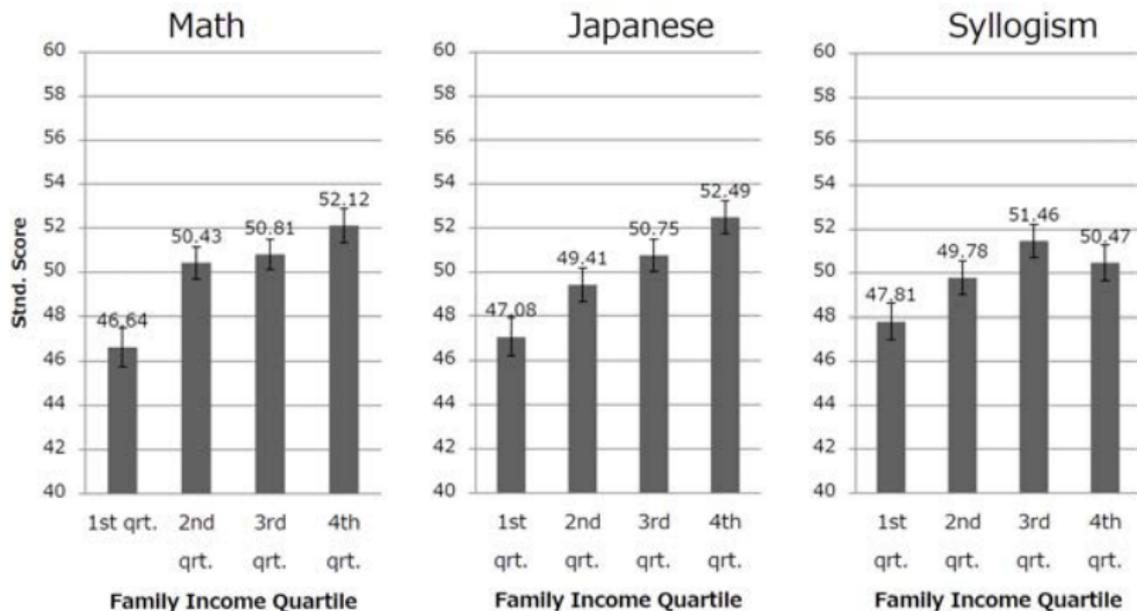
Figure 9: Father's Education



Source: Akabayashi et al., 2013

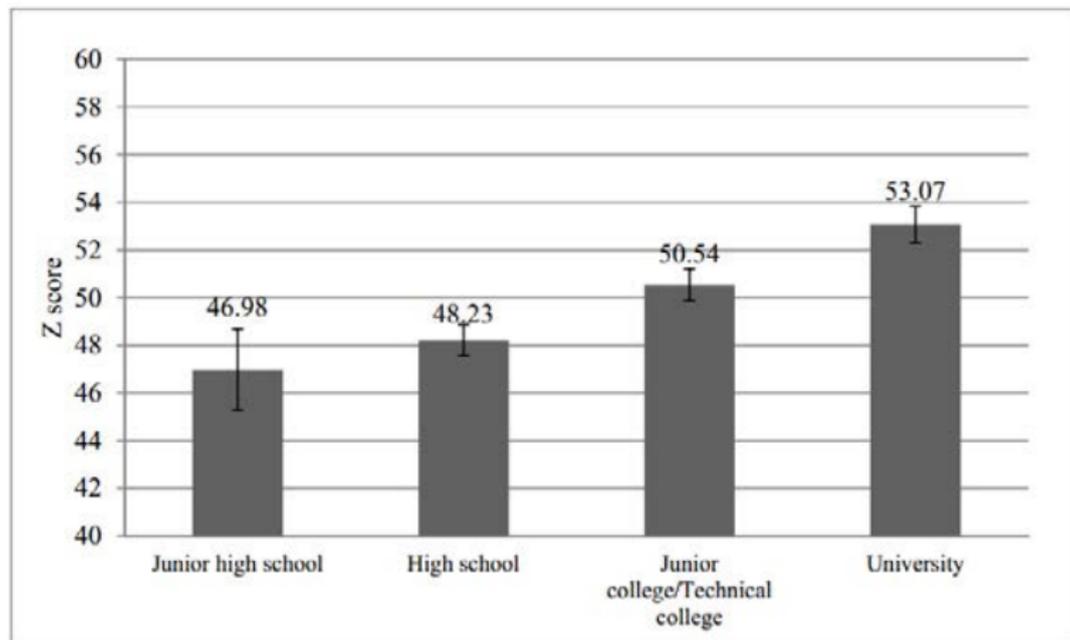
# Family Background and Cognitive Measures

Figure 10: Family Income



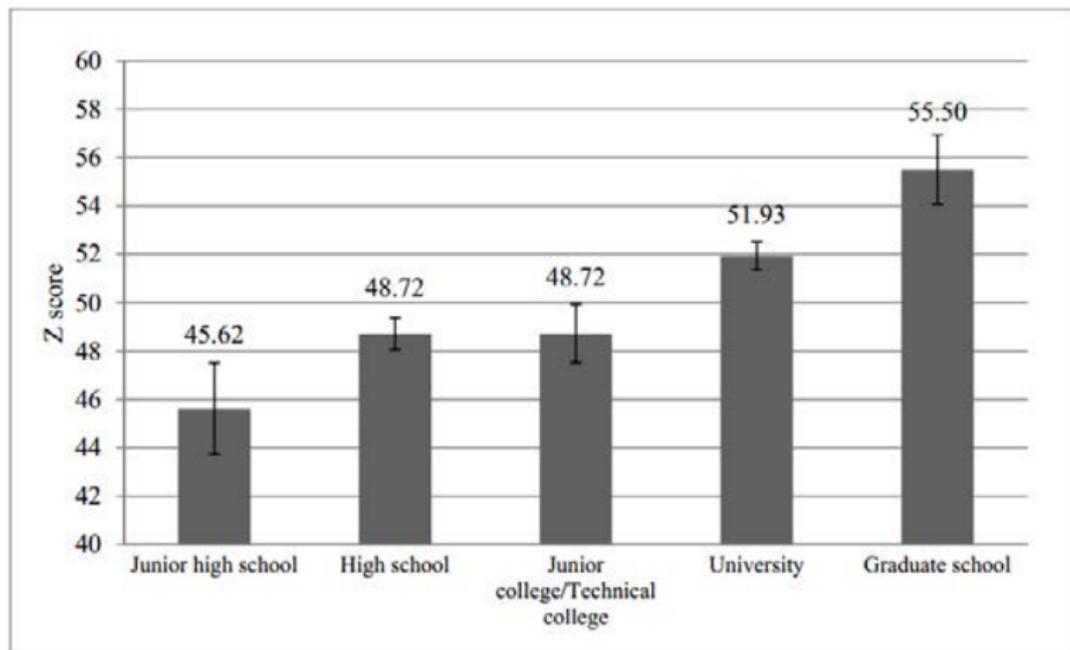
Source: Akabayashi et al., 2013

**Figure 11:** Mother's educational attainment and level of academic ability, Mathematics



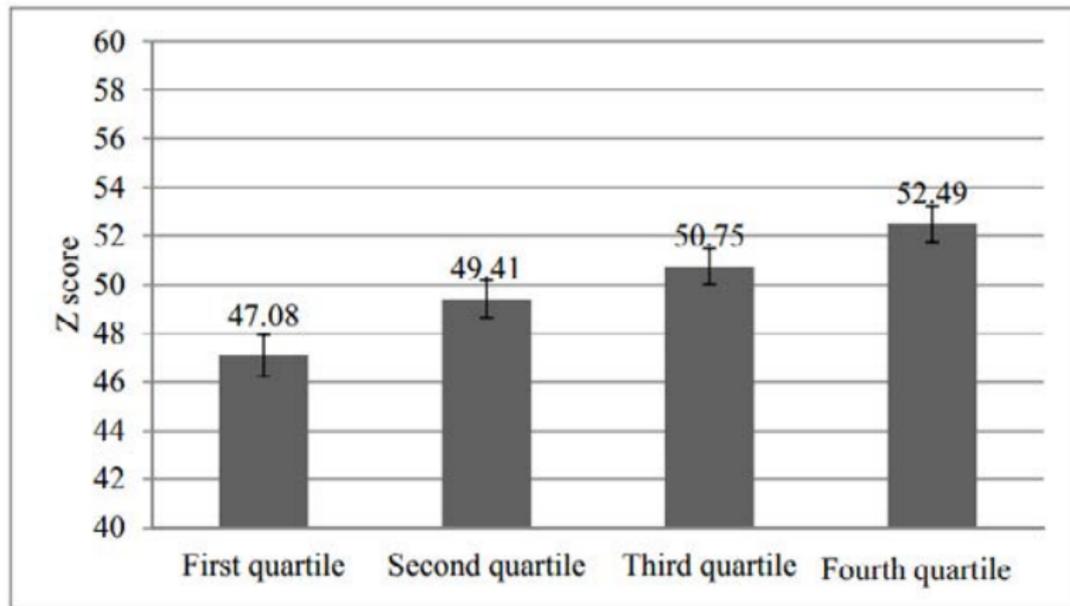
Source: Akabayashi et al. (2013).

**Figure 12:** Father's educational attainment and level of academic ability, Mathematics



Source: Akabayashi et al. (2013).

Figure 13: Family income and academic ability, Mathematics



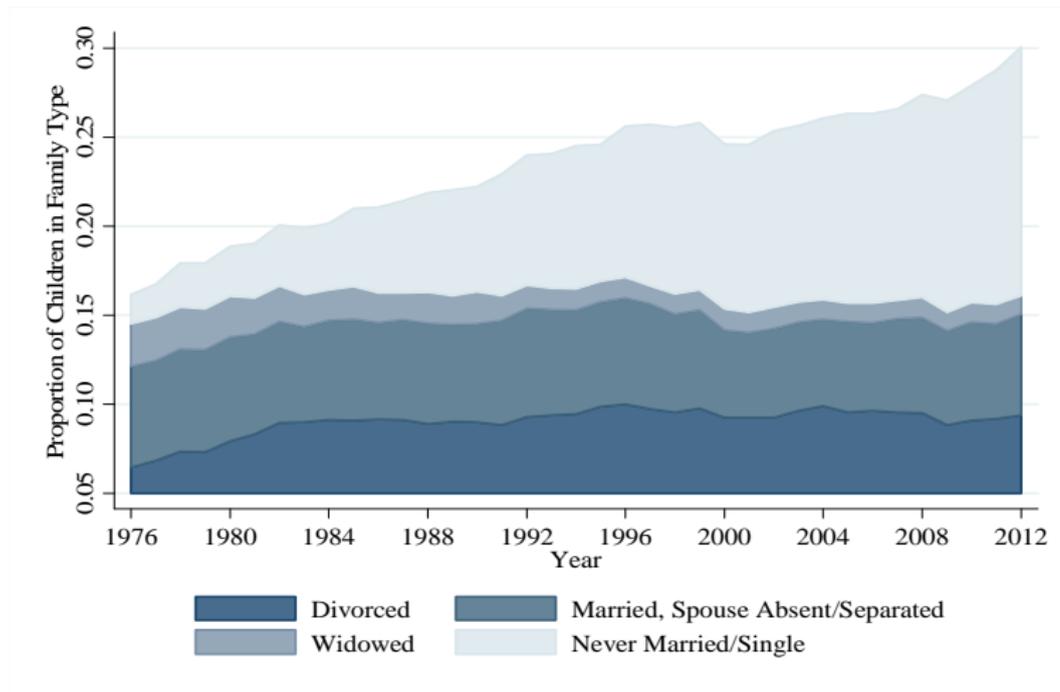
Source: Akabayashi et al. (2013).

## Source of Gaps

- Is it due to genes?
- Family environments?
- Parenting and family investment decisions?
- Schools?

## Trends in Family Environments

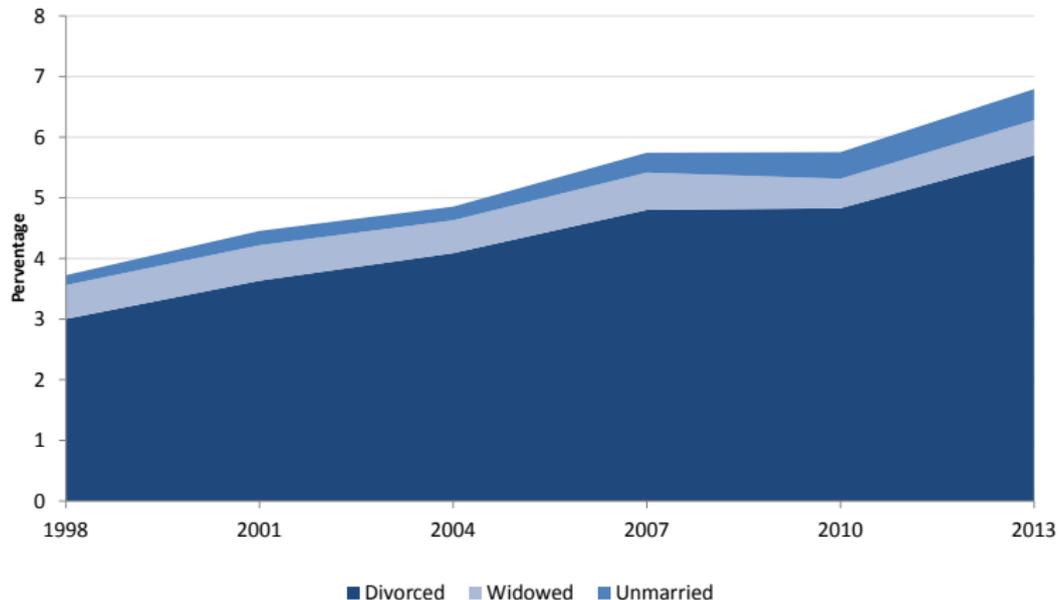
## Children Under 18 Living in Single Parent Households by Marital Status of Parent



Source: IPUMS March CPS 1976-2012

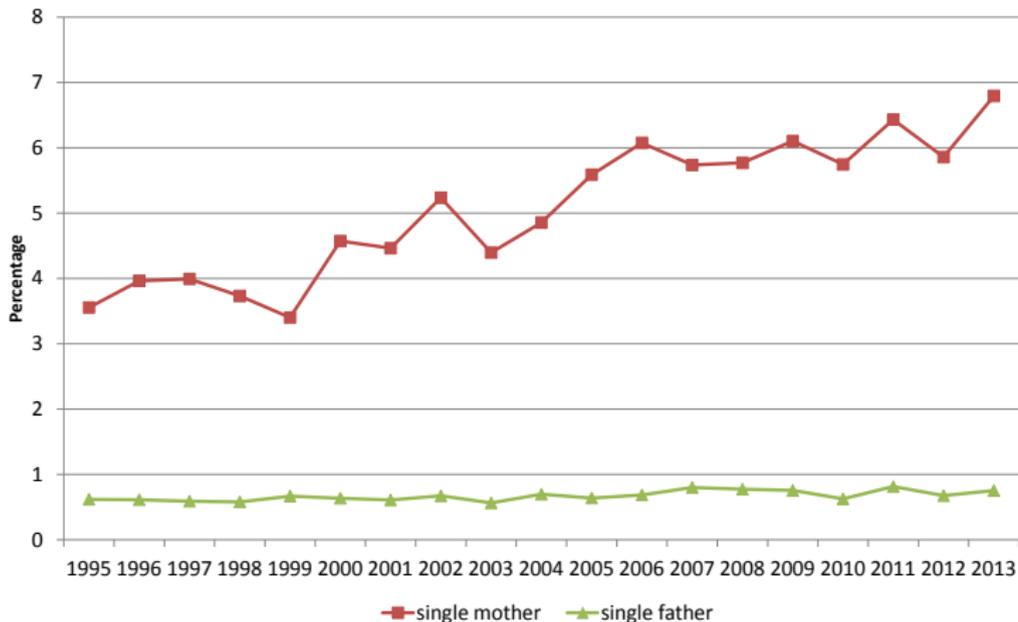
Note: Parents are defined as the head of the household. Children are defined as individuals under 18, living in the household, and the child of the head of household. Children who have been married or are not living with their parents are excluded from the calculation. Separated parents are included in "Married, Spouse Absent" Category

## Children Under 20 Living in Single Parent Households by Marital Status of Single Mother (Japan)



Source: Comprehensive Survey of Living Condition

## Single Parent Households Among Households with Children under 20 in Japan



Source: Comprehensive Survey of Living Condition

# Capabilities, the Technology of Capability Formation, and the Essential Ingredients of a Life Cycle Model of Human Development

**Capabilities are defined as the *real freedoms* people have to achieve and the beings and doings that they value and have reason to value  
(Sen, 1979, 1985, 1992; Nussbaum and Sen, 1993).**

- Capabilities are **multiple** in nature.
- More than just cognition of IQ.
- Non-cognitive skills.
- They encompass cognition, noncognitive and social preferences and personality and preference traits, as well as health.
- **Vector of capabilities** at age  $t$ :  $\theta_t$ .
- Capacities to act.
- Capabilities affect (a) resource constraints, (b) agent information sets and expectations, (c) parental information and expectations and (d) preferences.
- **They are stable across situations but evolve over time.**

Define relationships  $M_t$  mapping  $\theta_t$  to outcomes  $Y_t$  at stage  $t$  of the life cycle as:

$$M_t : \theta_t \rightarrow Y_t. \quad (1)$$

A core *low-dimensional* set of capacities generates a variety of diverse outcomes.

## Technology of Capability Formation

Cunha and Heckman (2007), Cunha (2007)

$\theta_t$ : a vector

$$\theta_{t+1} = f_t \left( \underbrace{\theta_t}_{\substack{\text{self productivity} \\ \text{and cross effects}}}, \underbrace{I_t}_{\substack{\text{investment} \\ \text{broadly defined} \\ \text{(parents, environment)}}}, \underbrace{\theta_{P,t}}_{\substack{\text{parental} \\ \text{capabilities}}} \right) \quad (2)$$

## Complementarity Increases with Age

$$\frac{\partial^2 \theta_{t+1}}{\partial \theta_t \partial I'_t} \uparrow t \uparrow .$$

**Positive at later stages ( $t > t^*$ ) of childhood**

$$\frac{\partial^2 \theta_{t+1}}{\partial \theta_t \partial I_t'} > 0, \quad t > t^*.$$

Some evidence suggesting

$$\frac{\partial^2 \theta_{t+1}}{\partial \theta_t \partial I_t'} \leq 0, \quad t < t^*,$$

But even if positive, still smaller than at  $t > t^*$ .

Complementarity coupled with self-productivity  $\Rightarrow$

**Dynamic Complementarity**

$$\begin{aligned} & \mathbf{I}_t \uparrow \quad \boldsymbol{\theta}_{t+1} \uparrow \\ \boldsymbol{\theta}_{t+1} \uparrow & \Rightarrow \boldsymbol{\theta}_{t+s} \uparrow \quad s > 1 \end{aligned}$$

$$\therefore \frac{\partial^2 \boldsymbol{\theta}_{t+s+1}}{\partial \mathbf{I}_t \partial \mathbf{I}'_{t+s}} > 0$$

## **Family Preferences for Child Outcomes**

Different versions of altruism, paternalism and beliefs about “proper” child rearing

**Family Resources Broadly Defined:  
Parental and Child Interactions  
with Financial Markets and Access to Support from External  
Institutions**

- (a) Restrictions on transfers across generations
- (b) Restrictions on transfers within generations (parental lifetime liquidity constraints)
- (c) Public provision of investment; public policy towards children

## Other Constraints on The Family Actively Being Investigated

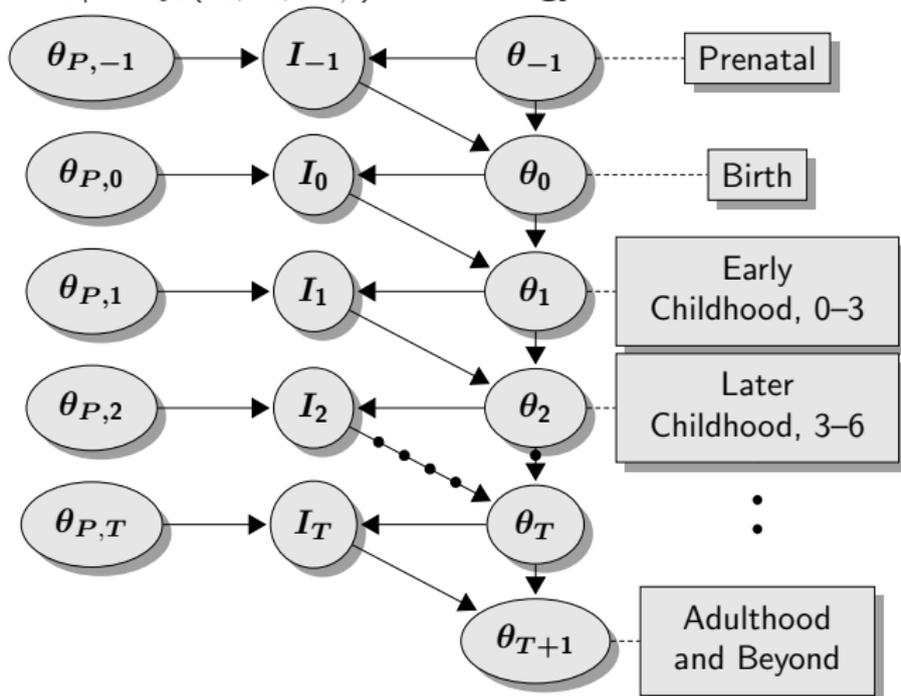
- (a) **Information** on parenting and other aspects of life across generations
- (b) Genes
- (c) Structure of household and assortative matching patterns (marriage markets)

# The Empirical and Theoretical Challenge

## A Life Cycle Framework for Organizing Studies and Integrating Evidence

$\theta_t$ : Capacities at  $t$ ;  $I_t$ : investment at  $t$ ;  $\theta_{P,t}$ : Parental environmental variables

$\theta_{t+1} = f_t(\theta_t, I_t, \theta_{P,t})$ : Technology of Skill Formation



# Bare-Bones Models of Parental Investment

Life lasts four periods:

- Two periods as a passive child who makes no economic decisions (and whose consumption is ignored) but who receives investment in the form of goods.
- Two periods as a parent.

Denote by  $\theta_1$  the initial capability level of a child drawn from the distribution  $J(\theta_1)$ .

(For notational simplicity, denote  $\theta_{P,t} = \theta_P = h$ .)

Denoting by  $h'$  the human capital of the child when child reaches adulthood

## Simplified parameterization of technology:

$$\theta_{t+1} = \delta_t \left\{ \gamma_{1,t} \theta_t^{\phi_t} + \underbrace{\gamma_{2,t} l_t^{\phi_t}}_{\text{investment}} + \underbrace{\gamma_{3,t} h_t^{\phi_t}}_{\text{parental human capital}} \right\}^{\frac{\rho_t}{\phi_t}}$$

with  $0 < \gamma_{1,t}, \gamma_{2,t}, \gamma_{3,t}, \rho_t \leq 1$ ,  $\phi_t \leq 1$ ,  $\sum_k \gamma_{k,n_t} = 1$ .

## Final Form Representation

If  $T = 2$ ,  $\rho_1 = \rho_2 = 1$ ,  $\delta_1 = 1$ , and  $\phi_1 = \phi_2 = \phi \leq 1$ , skills at adulthood,  $h' = \theta_3 = \theta_{T+1}$  can be written as

$$h' = \delta_2 \left[ \gamma_{1,2} \gamma_{1,1} \theta_1^\phi + \underbrace{\gamma_{1,2} \gamma_{2,1}}_{\text{"Multiplier"}} l_1^\phi + \gamma_{2,2} l_2^\phi + (\gamma_{3,2} + \gamma_{1,2} \gamma_{3,1}) h^\phi \right]^{\frac{1}{\phi}} .$$

- Polar example arises in the Leontief case where  $\phi \rightarrow -\infty$ :

$$h' = m_2(h, \theta_0, \min(l_1, l_2)) \quad (3)$$

- $u(\cdot)$ : parental utility function
- $\beta$ : discount factor
- $r$ : real interest rate
- $v$ : parental altruism
- $c_1, c_2$  are consumption in parental life cycle periods 1 and 2

The goal of the parent is to optimize:

$$V(h, b, \theta_1) = \max_{c_1, c_2, l_1, l_2} \{u(c_1) + \beta u(c_2) + \beta^2 v \mathbb{E}[V(h', b', \theta'_1)]\} \quad (4)$$

subject to technology and budget constraints.

Budget constraint is:

$$c_1 + l_1 + \frac{c_2 + l_2}{(1+r)} + \frac{b'}{(1+r)^2} = wh + \frac{wh}{(1+r)} + b. \quad (5)$$

- Tractable final form technology:

$$h' = m_2 \left( h, \theta_0, \left[ \underbrace{\gamma}_{\text{investment multiplier}} (I_1)^\phi + (1 - \gamma) (I_2)^\phi \right]^{\frac{\rho}{\phi}} \right), \quad (6)$$

for  $\phi \leq 1$  and  $0 \leq \gamma \leq 1, \rho \leq 1$ .

$$\frac{l_1}{l_2} = \left[ \frac{\gamma}{(1-\gamma)(1+r)} \right]^{\frac{\rho}{1-\phi}}. \quad (7)$$

$\frac{l_1}{l_2} \uparrow$  as  $\gamma \uparrow$ ,  $\phi \uparrow$ ,  $\rho \uparrow$  and  $r \downarrow$ .

- Important policy question: How easy (costly) is it to remediate low  $I_1$  with high  $I_2$ ?

## Implications of the Model

# Borrowing Limits

## Liquidity Constraints Within the Life Cycles of Parents

- The **parent, within his/her lifetime**, faces a sequence of constraints at each stage of the life of the child.

Denoting parental financial assets by  $a$  and allowing parental labor market productivity to grow at exogenous rate  $g$ , these budget constraints can be represented by a sequence of constraints:

$$c_1 + l_1 + \frac{a}{(1+r)} = wh + b \quad (8)$$

and

$$c_2 + l_2 + \frac{b'}{(1+r)} = w(1+g)h + a \quad (9)$$

and the borrowing constraints  $a \geq \underline{a}$  and  $b' \geq 0$ .

Assume that  $\underline{a} \geq 0$ : parents cannot borrow against their own future income.

Child investments at different ages are not perfect substitutes ( $\phi < 1$ ).

Parental utility:  $u(c) = (c^\lambda - 1)/\lambda$ .

$$\frac{l_1}{l_2} = \underbrace{\left( \frac{\gamma}{(1-\gamma)(1+r)} \right)^{\frac{1}{1-\phi}}}_{\text{unconstrained ratio}} \underbrace{[\beta(1+r)]^{\frac{1}{1-\phi}} \left( \frac{c_1}{c_2} \right)^{\frac{1-\lambda}{1-\phi}}}_{\substack{=1 \text{ if unconstrained,} \\ <1 \text{ if constrained}}}. \quad (10)$$

$$\lambda \leq 1$$

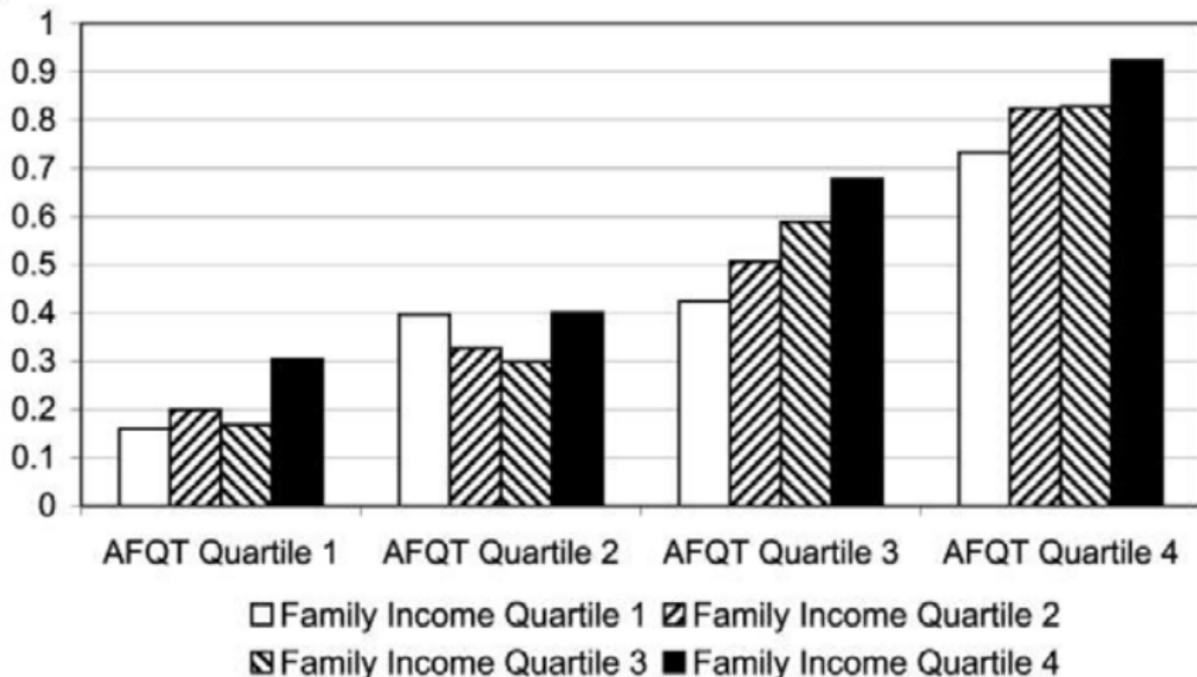
- Cunha, Heckman, and Schennach (2010):  
 $1/(1 - \phi) = .\bar{3}$  ( $\phi \doteq -2$ ).
- Attanasio and Browning (1995):  $\lambda \in [-3, -1.5]$
- $(1 - \lambda)/(1 - \phi) \in [0.8\bar{3}, 1.\bar{3}]$ . Family resource influence on *relative* investment.
- Dynamic complementarity coupled with borrowing constraints in the early years raises a potentially serious market imperfection.

## Introducing income uncertainty

# **Empirical Estimates of Credit Constraints and the Effects of Family Income on Child Outcomes**

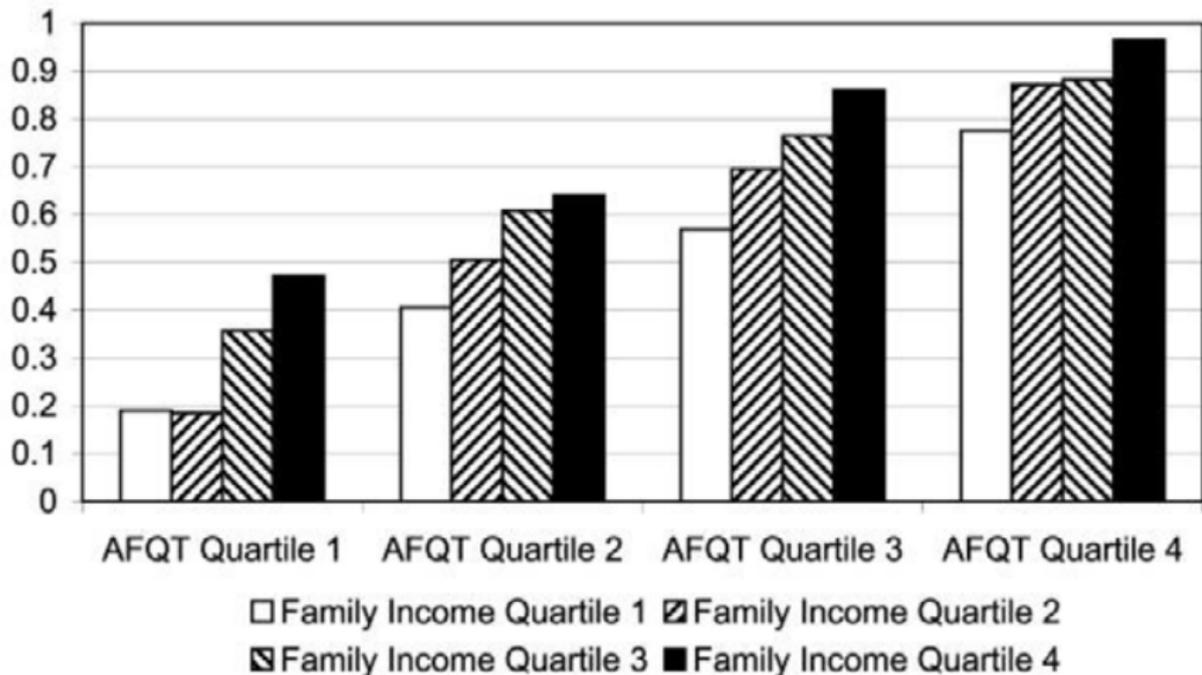
# Recent Evidence on the Importance of Credit Constraints and Family Income

## College attendance by AFQT and Family Income Quartiles (1979)



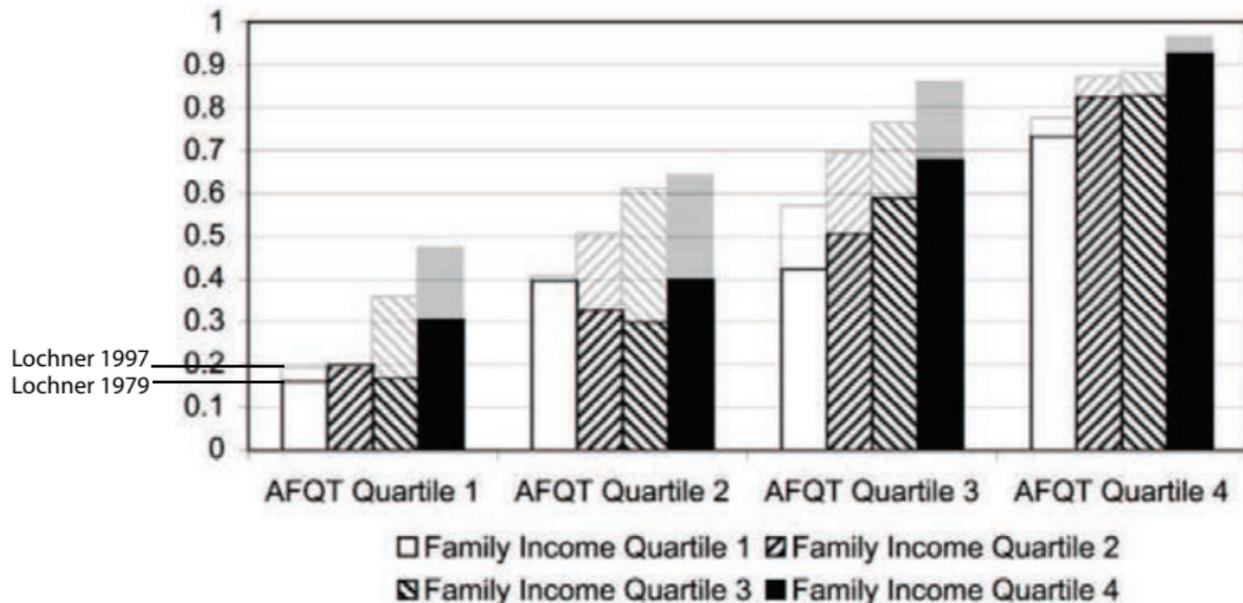
Source: Belley and Lochner (2007).

## College attendance by AFQT and Family Income Quartiles (1997)



Source: Belley and Lochner (2007).

# College attendance by AFQT and Family Income Quartiles (1979 and 1997 placed on one graph)



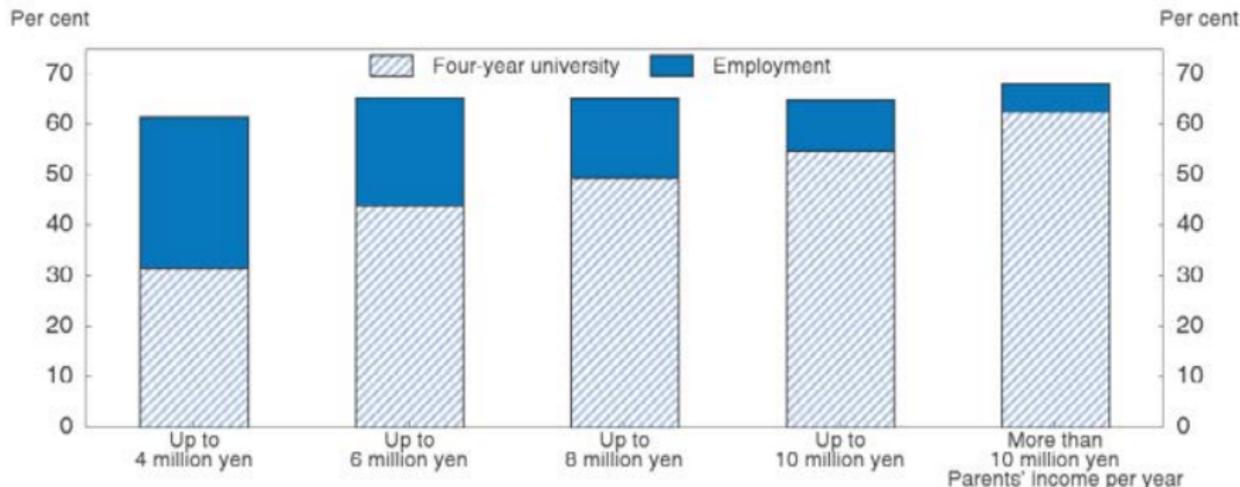
Source: Belley and Lochner (2007).

- More people going to college at **virtually all quartiles of ability and income**.
- Increases in college going is strongest for the lowest ability group, especially less able children with richer parents.

- This provides no firm evidence for or against credit constraints.

**Figure 14:** In Japan, family income plays a key role in determining students' path following high school graduation

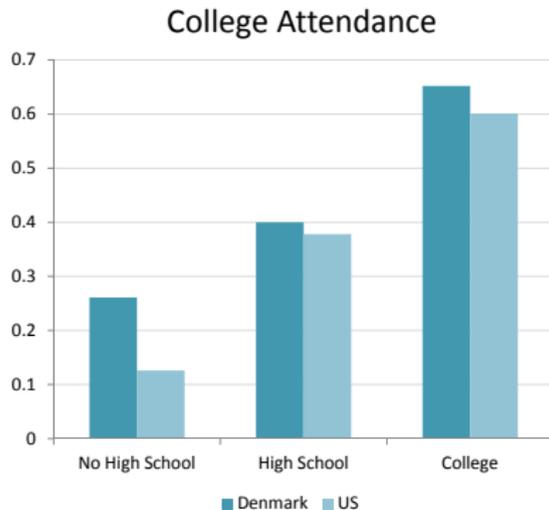
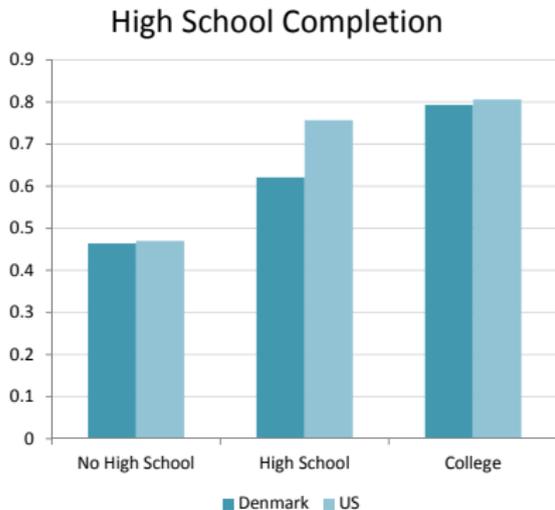
### Percent of High School Graduates



Source: Ministry of Education, Culture, Sports, Science and Technology (2009).

**Do these problems disappear in the welfare state? Compare Denmark and the U.S.**

## High School Completion and College Attendance by Mother's Education Denmark and US

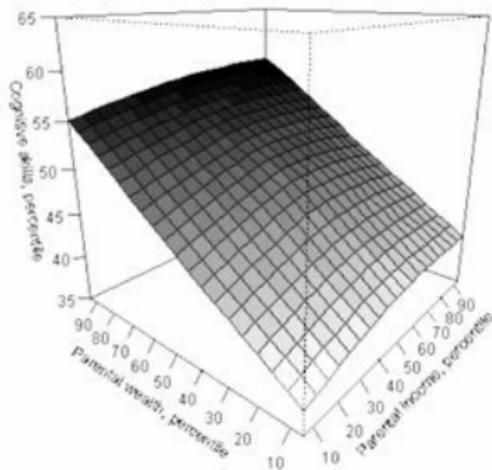


Source: Rasmus Landers

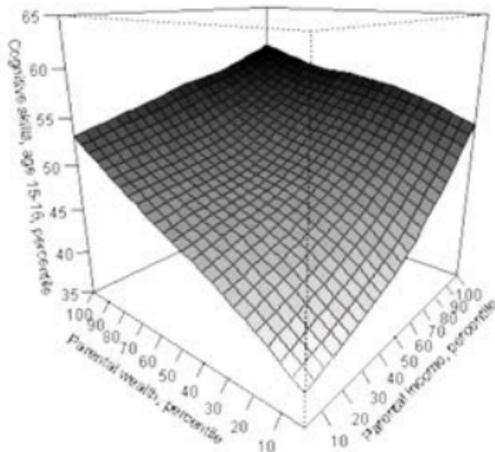
Note: Observation Denmark 33,954; CNLSY 3,268

Figure 15: Cognitive skills at age 15-16 and parental income / wealth

(a) CNLSY



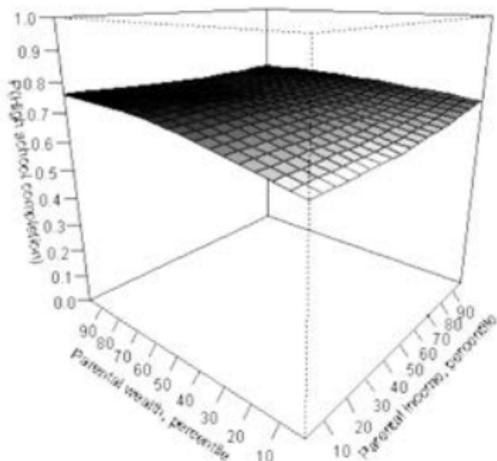
(b) Denmark



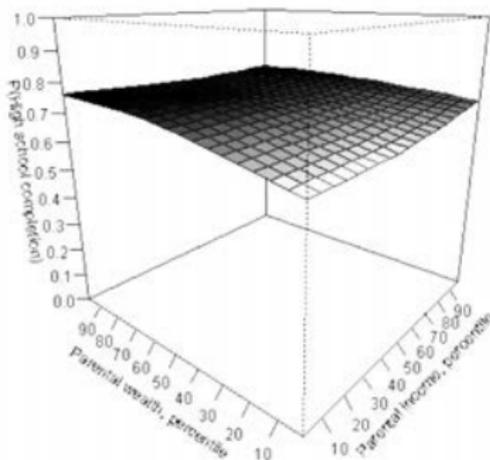
Source: Rasmus Landersø

Figure 16: High school completion by parental income and wealth —  $\theta^C$ ,  $\theta^{N,C}$

(a) CNLSY



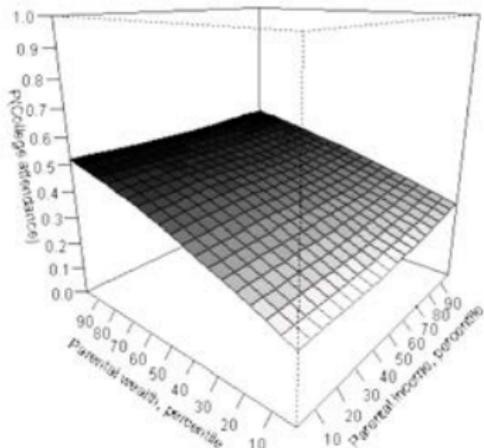
(b) Denmark



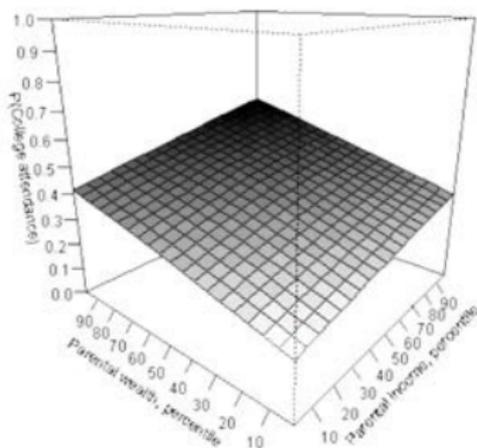
Source: Rasmus Landersø

Figure 17: College attendance by parental income and wealth —  $\theta^C$ ,  $\theta^{N,C}$

(a) CNLSY



(b) Denmark



Source: Rasmus Landersø

# **Studies on the role of income on children's outcomes and on credit constraints**

# Summary of the Evidence on Family Income, Credit Constraints, and Child Development

- The literature on credit constraints and family income shows that higher levels of parental resources, broadly defined, promote child outcomes.
- However, a clear separation of parental resources into pure income flows, parental environmental variables and parental investment has not yet been done.
- It is **premature** to advocate pure income transfer policies as effective ways for promoting child welfare and promoting social mobility.
- What studies exist suggest **very weak** effects of income transfers on childhood test scores.
- The evidence from the structural models supports this conclusion.
- Many of the studies show effects of prices, not constraints or pure income.

# Structural Models of Parental Investment

## Recent Extensions

- (a) Parental time (mother and father) (Del Boca et al., 2013; Gayle et al., 2013)
- (b) Role of multiple parents (Del Boca et al., 2013; Gayle et al., 2013)
- (c) Multiple children (Del Boca et al., 2013; Gayle et al., 2013)
- (d) Parental learning about technology (Badev and Cunha, 2012; Cunha, 2012; Cunha et al., 2013)
- (e) Fertility (Gayle et al., 2013)
- (f) Marriage market (Gayle et al., 2013)
- (g) Multiple capabilities (Cunha and Heckman, 2008; Cunha, Heckman, and Schennach, 2010)

## Estimates of the Technology of Capability Formation in the Literature

- (a) Most of literature focuses on *cognitive skill* technology
- (b) Noncognitive skills recently introduced (Cunha and Heckman)
- (c) Noncognitive skills foster production of cognitive skills
- (d) Most analysts use linear technologies
- (e) Nonlinearity essential to capture dynamic complementarity
- (f) When estimated complementarity **increases** with the stage of the life cycle (dynamic complementarity)
- (g) Measurement error empirically important

# Estimates of Technologies of Capability Formation and Some Implications

## Investment with Multiple Children

Representation for the utility parents receive from  $N$  children:

$$V^c = \left( \sum_{k=1}^N \omega_k V_k^\sigma \right)^{\frac{1}{\sigma}} \quad (11)$$

where  $V_k$  represents the relevant outcome for each child which is valued by parents Behrman et al. (1982).

# Targeting Relatively More Investment Toward Disadvantaged Children Can Be Socially Efficient

- **What is socially fair can also be economically efficient.**

## Summary of Main Results

- Roughly speaking, the more concave are the technologies in terms of stocks of skills, the more favorable is the case for investing relatively more in the disadvantaged child.
- The greater the second period complementarity ( $f_{12}^{(2)}$ ), the greater the case for investing more in the initially disadvantaged child to allow the child to benefit from greater second period complementarity of the stock of skills with second period investment.
- **In general, even when investment is greater in the first period for the disadvantaged child, second period investment is greater for the initially advantaged child.**
- **It is generally not efficient to make the initially disadvantaged child whole as it enters the second period when the effect of greater second period complementarity kicks in.**

# Testing and Operationalizing the Theory

# Capabilities as Determinants of Functionings

Decompose the  $\theta_t$  vector into three subvectors:

$$\theta_t = (\theta_{C,t}, \theta_{N,t}, \theta_{H,t}) \quad (12)$$

where  $\theta_{C,t}$  is a vector of cognitive abilities (e.g., IQ) at age  $t$ ,  $\theta_{N,t}$  is a vector of noncognitive abilities (e.g., patience, self-control, temperament, risk aversion, discipline, and neuroticism) at age  $t$ , and  $\theta_{H,t}$  is a vector of health stocks for mental and physical health at age  $t$ .

- Capabilities, combined with effort, incentives and purchased inputs determine **functionings**.

- Functionings (task  $j$ ) at age  $t$ :

$$Y_{j,t} = \psi_{j,t}(\boldsymbol{\theta}_t, e_{j,t}, \mathbf{X}_{j,t}), \quad j \in \{1, \dots, J_t\} \quad \text{and} \quad t \in \{1, \dots, 2T\} \quad (13)$$

- $Y_{j,t}$ : outcome from activity  $j$  at time  $t$
- $\boldsymbol{\theta}_t$  is the vector of capabilities at age  $t$
- $\mathbf{X}_{j,t}$  is a vector of purchased inputs that affect the functionings
- $e_{j,t}$  is effort in task
- $T$  is the length of childhood
- $T$  is the length of adulthood
- $2T$  is total **lifetime**

**Effort:**  $e_{j,t}$

$$e_{j,t} = \delta_j(\boldsymbol{\theta}_t, \mathbf{A}_t, \mathbf{X}_{j,t}, \mathbf{R}_{j,t}^a(\mathcal{I}_{t-1}) \mid u). \quad (14)$$

- $\mathbf{A}_t$ : environment
- $\mathbf{R}_{j,t}^a$ : incentives

**Estimating and Interpreting the Distribution of Capabilities,  
the Maps Between Capabilities and Functionings and the  
Technology of Capability Formation**

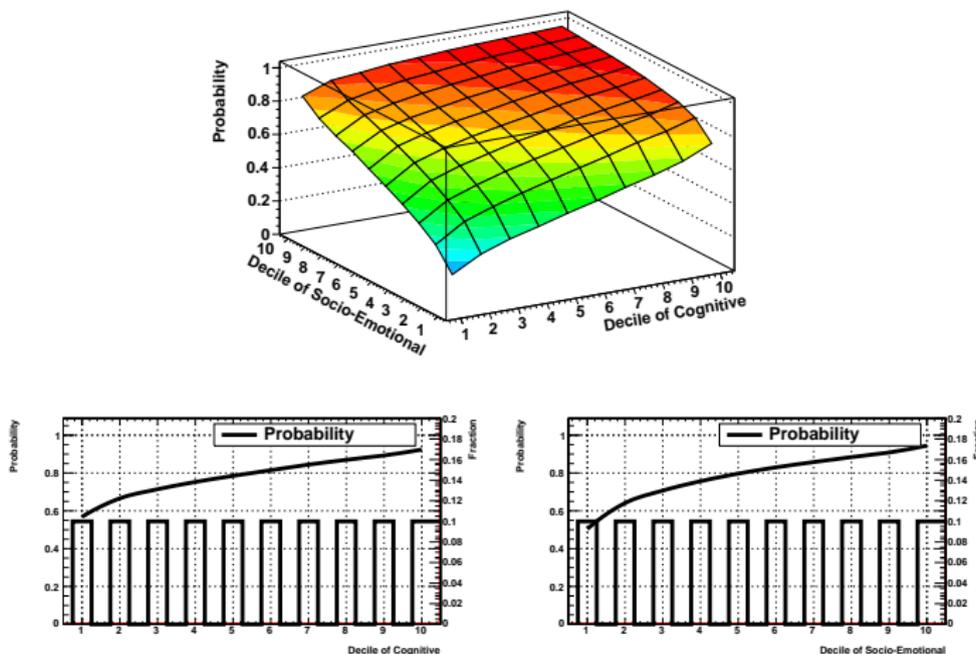
**Nonparametric Factor Models Are Natural Frameworks for Estimating Capabilities and Determining Frontier Capability Sets**

- **Low dimensional** capabilities (“factors”) generate a high dimensional set of functionings.
- Dimension and factor structures selected through a variety of methods.
- Exploratory factor analysis.
- Novel Bayesian procedures—avoid arbitrary methods in Exploratory Factor Analysis.

**Estimating Functionings and Extracting Factors:  
Multiple Capabilities Shape Human Achievement Across a  
Variety of Dimensions**

- The relationship between capabilities estimated in the recent literature and traditional preference parameters (time preference, leisure, risk aversion, etc.) is weak. Dohmen, Falk, et al. (2012)
- Suggests that a richer set of preference and constraint descriptions may characterize choice behavior.

**Figure 18:** The Probability of Educational Decisions, by Endowment Levels, Dropping from Secondary School vs. Graduating



Source: Heckman et al., 2011

The same low-dimensional vector of capabilities predicts a wide variety of outcomes for:

- Crime
- Wages
- Health
- Healthy behaviors (smoking, drug use)
- Trust
- Voting behavior
- Employment
- Participation in welfare

## Technology of Skill Formation



$$\theta_{k,t+1} = f_{s,k}(\theta_t, I_{k,t}, \theta_{P,t}) \quad (15)$$

for  $k \in \{C, N, H\}$ ,  $t \in \{1, 2, \dots, T\}$ .

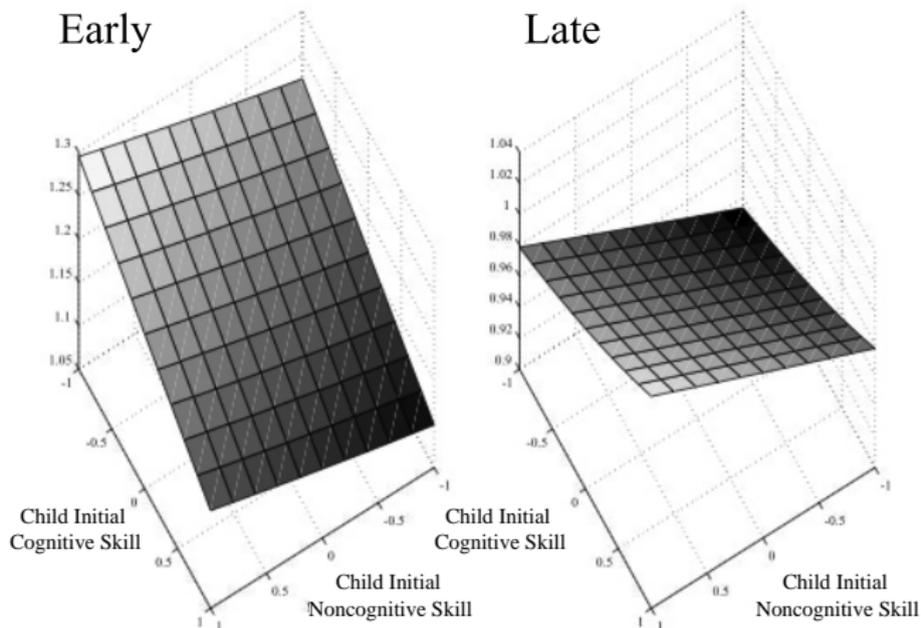
- Capabilities evolve over the life cycle
- Parental investments explain 34% of variance of educational attainment
- Self-productivity becomes stronger as children become older, for both cognitive and noncognitive skill formation (i.e.,  $\frac{\partial \theta_{t+1}}{\partial \theta_t} \uparrow t$ ).
- Strong cross effects (noncognitive skills foster cognitive investment)
- Complementarity between cognitive skills and investment becomes **stronger** as children become older. The elasticity of substitution for cognitive production is *smaller* in second stage production

- **Emerging dynamic complementarity.**
- It is more difficult to compensate for the effects of adverse environments on **cognitive** endowments at later ages than it is at earlier ages. This pattern of the estimates helps to explain the evidence on ineffective cognitive remediation strategies for disadvantaged adolescents reported in Cunha et al. (2006), Cunha (2007), and later papers.
- Complementarity between **noncognitive** skills and investments stays roughly constant over the life cycle.
- Suggests that later life investments should be more focused on promoting noncognitive—personality—skills.
- The evidence on which adolescent interventions are successful is consistent with this evidence.

## The Implications of the Estimates for Design of Policy

- Targeted strategies
- Consider a policy for a social planner to optimize the stock of education in society.
- Assume (for simplicity) full control of investment (ignores parental responses)
- The bulk of the evidence in the child development literature shows **reinforcement** of investment by parents.
- No consideration of social fairness, equality of opportunity or equality of final outcomes—just efficiency.
- Yet with these estimates the optimal policy invests the most in the disadvantaged.
- As an empirical matter, social justice is enhanced by what is productively efficient.

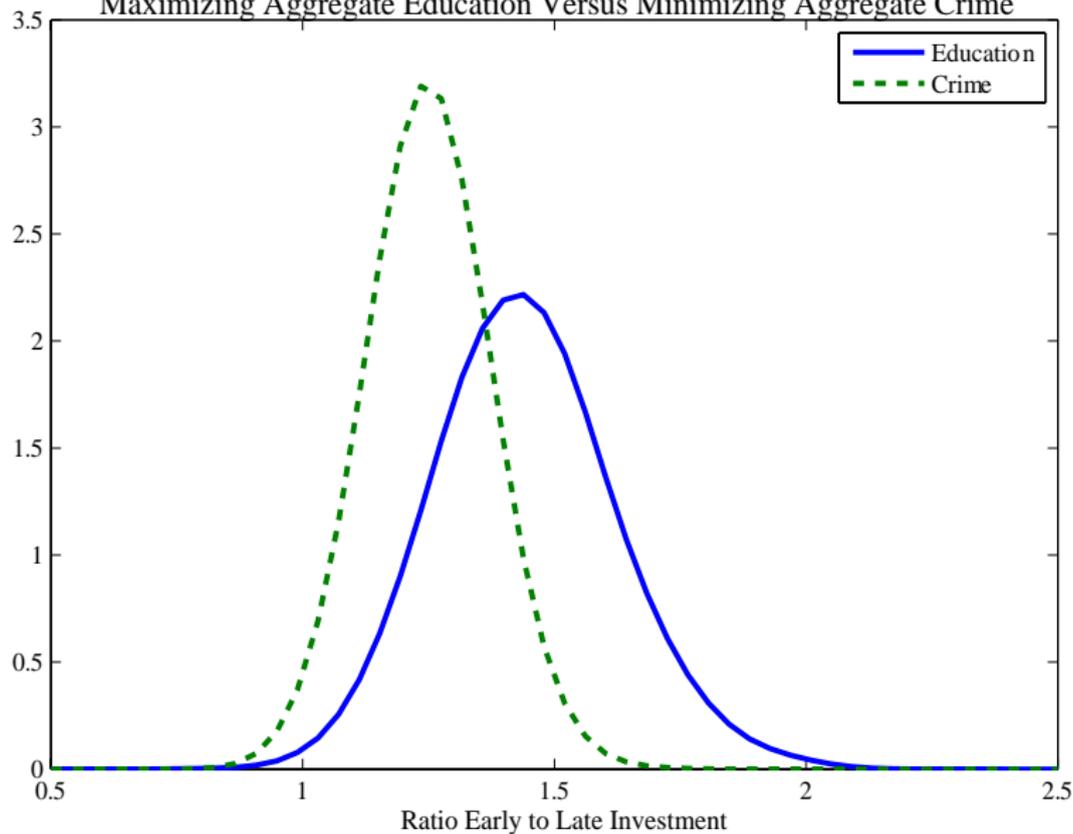
# Socially Optimal Early and Late **Levels** of Investment by Initial Capabilities



Source: Cunha et al. (2010). Optimal investments to maximize aggregate education in society.

# Densities of Ratio of Early to Late Investments

## Maximizing Aggregate Education Versus Minimizing Aggregate Crime



## Using Economics to Go Behind Estimated Program Treatment Effects and Beyond Meta-Analyses of Treatment Effects: Linking the Program Evaluation Literature with the Economics of the Family

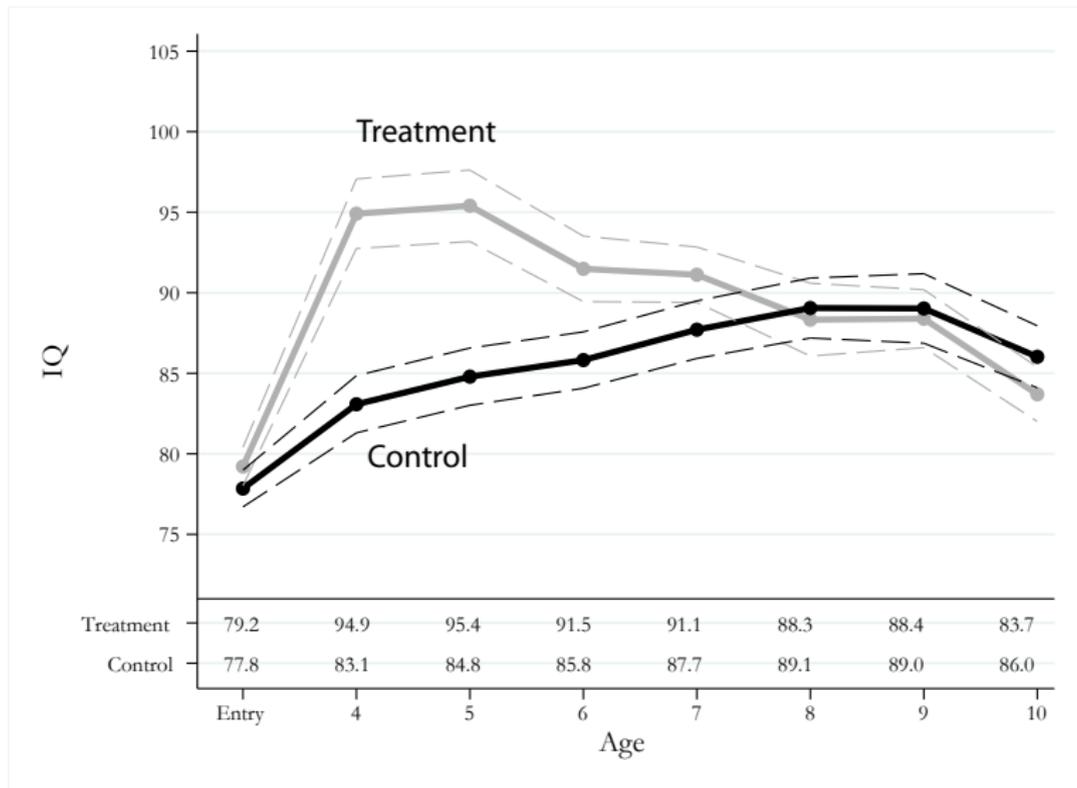
- Widely used “metanalyses” on early childhood do not recognize that various interventions in early childhood previously implemented differ.
  - ① The populations targeted differ.
  - ② The objectives and curricula of the programs differ.
  - ③ The measurement systems for backgrounds and outcomes differ among each other and also with observational studies.
  - ④ The methods of evaluation differ.
  - ⑤ Need to integrate the studies of family influence with the intervention studies to understand how interventions affect family life.
  - ⑥ Need to compare alternative policies in comparable metrics; i.e., rates of return to policies or cost-benefit analyses.

# Lessons From and Lessons For the Intervention Literature

# The Mechanisms Producing the Treatment Effects: A Case Study

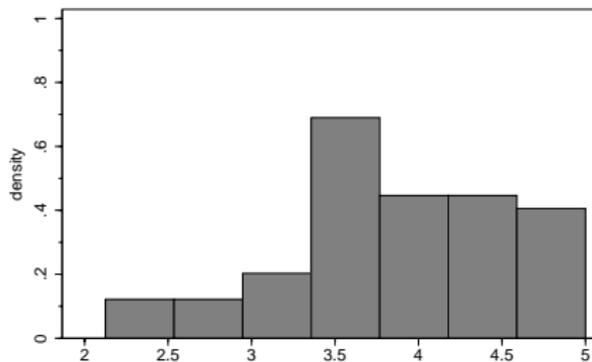
# Cognitive Evolution by Age, Perry Males

## Male Cognitive Dynamics

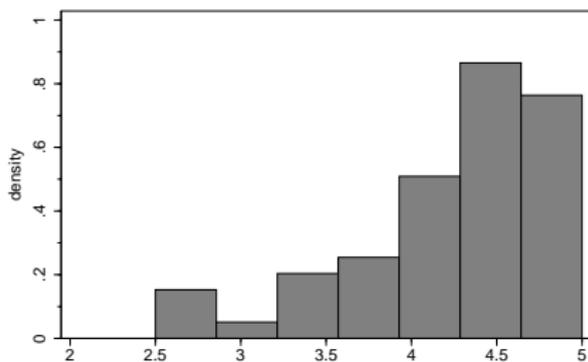


## Personal Behavior Index by Treatment Group

Control

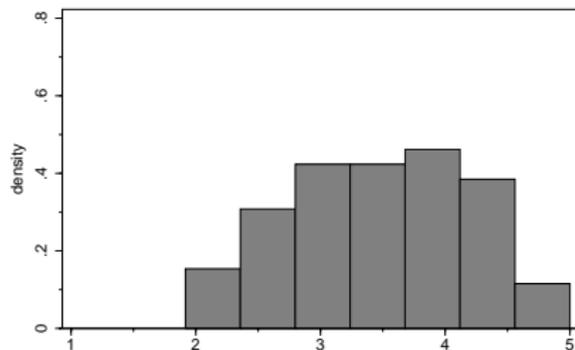


Treatment

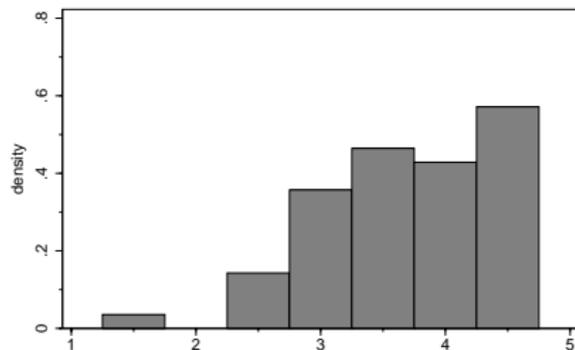


## Socio-Emotional Index by Treatment Group

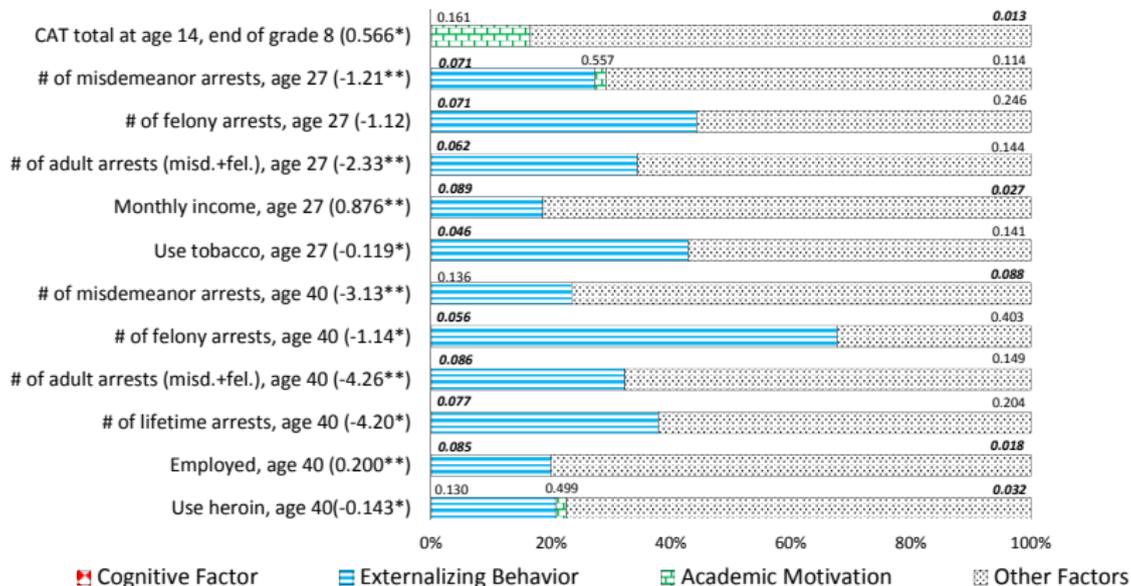
Control



Treatment



# Decomposition of Treatment Effects, Males



## Effects on Health

# Long-Term Health Effects, Males

Outcome	Control Mean	Treatment Mean	Permutation $p$ -value	Stepdown $p$ -value
Not a daily smoker at age 27	0.462	0.581	0.080	0.080
Light or non-smoker at age 27	0.615	0.903	0.004	0.004
No. of cigarettes at age 27	8.744	4.291	0.006	0.007
Not a daily smoker at age 40	0.472	0.633	0.020	0.041
Light or non-smoker at age 40	0.743	0.929	0.011	0.021
No. of cigarettes at age 40	6.543	3.714	0.036	0.053
Change in diet at age 40	0.229	0.380	0.018	0.061

Data: Perry Preschool Program. Source: Conti, Heckman et al. (2013)

## Abecedarian Intervention, Health Effects at Age 35

	Treatment Mean	Control Mean	Treatment p-value
Systolic Blood Pressure	125.79	143.33	0.018
Diastolic Blood Pressure	78.53	92.00	0.024
Pre-Hypertension	0.68	0.78	0.235
Hypertension	0.10	0.44	0.011
HDL Cholesterol	53.21	42.00	0.067
Cholesterol/HDL-C	3.89	4.69	0.057
Abdominal Obesity	0.65	0.87	0.136
Metabolic Syndrome	0.00	0.25	0.009

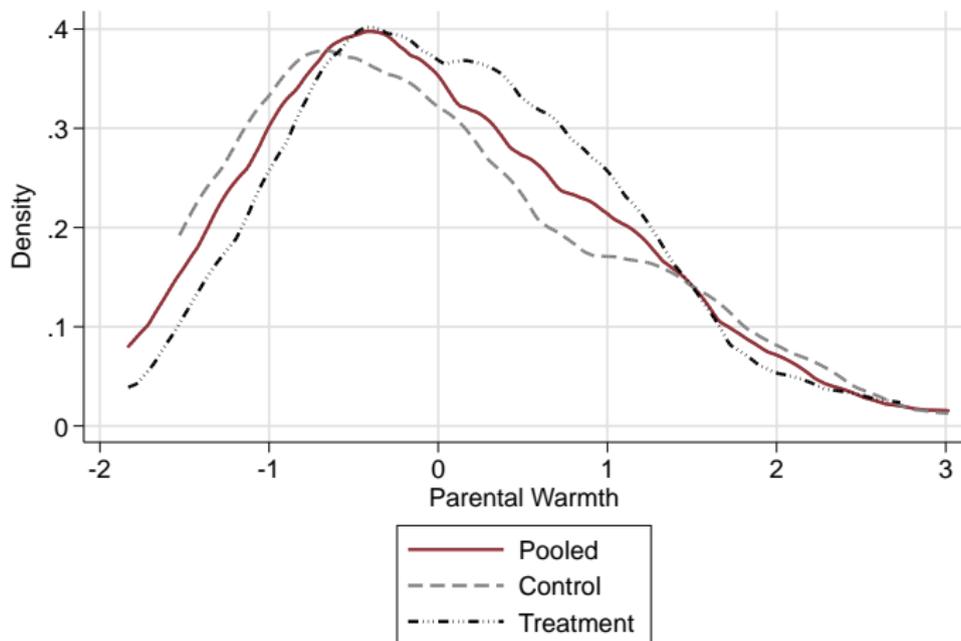
## Attachment, Engagement Toward a Deeper Understanding of Parenting and Learning

- In both Perry and ABC (and many other interventions) a main channel of influence is on the parent-child interactions.
- **Enhanced *attachment and engagement* of parents.**
- This has important implications for how we model family influence.

## Mechanisms—producing effects

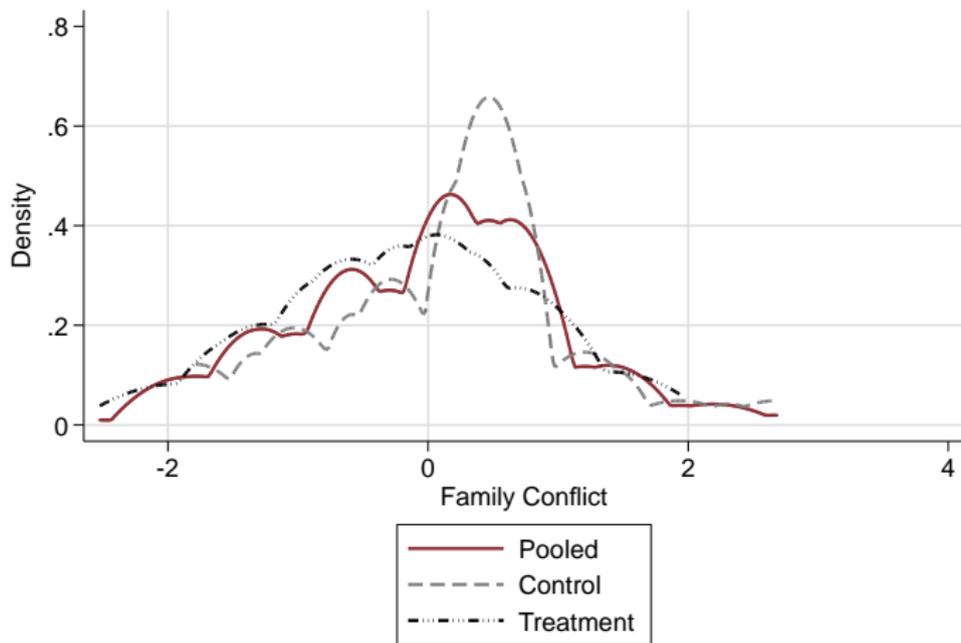
- (a) Information
- (b) Changing preferences of parents
- (c) Parental response to child's curiosity and interest induced by participation in the program

Figure 19: Parental Warmth, Perry Preschool



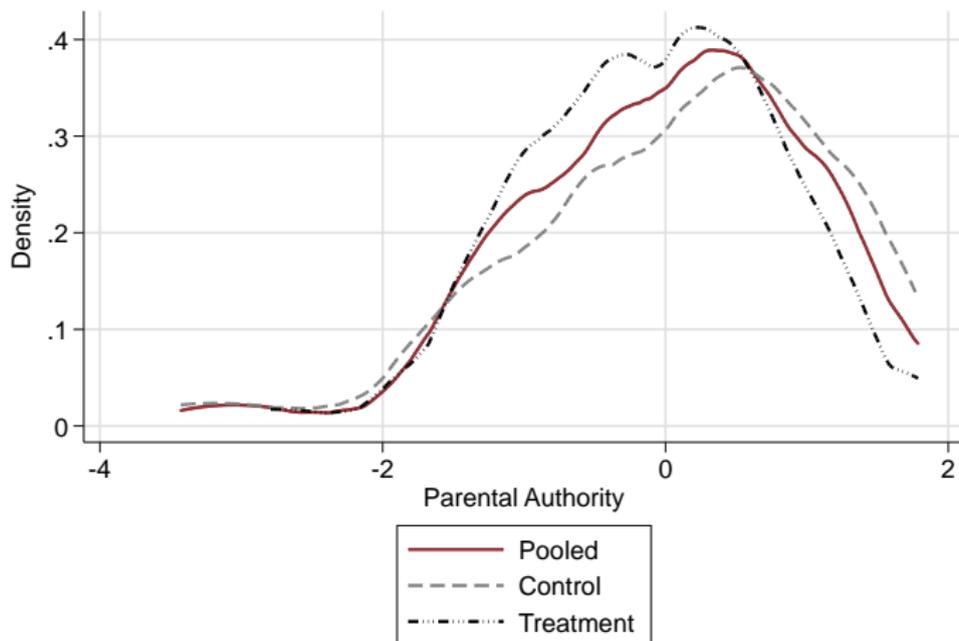
Note: this figure presents the densities –pooled and by treatment status– for a single factor summarizing a set of questions in the Perry questionnaire attempting to measure how much affection the child gets from the parent(s).

Figure 20: Family Conflict, Perry Preschool



Note: this figure presents the densities –pooled and by treatment status– for a single factor summarizing a set of questions in the Perry questionnaire attempting to measure family conflict in the household.

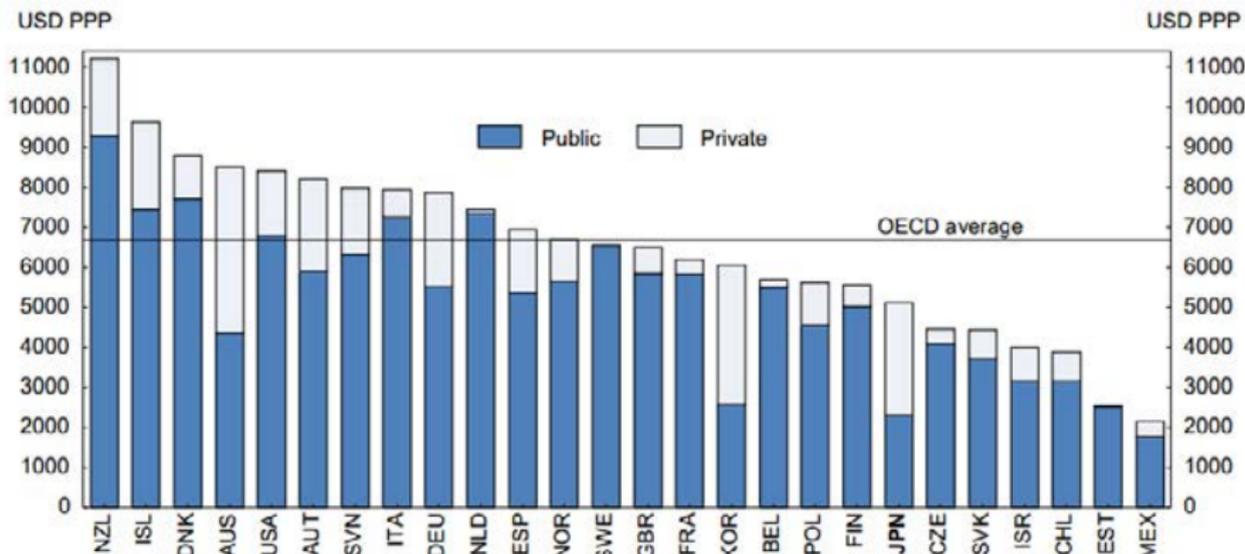
Figure 21: Parental Authority, Perry



Note: this figure presents the densities –pooled and by treatment status– for a single factor summarizing a set of questions in the Perry questionnaire attempting to measure how much discipline the child is subject to from the parent(s).

- An approach where parents learn about child quality and **scaffold** the child

**Figure 22:** Spending per student on pre-primary education was low in Japan in 2009



*Note:* The bars show public (bottom part) and private (top part) education spending in US dollars, adjusted for price level differences across countries, for children too young for primary school. Annual spending is based on the number of students, calculated on a full-time basis.

*Source:* OECD (2012f), OECD Education at a Glance 2012.

# Integrating Experimental Studies with Family Influence Studies

- $I_{G_t}$ : government investment
- $I_{P_t}$ : private (family) investment
- Government technology:  $f^G(\theta_t, \theta_{P_t}, I_{G_t}, I_{P_t})$
- Private technology:  $f^P(\theta_t, \theta_{P_t}, I_{G_t}, I_{P_t})$
- Mixed technology:  $f^M(\theta_t, \theta_{P_t}, I_{G_t}, I_{P_t})$

- Studies under way doing this (Fan, Hai, Heckman, Wei, and Zhang, 2013)

**What about promoting education?**

# Summary

## Point 1

- Multiple skills shape child and adult achievement.
- Broader concept of what capabilities matter for life success.
- Cognition and personality are important predictors of lifetime success.
- They are not epiphenomena solely determined by situations.
- They are stable across situations.
- Traits are skills and can be shaped. They evolve over the life cycle.

## Point 2

- Different critical and sensitive periods for the formation of skills.
- Deeper understanding when in the life cycle policies to promote particular capabilities are more effective.
- Understanding that formal education starting at age 5 or 6 is only one of many skills—it plays an important role, but we should move beyond focusing solely on education in thinking about skill formation policy.

### Point 3

- Parenting, attachment, and parent-child **interactions** more generally are key components, and information play key roles in shaping child abilities.
- The child as an **emergent** system.

## Point 4

- **Multiple channels** through which policies operate as they affect capabilities.
- Not enough to know that early environments affect adult outcomes
- When and where do they have effects?
- We are slowly learning about the channels of influence.

## Point 5

- Strong correlation between family income and child outcomes.
- Mechanisms through which it works are not yet clearly understood.
- **The evidence on credit constraints and income per se as determinants of child welfare is not strong, and estimated effects are weak.**
- This is consistent with both the treatment effect model and the structural literature.

## Point 6

- Despite the emphasis in some quarters in many recent economic models of skill formation, parental liquidity constraints interacting with dynamic complementarity are not so empirically important, and the evidence supporting the importance of liquidity constraints is weak.
- **Reducing these constraints reduces social mobility.**

## Point 7

- Addressing the problems of inequality and social mobility, move beyond simple redistribution policies that dominate current discussion.

# Predistribution Not Simply Redistribution

## Point 8

- Recent developments in the literature on capability formation are providing a unification of the literature in the economics of the family and the intervention literature.
- Show the value of economics and econometrics in interpreting diverse evidence and shaping policy.

- (a) Should there be policies that attempt to lower the IGE?**
- (b) If so, what form should interventions take?**

# Answers

- ① Evidence on the importance of the accident of birth is powerful.
- ② One can interpret this as a market failure (markets to insure against “bad” or “poor” parents missing).
- ③ Evidence of limited parental knowledge and parental skills.
- ④ Recognize altruism and especially paternalism. There is a wealth elasticity of parental transfers that affects *tied* transfers to children. More educated parents have greater responsiveness. (This can arise for multiple reasons:
  - (i) Preference
  - (ii) Samaritan's dilemma))
- ⑤ Returns to college going for low ability children—low or negative.

- ① Evidence on the effectiveness of *pure income transfers* is quite weak.
- ② Targeted transfers with incentives for child skill formation are relatively effective.
- ③ Parental time and interactions appear to have very strong effects: interventions that promote knowledge and parenting skills look to be effective.

- But we should recognize that the case for reducing the IGE is largely political or philosophical.
- Except for the uninsurability of the consequences of the accident of birth, the evidence of market failure is weak.
- One thing for sure—the evidence does *not* support income redistribution per se.
- There are efficiency enhancing policies that promote social mobility