The Economics of Human Development and Social Mobility

James J. Heckman & Stefano Mosso
From "The Economics of Human Development and Social Mobility"

Annual Reviews of Economics, Vol. 6, 689–733. (2014).

James J. Heckman

AEA Continuing Education Program
ASSA Course: Microeconomics of Life Course Inequality
San Francisco, CA, January 5-7, 2016

THE UNIVERSITY OF CHICAGO

- Recent research in the economics of human development and social mobility focuses on skills and the technology of skill formation.
- It establishes the importance of accounting for:
  (1) Multiple periods in the life cycle of childhood and adulthood and the existence of critical and sensitive periods of childhood in the formation of skills
  (2) Multiple skills for both parents and children that extend traditional notions about the skills required for success in life
  (3) Multiple forms of investment

- Some of the most exciting recent research models parent-child / mentor-child, and parent-teacher-child relationships as interactive systems, involving attachment and *scaffolding* as major determinants of child learning.
- Scaffolding is an adaptive interactive strategy that recognizes the current capacities of the child (trainee) and guides him or her to further learning without frustrating the child.
- Activities are tailored to the individual child's ability so they are neither too hard or too easy in order to keep in the "zone of proximal development," which is the level of difficulty at which the child can learn the most.

- The recent literature also takes a more nuanced view of child investment and accounts for parental time and lack of parental knowledge about the capacities of children and effective parenting practices.
- It creates and implements an econometric framework that unifies the study of family influence and the consequences of external interventions in child outcomes.
- There is a well-established empirical relationship between family income and child achievement.
- Many interpret this relationship as evidence of market restrictions including credit constraints.

- Although it is conceptually attractive to do so, and amenable to analysis using standard methods, the empirical evidence that credit constraints substantially impede child skill formation is not strong.
- **Family income** proxies many aspects of the family environment – parental education, ability, altruism, personality, and peers.
- The empirical literature suggests that unrestricted income transfers are a weak reed for promoting child skills.

Some Facts about Skills Over the Life Cycle

- Skills are capacities to act.
- Shape expectations, constraints, and information.
- Enlarge agent choice sets.

Eight Important Facts

1. Multiple Skills

- Multiple skills vitally affect performance in life across a variety of dimensions.

See Appendix E

on **Evidence on the Predictive Power of Cognitive and Socioemotional Traits**

on Slide 292

Link

2. Gaps in Skills

- Gaps in skills between individuals and across socioeconomic groups open up at early ages for both cognitive and noncognitive skills.

See Appendix A

on **Evidence on Achievement Gaps by Age for Different Socio-economic Groups**

on Slide 330

Link

3. Genes

- The early emergence of skill gaps might be interpreted as the manifestation of genetics: Smart parents earn more, achieve more, and have smarter children.
- Genes are important, but skills are not solely genetically determined.
- The role of heritability is exaggerated in many studies and in popular discussions. Nisbett et al. (2012), Tucker-Drob et al. (2009), and Turkheimer et al. (2003) show that estimated heritabilities are higher in families of higher socioeconomic status.
- Epigenetics.

See Appendix M
on **Evidence on Gene Environment Interactions**
on Slide 441

Link

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 (see Thompson and Nelson, 2001, Knudsen et al., 2006, and the body of evidence summarized in Cunha et al., 2006).
- IQ is rank stable after age 10.
- Personality skills are malleable through adolescence and into early adulthood.

See Appendix G

on **Evidence of Critical and Sensitive Periods and of Dynamic Complementarities**

on Slide 455

Link

5. Family Investments

- Gaps in skills by age across different socioeconomic groups have counterparts in gaps in family investments and environments.

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 Quantity of Words Heard	Actual Differences in Quality 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

5. Family Investments (cont.)

- Disadvantaged children have compromised early environments as measured on a variety of dimensions.
- Cunha et al. (2013): the lack of parenting knowledge among disadvantaged parents.
- Parenting styles in disadvantaged families are much less supportive of learning and encouraging child exploration (see Hart and Risley, 1995; Kalil, 2013; Lareau, 2011).

See Appendix B
on **Measures of Investments**
on Slide 459

Link

See Appendix C
on **Trends**
on Slide 539

Link

6. Resilience and Targeted Investment

- The body of evidence as a group 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 (see Cunha et al., 2006; Heckman and Kautz, 2014; Heckman et al., 1999).

6. Resilience and Targeted Investment (cont.)

- However, workplace-based adolescent intervention programs and apprenticeship programs with mentoring, surrogate parenting, and guidance show promising results.

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.

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.
- The evidence is explained by **dynamic complementarity**.

See Appendix I.1
on **Some Evidence on Early Life Interventions**
on Slide 581

Link

THE UNIVERSITY OF CHICAGO

Skills, the Technology of Skill Formation, and the Essential Ingredients of a Life-Cycle Model of Human Development

Skills

- *Vector* of skills at age t: $\boldsymbol{\theta_t}$
- Lifetime T.
- $\boldsymbol{\theta_t}$:

$$\boldsymbol{\theta_t} = (\boldsymbol{\theta_{C,t}}, \boldsymbol{\theta_{N,t}}, \boldsymbol{\theta_{H,t}}), \quad t = 1, \ldots, T. \tag{1}$$

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

- The dimensionality of $\boldsymbol{\theta_t}$ may also change with t.
- As people mature, they acquire new skills previously missing in their personas and sometimes shed old attributes.
- Skills determine in part
    (a) Resource constraints
    (b) Agent information sets
    (c) Expectations

Key Idea

- Core *low-dimensional* set of skills joined with incentives and constraints generates a variety of diverse outcomes.
- Both the skills and their relationship with outcomes may change with the stage of the life cycle.

- Age-specific outcome $Y_{j,t}$ for action (task) j at age t:

$$Y_{j,t} = \psi_{j,t}(\boldsymbol{\theta_t}, e_{j,t}, \boldsymbol{X_{j,t}}), \quad j \in \{1, \ldots, J_t\} \quad \text{and} \quad t \in \{1, \ldots, T\}. \tag{2}$$

- $\boldsymbol{X_{j,t}}$: vector of purchased inputs that affect outcomes.
- Effort $e_{j,t}$: characterized by supply function:

$$e_{j,t} = \delta_j(\boldsymbol{\theta_t}, \boldsymbol{A_t}, \boldsymbol{X_{j,t}}, \boldsymbol{R^a_{j,t}}(\mathcal{I}_{t-1}) \mid \boldsymbol{u}). \tag{3}$$

- $\mathcal{I}_{t-1}$ is the information set.
- $\boldsymbol{R^a_{j,t}}(\mathcal{I}_{t-1})$ is the anticipated reward per unit effort in activity j in period t.
- $\boldsymbol{A_t}$ represents other determinants.
- $\boldsymbol{u}$ represents a *vector* of parameters characterizing preferences.

- **Tests are just measures of performance on some tasks (i.e., some other behaviors).**

- Incentivized boosts in achievement have not been shown to persist when the incentives are removed.

- Equation (2) suggests an important identification problem.

- Using the empirically specified system of equations (2), and the technology of skill formation in equation (4) exposited below, one can characterize how different interventions or different family influence variables affect $\boldsymbol{\theta_t}$ and hence outcomes ($\boldsymbol{Y_t}$) and make comparisons across those literatures.

- Define the set of possible actions for people—their *action spaces*.
- This is closely related to the space of “functionings” in Sen’s capability theory.
- A fundamental notion in that literature is that of **maximum possible flexibility**.

Technology

- *Technology of skill formation*

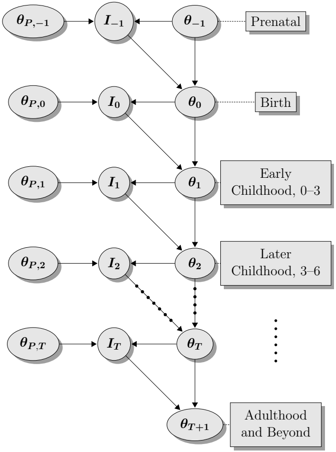
$$\boldsymbol{\theta_{t+1}} = \boldsymbol{f^{(t)}}(\underbrace{\boldsymbol{\theta_t}}_{\substack{\text{self productivity} \\ \text{and cross effects}}}, \underbrace{\boldsymbol{I_t}}_{\text{investments}}, \underbrace{\boldsymbol{\theta_{P,t}}}_{\substack{\text{parental} \\ \text{skills}}}). \qquad (4)$$

- $\boldsymbol{f^{(t)}}$ is assumed to be twice continuously differentiable, increasing in all arguments and concave in $\boldsymbol{I_t}$.
- As noted above, the dimension of $\boldsymbol{\theta_t}$ and $\boldsymbol{f^{(t)}}$ likely increases with the stage of the life cycle t, as does the dimension of $\boldsymbol{I_t}$.
- New skills emerge along with new investment strategies.
- The technology is stage-specific, allowing for critical and sensitive periods in the formation of capabilities and the effectiveness of investment.

Figure 1: The Empirical Challenge: A Life Cycle Framework for Organizing Studies and Integrating Evidence

Capacities at t; $\boldsymbol{I_t}$: investment at t;

$\boldsymbol{\theta_{t+1} = f^t(\theta_t, I_t, \theta_{P,t})}$: Technology of Capability Formation



- Crucial concept emphasized in the recent literature is *complementarity between skills and investments at later stages* ($t > t^*$) of childhood:

$$\frac{\partial^2 \boldsymbol{\theta}_{t+1}}{\partial \boldsymbol{\theta}_t \partial \boldsymbol{I}_t'} > 0, \quad t > t^*.$$

- Empirical literature: consistent with the notion that investments and endowments are direct substitutes (or at least weak complements) at early ages:

$$\frac{\partial^2 \boldsymbol{\theta}_{t+1}}{\partial \boldsymbol{\theta}_t \partial \boldsymbol{I}_t'} \leq 0, \quad t < t^*, \left(\text{or } \epsilon > \frac{\partial^2 \boldsymbol{\theta}_{t+1}}{\partial \boldsymbol{\theta}_t \partial \boldsymbol{I}_t'} > 0, \text{ for } \text{ ``small'' } \epsilon\right).$$

- Complementarity increases with age:

$$\frac{\partial^2 \boldsymbol{\theta}_{t+1}}{\partial \boldsymbol{\theta}_t \partial \boldsymbol{I}_t'} \uparrow t \uparrow .$$

- The first is that investments in adolescents and adults with higher levels of capacity $\boldsymbol{\theta_t}$ tend to be more productive.
- This is a force for the social disequalization of investment.

Table 1: Return to one year of college for individuals at different percentiles of the math test score distribution
White males from high school and beyond

	5%	25%	50%	75%	95%
Average return in the population	0.1121	0.1374	0.1606	0.1831	0.2101
	(0.0400)	(0.0328)	(0.0357)	(0.0458)	(0.0622)
Return for those who attend college	0.1640	0.1893	0.2125	0.2350	0.2621
	(0.0503)	(0.0582)	(0.0676)	(0.0801)	(0.0962)
Return for those who do not attend college	0.0702	0.0954	0.1187	0.1411	0.1682
	(0.0536)	(0.0385)	(0.0298)	(0.0305)	(0.0425)
Return for those at the margin	0.1203	0.1456	0.1689	0.1913	0.2184
	(0.0364)	(0.0300)	(0.0345)	(0.0453)	(0.0631)

Source: Carneiro and Heckman (2003).
Notes: Wages are measured in 1991 by dividing annual earnings by hours worked per week multiplied by 52. The math test score is an average of two 10th grade math test scores. There are no dropouts in the sample and the schooling variable is binary (high schoolcollege). The gross returns to college are divided by 3.5 (this is the average difference in years of schooling between high school graduates who go to college and high school graduates who do not in a sample of white males in the similar NLSY data). To construct the numbers in the table, we proceed in two steps. First we compute the marginal treatment effect using the method of local instrumental variables as in Carneiro, Heckman, and Vytlacil (2001). The parameters in the table are different weighted averages of the marginal treatment effect. Therefore, in the second step we compute the appropriate weight for each parameter and use it to construct a weighted average of the marginal treatment effect (see also Carneiro 2002). Individuals at the margin are indifferent between attending college or not. Standard errors are in parentheses. For additional evidence see Knudsen et al. (2006) and Cunha et al. (2006).

- The second idea is that complementarity tends to increase over the life cycle.
- Complementarity coupled with self-productivity leads to the important concept of *dynamic complementarity* introduced in Cunha and Heckman (2007, 2009).

- $\boldsymbol{I_t} \uparrow \Rightarrow \boldsymbol{\theta_{t+1}} \uparrow$
- Because of self-productivity, $\boldsymbol{\theta_{t+1}} \uparrow \Rightarrow \boldsymbol{\theta_{t+s}} \uparrow$, $s \geq 1$:

$$\frac{\partial^2 \boldsymbol{\theta_{t+s+1}}}{\partial \boldsymbol{I_t} \partial \boldsymbol{I'_{t+s}}} > 0, \quad s \geq 1.$$

- Investments in period $t+s$ and investments in any previous period t are *always* complements as long as $\boldsymbol{\theta}_{t+s}$ and $\boldsymbol{I}_{t+s}$ are complements, irrespective of whether $\boldsymbol{I}_t$ and $\boldsymbol{\theta}_t$ are complements or substitutes in some earlier period t.
- Dynamic complementarity is a consequence of static complementarity in later life periods.
- Because future capacities are increasing in current investments and future investments are complements with future capacities, current and future investments tend to be complements the stronger the static complementarity in future periods.

- Consider the following specification for the technology with scalar θ_t and I_t:

$$\theta_{t+1} = f^{(t)}(\theta_t, I_t).$$

- Denote by f_1^t and f_2^t the derivatives with respect to the first and second argument, respectively,

$$sign\left\{\frac{\partial^2 f^{(t+s)}(\theta_{t+s}, I_{t+s})}{\partial I_{t+s}\partial I_t}\right\} = sign\{f_{21}^{(t+s)}\}$$

independently of the sign of f_{21}^t, for $s \geq 1$.

- Proof

$$\frac{\partial^2 f^{(t+s)}(\theta_{t+s}, I_{t+s})}{\partial I_{t+s} \partial I_t} = f_{21}^{(t+s)} \underbrace{\left(\prod_{j=1}^{s-1} f_1^{(t+j)} \right)}_{>0} \underbrace{f_2^{(t)}}_{>0} .$$

See Appendix L
on **Dynamic Complementarity for the Vector Case**
on Slide 618

Link

- Empirical evidence (Cunha, 2007; Cunha and Heckman, 2008a; Cunha et al., 2010)
- In multiperiod models
- $\cdots > f_{12}^{(3)} > f_{12}^{(2)} > f_{12}^{(1)}$.

- Dynamic complementarity also suggests that limited access to parenting resources at early ages can have lasting lifetime consequences that are difficult to remediate at later ages.
- Parental skills also play a disequalizing role as they enhance the productivity of investments ($\frac{\partial^2 \boldsymbol{\theta_{t+1}}}{\partial \boldsymbol{\theta_{P,t}} \partial \boldsymbol{I_t'}} > 0$).

- Public investments: usually thought to promote equality.
- Whether they do so depends on the patterns of substitutability with private investments and parental skills ("Matthew Effect").
- If more skilled parents are able to increase the productivity of public investments as they are estimated to do with private ones, or if public investments crowd out private investments relatively more among disadvantaged families, then public investments will also play a role towards disequalization.

See Appendix J
on **Parental Responses to Intervention Programs**
on Slide 624

Link

THE UNIVERSITY OF CHICAGO

Other Ingredients

- In addition to the functions linking outcomes to skills and the technology of capability formation, a fully specified model of family influence considers *family preferences for child outcomes*.

- This includes traditional restrictions (if any) on transfers across generations, restrictions on transfers within generations (parental lifetime liquidity constraints), and the public provision of investments in children.
- Less traditional, but central to the recent literature are other constraints on parents:
  (a) Information on parenting practices and parental guidance
  (b) Genes
  (c) The structure of households, including assortative matching patterns

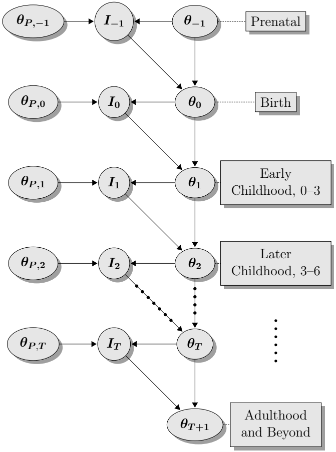
The Empirical Challenge

- The empirical challenge: sort out the relative importance of the different causal influences on adult outcomes and stages of the life cycle where they are most influential.

Figure 2: The Empirical Challenge: A Life Cycle Framework for Organizing Studies and Integrating Evidence

Capacities at t; $\boldsymbol{I_t}$: investment at t;

$\boldsymbol{\theta_{t+1} = f^t(\theta_t, I_t, \theta_{P,t})}$: Technology of Capability Formation



A Bare-Bones Model of Parenting as Investment

- To focus ideas, we present a simple model of family investment and skill development based on Cunha (2007) and Cunha and Heckman (2007).

The Problem of the Parent

- Life is assumed to last 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.
- When the parent dies, she is replaced by the generation of her grandchild.
- Denote by θ_1 the initial capability level of a child drawn from the distribution $J(\theta_1)$.
- The evolution of child skills depends on parental investments in the first and second period, I_1 and I_2.

- The productivity of parental investment depends on parental human capital, $\theta_{P,t}$.
- (For notational simplicity, we set $\theta_{P,t} = \theta_P$.) Equate scalar human capital with skill for both parents and children.
- Denoting by θ_3 the human capital of the child when he reaches adulthood
- Recursive substitution of the technology of skill formation using a CES specification gives the following representation:

$$\theta_3 = \delta_2 \left[\theta_1, \theta_P, \left(\gamma \left(I_1 \right)^{\phi} + (1 - \gamma) \left(I_2 \right)^{\phi} \right)^{\frac{\rho}{\phi}} \right], \tag{5}$$

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

- γ is a skill multiplier.

How to Get Simple Representation

- Consider the following parameterization of the stage-specific production functions:

$$\theta_{t+1} = \delta_t \left\{ \gamma_{1,t} \theta_t^{\phi_t} + \gamma_{2,t} I_t^{\phi_t} + \gamma_{3,t} \theta_P^{\phi_t} \right\}^{\frac{\rho_t}{\phi_t}}$$

with $0 < \gamma_{1,t}, \gamma_{2,t},$ and $\gamma_{3,t}$; $\rho_t \leq 1$; $\phi_t \leq 1$; and $\sum_{k=1}^{3} \gamma_{k,t} = 1$.

- Substitute recursively. If $T = 2$, $\rho_1 = \rho_2 = 1$, $\delta_1 = 1$, and $\phi_1 = \phi_2 = \phi \leq 1$, skills at adulthood, $\theta_3 = \theta_{T+1}$, can be expressed as

$$\theta_3 = \delta_2 \left[\gamma_{1,2}\gamma_{1,1}\theta_1^{\phi} + \underbrace{\gamma_{1,2}\gamma_{2,1}}_{\textbf{``Multiplier''}} I_1^{\phi} + \gamma_{2,2} I_2^{\phi} + \left(\gamma_{3,2} + \gamma_{1,2}\gamma_{3,1}\right)\theta_P^{\phi} \right]^{\frac{1}{\phi}} .$$

- **Multiplier**: $\gamma = \gamma_{1,2}\gamma_{2,1}$.
- Arises from the conjunction of self-productivity ($\gamma_{2,1} \neq 0$) and the productivity of investment ($\gamma_{1,2} \neq 0$).
- Self-productivity joined with the productivity of investment generates dynamic complementarity.
- $\gamma_{2,1}$ characterizes how much of the investment in period $t = 1$ propagates into skills at adulthood, θ_3.
- The parameter ϕ captures the substitutability/complementarity of investments.

- If $\phi = 1$, investments at different periods are (almost) perfect substitutes.
- They are perfect substitutes if $\gamma_{1,2}\gamma_{2,1} = \gamma_{2,2}$, in which case the timing of investment in skills does not matter for the developmental process.
- This is the only circumstance in which collapsing childhood into one period as in Becker–Tomes is without loss of generality.

- Polar opposite case: $\theta_3 = \delta_2\left(\theta_1, \theta_P, \min\left(I_1, I_2\right)\ \right)$
- Closer to the empirical truth than perfect substitution.

- Complementarity has a dual face.
- Early investment is essential but ineffective unless later investments are also made.
- In this extreme case, there is no possibility of remediation.
- If parents are poor and unable to borrow against the future earnings of their children and, as a result, I_1 is low, there is no amount of investment at a later age, I_2, that can compensate for early neglect.

- The parameters of the technology determine whether early and later investments are complements or substitutes.
- "Direct" complementarity for Equation (5) holds if $\rho > \phi$, whereas substitutability holds otherwise.
- Another definition of complementarity in the literature distinguishes (in the case of $\rho = 1$) whether $\phi > 0$ (*gross* substitutes; the elasticity of substitution is greater than 1) or $\phi < 0$ (*gross* complements; the elasticity of substitution is less than 1)
- Cobb-Douglas ($\phi = 0$) is the boundary case.

- Given ρ, the smaller ϕ, the harder it is to remediate low levels of early investment I_1 by increasing later investments.
- At the same time, the stronger the complementarity (the lower ϕ)
- The more important it is to follow high volumes of early investments with high volumes of late investments to achieve high levels of production of adult human capital.

Parent's Problem

- The parent allocates resources across household consumption in both periods of the child's life, c_1 and c_2; early and late investments, I_1 and I_2; and bequests, b'.
- Assets at the end of the first period, period a, may be constrained to be non-negative.
- Bequests are received when entering adulthood and may be positive or negative.
- The state variables for the parent are her initial wealth, b; human capital level, θ_P; and the initial skill level of the child, θ_1.
- Human capital is rewarded in the labor market according to the wage rate, w.
- Economy is characterized by one risk-free asset with return r.

- $u(\cdot)$: parental utility function
- β: discount factor
- υ: parental altruism given by the weight assigned to the utility of future generations
- θ_1': uncertain initial endowment of the child's child
- Goal of the parent: optimize

$$V\left(\theta_P, b, \theta_1\right) = \max_{c_1, c_2, I_1, I_2} \left\{ u\left(c_1\right) + \beta u\left(c_2\right) + \beta^2 \upsilon \mathbb{E}\left[V\left(\theta_3, b', \theta_1'\right)\right] \right\} \tag{6}$$

- subject to (5), (7) and (8).

- Denote parental financial assets by a
- Parental labor market productivity grows at exogenous rate g
- One can represent the stage-of-childhood-specific budget constraints:

$$c_1 + I_1 + \frac{a}{(1+r)} = w\theta_P + b \tag{7}$$

and

$$c_2 + I_2 + \frac{b'}{(1+r)} = w\left(1+g\right)\theta_P + a \tag{8}$$

- Allow for the possibility of borrowing constraints
- $a \geq \underline{a}$ (intragenerational)
- $b' \geq 0$ (intergenerational).

- If no intra- and intergenerational credit constraints are assumed, a key property of the Becker and Tomes (1986) model persists in this framework.
- There is no role for initial financial wealth b, parental income, parental utility, or the magnitude of parental altruism υ (above zero) in determining the optimal level of investment because parents can borrow freely in the market to finance the wealth-maximizing level of investment.

- Even if the altruism parameter is zero ($\upsilon = 0$), if the parents can make binding commitments, selfish parents ($\upsilon = 0$) will still invest in the child, as long as the economic return in doing so is positive.
- However, even in this setup, returns to parental investments depend on parental skills, θ_P, as they affect the productivity of investments.
- The returns to investments are higher for children of parents with higher θ_P.

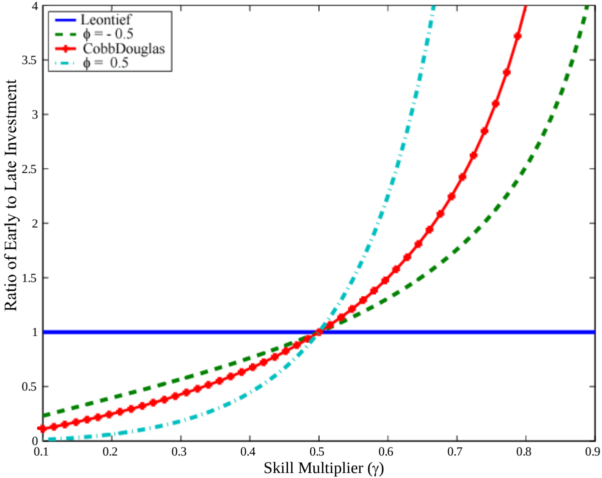
- These children receive higher levels of investment.
- This is a type of market failure due to the "accident of birth" that induces a correlation of human capital and earnings across generations even in the absence of financial market imperfections.
- The initial condition θ_1 also affects investments.
- It creates a second channel of intergenerational dependence due to the "accident of birth" if it is genetically related to parental endowments, as considerable evidence suggests.

- When there are no intra-period constraints,

$$\frac{I_1}{I_2} = \left[\frac{\gamma}{(1-\gamma)(1+r)} \right]^{\frac{1}{1-\phi}} \tag{9}$$

- $\frac{I_1}{I_2} \uparrow$ as $\gamma \uparrow$, $\phi \uparrow$, and $r \downarrow$.

Figure 3: The Ratio of Early to Late Investment in Human Capital As a Function of the Skill Multiplier for Different Values of Complementarity



(Assumes $r = 0$)

- Imperfect credit markets create another channel of intergenerational dependence.
- One possible constraint is the impossibility of borrowing against the child's future earnings (Becker and Tomes, 1986).

- Because $b' \geq 0$, parental wealth matters in this model when this constraint binds.
- Children coming from constrained families will have lower early and late investments.

- However, even with $b' \geq 0$, the *ratio* of early to late investment is not affected.

- Suppose constraints (7) and (8) bind separately.
- Suppose parental utility is given by
  - $u(c) = \left(c^{\lambda} - 1\right)/\lambda$
- $\lambda = 1$ corresponds to perfect intertemporal substitutability.

- The ratio of early to late investment is then

$$\frac{I_1}{I_2} = \underbrace{\left(\frac{\gamma}{(1-\gamma)(1+r)}\right)^{\frac{1}{1-\phi}}}_{\substack{\text{unconstrained ratio} \\ \frac{I_1}{I_2}\uparrow \text{ as } \gamma\uparrow,\ \phi\uparrow, \text{ and } r\downarrow}} \quad \underbrace{[\beta(1+r)]^{\frac{1}{1-\phi}}\left(\frac{C_1}{C_2}\right)^{\frac{1-\lambda}{1-\phi}}}_{\substack{=1 \text{ if unconstrained,} \\ <1 \text{ if constrained}(a \geq \underline{a} \text{ binds})}}. \tag{10}$$

- If early parental income is low compared to later life income, or if λ is small, the level and timing of family resources will influence the parental investment.
- Estimates from Cunha et al. (2010) suggest that $1/(1-\phi) = .\bar{3}$
- Estimate of $\lambda \in [-3, -1.5]$ (Attanasio and Browning, 1995)
- $(1-\lambda)/(1-\phi) \in [0.8\bar{3}, 1.\bar{3}]$.
- Notice that even if $\lambda = 1$, parents may hit constraints on the level of investment if future resources are of insufficient magnitude.
- This constraint could be very harmful to a child if it binds in a critical period of development and the complementarity parameter ϕ is low so that later life remediation is ineffective.

The Presence of Constraints is not Synonymous with Low Levels of Investment

- However, the presence of constraints is not necessarily synonymous with a low level of investment.
- For a given family, a binding constraint implies that the investments are lower than the unconstrained optimum.
- Whether a family is constrained, however, is uninformative on how that family compares with others in terms of the effective level of investments provided.

- Caucutt and Lochner (2012) use a variant of the model of Cunha (2007, 2013) to investigate the role of income transfers and credit constraints in the early years.
- They find that a large proportion of young parents are credit constrained (up to 68% among college graduates) but that reducing borrowing constraints is effective in promoting skills only for the children in the generation in which they are relaxed.

Introducing Income Uncertainty

- Cunha (2007, 2013): overlapping generations model with stochastic innovations to parental income.
- If g is stochastic on the interval $[-1, \infty)$, so parents face uncertain income growth, constraints play a dual role.
- First, as before, if the constraints bind, they reduce investments in the constrained periods.
- Second, because future income is uncertain, so is the likelihood of binding future constraints.

- Absent full insurance markets, consumption and investments in children are less than optimal, even if the parent is not currently constrained but expects to be constrained in the future with a probability greater than zero.

See Appendix D.4
on **The Problem of the Parent**
on Slide 635

Link

- Under this scenario, young parents who just entered the labor force accumulate more assets than they would in the absence of possible future constraints to ensure against bad future shocks.
- This implies a reduction in household consumption and investments in child human capital.

Recent Extensions of the Basic Model

- By and large, the recent literature has moved beyond the simple models just discussed.

See Appendix K.1
on **Overview of Structural Models of Parental Investments**
on Slide 795

Link

- Most assume parental altruism.
- Some are explicitly paternalistic.
- They all feature investment in *goods*.
- Only recently has parental time been analyzed as an explicit input to child quality.
- Most models analyze how child investment depends on parental skills.

- Until recently, most studies considered the self-productivity of skills.
- Some recent papers ignore this feature, despite the empirical evidence that supports it.

- Most analyses assume that parents know the technology of skill formation, as well as the skills of their children, in making investment decisions.
- The recent literature also ignores intergenerational transfers.
- Some papers consider extreme credit constraints that do not permit any borrowing (or lending), even within a lifetime of a generation, much less inter-generational transfers.
- Virtually the entire literature focuses on single-child models, exogenous fertility, and exogenous mating decisions.
- Most models are for single-parent families, for which the characteristics of the spouse are irrelevant.

See Appendix E

on **Evidence on The Predictive Power of Cognitive and Socioemotional Traits**

on Slide 292

Link

- Third, families usually have more than one child.

- Fourth, the models in the literature ignore the interaction of parents and children in the process of development.

- Fifth, fertility is taken as exogenous.

- Do not take too literally models of credit constraints interacting with dynamic complementarity that take fertility as exogenously determined.

- Child's development is influenced by the environment outside his family: day care, kindergarten, school, and neighborhood.
- In addition, the effectiveness of policies is determined in part by parental responses to them.
- Policies that complement rather than substitute for family investments will have greater impacts and lower costs.

Empirical Estimates of Credit Constraints and the Effects of Family Income

The Effects of Family Income

- The literature is unanimous in establishing that families with higher levels of long-run (or permanent) income on average invest more in their children and have children with greater skills.
- The literature is much less clear in distinguishing the effect of income by source or in distinguishing pure income effects from substitution effects induced by changing wages and prices (including child-care subsidies or educational incentive payments).

- Levels of permanent income are highly correlated with family background factors such as parental education and maternal ability, which, when statistically controlled for, largely eliminate the gaps across income classes.

- The literature sometimes interprets this conditioning as reflecting parenting and parental investments, but it could arise from any or all of the panoply of correlates of permanent income associated with parental preferences and skills.

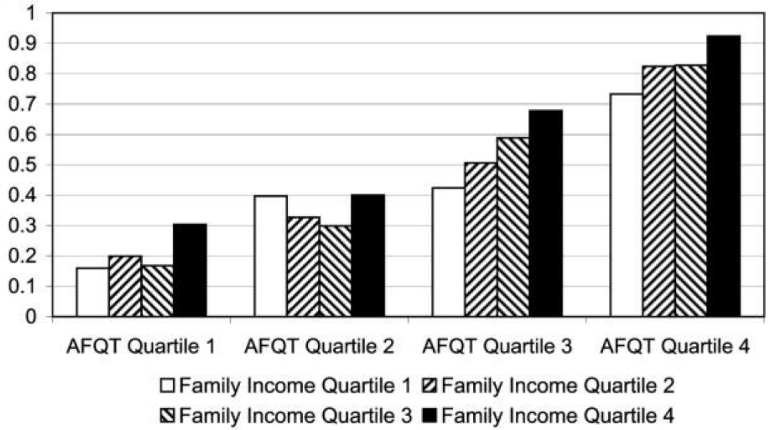
Effects of Borrowing Constraints

- The literature also analyzes the effect of borrowing constraints on child outcomes.

Restrictions in Lending Markets for College Education

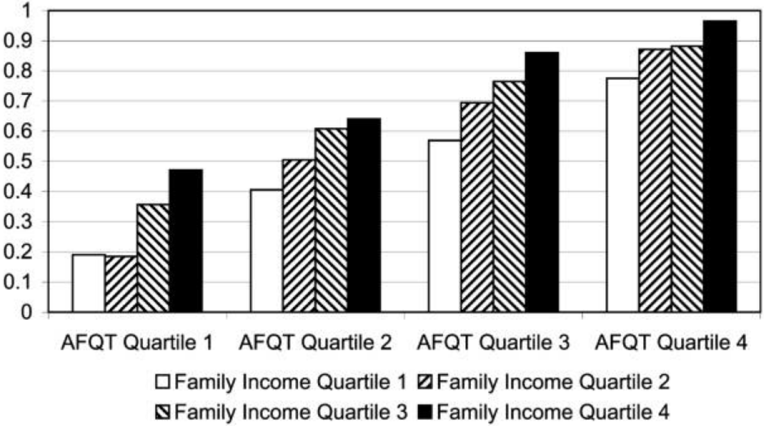
- Belley and Lochner update the NLSY79 analysis of Carneiro and Heckman (2002) using NLSY97 data and claim that credit constraints seem to bind predominantly among less able poor children.
- However, their analysis shows that, across all ability groups, college enrollment increased in 1997 compared to 1979.
- The increases are more substantial for more affluent, low-ability children.

Figure 4: College attendance by AFQT and Family Income Quartiles (1979)



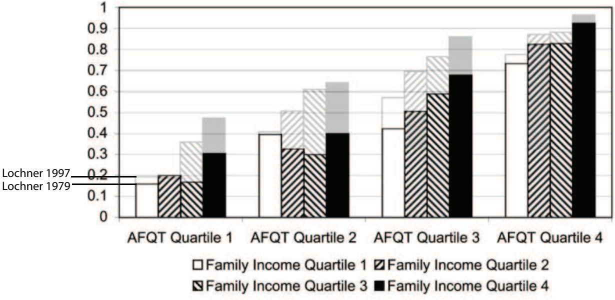
Source: Belley and Lochner (2007).

Figure 5: College attendance by AFQT and Family Income Quartiles (1997)



Source: Belley and Lochner (2007).

Figure 6: College attendance by AFQT and Family Income Quartiles (1979 and 1997 on one graph)



Source: Belley and Lochner (2007).

The Timing of Income, Dynamic Complementarity, and Credit Constraints

- The interaction of dynamic complementarity and lifetime liquidity constraints motivates a recent literature.
- Dahl and Lochner (2012) investigate how credit constraints affect test scores of children in early adolescence.
- They exploit the policy variation in the Earned Income Tax Credit (EITC) as an exogenous instrument for the effect of income on child outcomes.

See "Literature on Credit Constraints" on Slide 315

Link

Lessons from the Literature on Family Income and Credit Constraints

- 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.
- **Premature** to advocate income transfer policies as effective policies for promoting child development.

- The literature establishes the first-order importance of child ability for college going, irrespective of family income levels.
- More advantaged families with less able children send their children to college at greater rates than less advantaged families, but the literature does not establish the existence of market imperfections or any basis for intervention in credit markets.
- The observed empirical regularity may result from the exercise of parental preferences.
- Recent work shows that the returns to college for less able children are low, if not negative.

- The literature that presents more formal econometric analyses of the importance of credit market restrictions on educational attainment shows little evidence for them.

- The analysis of Caucutt and Lochner (2012) is an exception.
- They *calibrate* that a substantial fraction of the population is constrained due to the interaction of dynamic complementarity, the receipt of income, and the imperfection of lending markets.
- Much further research is required before definitive policy conclusions can be drawn on the empirical importance of the timing of receipt of income over the life cycle for child outcomes.

See Bradley's handout, "Credit Constraints, Uncertainty & Misperceptions" on Slide 801

Link

Structural Estimates of Behavioral Responses to Public Policies

See Appendix K.1
on **Overview of Structural Models of Parental Investments**
on Slide 795

Link

- Most studies of the role of income transfer programs discussed earlier do not investigate the interactions of public policy interventions and family investments.
- To do so, some authors have estimated fully specified structural models and use them to study the effect of various types of policy experiments.

Overview of Policy Implications of Structural Models

Four main facts:

- First, subsidies to parental investments are more cost-effective in improving adult outcomes of children such as schooling attainment or earnings, when provided in the early stages of life (Caucutt and Lochner, 2012; Cunha, 2007; Cunha and Heckman, 2007).

- Second, financial investment subsidies have stronger effects for families who are already engaging in complementary investments.
- Targeted public investments and targeted transfers restricted to child-related goods that guarantee minimum investment amounts to every child increase the level of investments received by the children of the least-active parents (Caucutt and Lochner, 2012; Del Boca et al., 2014).
- Lee and Seshadri (2014) provide evidence on the importance of targeted education subsidies for increasing the educational expenditures of poor families.

- Third, time-allocation decisions are affected by transfers.
- Del Boca et al. (2014) show that unrestricted transfers increase the time parents spend with their children through a wealth effect.
- The increase in child quality is minimal.

- Lee and Seshadri (2014) show how this effect is especially strong for parents without college education, whereas, in their model, public transfers negatively affect time spent with children for college-educated parents.
- Fourth, targeted conditional transfers (on a child's ability improvements) are more cost-effective than pure income transfers to achieve any child outcome.

The Implications of Dynamic Complementarity for Investments across Children with Different Initial Endowments

- The average family usually has more than one child, and society allocates public investments across multiple children.
- The problem of intra-child allocations is sometimes formulated as a problem in fairness.
- CES representation of parental utility V is often used:

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

THE UNIVERSITY OF CHICAGO

- A Rawlsian version of maximal inequality aversion is obtained when $\sigma \to -\infty$, so utilities are perfect complements, and parents are concerned only with the maximization of the minimum outcome across children.

- In a two-child version of the one-period-of-childhood model analyzed by Becker and Tomes (1979, 1986), under complementarity between initial endowment and investment, the optimal policy when $\sigma = 1$ is to invest less in the initially disadvantaged child.
- Under substitutability, it is optimal to invest more in the disadvantaged child.

- Story richer when we consider a multiperiod model with dynamic complementarity.
- *Investing relatively more in initially disadvantaged young children can be efficient even when the* ω_k *are equal and* $\sigma = 1$.
- This is true even if there is complementarity in each period of the life cycle.

- **Dynamic complementarity** is a force promoting compensating early stage investments.
- In a multiperiod model at stage t

$$\theta_{t+1} = f^{(t)}(\theta_t, I_t), \tag{12}$$

- even if there is complementarity at all stages, so $f_{12}^{(t)}(\cdot) > 0$ (where $(\cdot)$ denotes the argument of the function), output-maximizing investments can be compensating.

- If $f_{12}^{(1)}(\cdot) < 0$, but $f_{12}^{(2)}(\cdot) > 0$, it is *always* efficient to invest relatively more in the initially disadvantaged child in the first period.

- It can also be productively efficient to invest in the disadvantaged child if $f_{12}^{(1)}(\cdot) > 0$, when initial endowments and investments are complements.

See Appendix D.7
on **Targeting Relatively More Investment Toward Disadvantaged Children**
on Slide 685

Link

- Intuition
- Increasing complementarity
- In this case, the stock of skills in the second period has a greater effect on the productivity of investments than it does in the first period $\left(f_{12}^{(2)}\left(\cdot\right) > f_{12}^{(1)}\left(\cdot\right)\right)$.
- First-period investments bolster the stock of second-period skills and prepare disadvantaged children to make productive use of them in the second period.
- This effect is stronger when $f_{12}^{(2)}(\cdot)$ is larger.

- Another force promoting greater initial investment in the disadvantaged child is diminishing self-productivity of skills in the first period $\left(f_{11}^{(1)}(\cdot) < 0\right)$
- The greater the diminishing returns to investment for the better-endowed child, the lower the benefits of early advantage.
- Diminishing productivity of the stock of second-period skills $\left(f_{11}^{(2)}(\cdot) < 0\right)$ operates in the same fashion to limit the effects of any initial advantage.

- The smaller the effect of the initial stock of skills on the productivity of investment in the first period $\left(f_{12}^{(1)}(\cdot)\right)$, the weaker is the disequalizing force of complementarity toward promoting investment in the initially advantaged child.

- Summarizing:
    1. The more concave are the technologies in terms of stocks of skills (the more they exhibit decreasing returns in the stocks of skills), the more favorable is the case for investing in more disadvantaged children.
    2. The stronger is second-period complementarity $\left(f_{12}^{(2)}(\cdot)\right)$, the stronger is the case for investing more in the initially advantaged child to build skill stocks to take advantage of this opportunity.
- The weaker is the first-period complementarity $\left(f_{12}^{(1)}(\cdot)\right)$, the less offsetting is the disequalizing effect of complementarity coupled with initial advantage.

- In general, even when investment is greater in the first period for the disadvantaged child, it is optimal for second-period investment to be greater for the initially advantaged child.
- It is generally not efficient to make the disadvantaged child whole in the first period.
- Greater second-period complementarity then kicks in to promote disequalizing second-period investments.

See Appendix D.8

on **Some Evidence from Simulations on Why Dynamic Complementarity is a Force...**

on Slide 780

Link

Operationalizing the Theory

- A dynamic state-space model with constraints and family investment decisions is the natural econometric framework for operationalizing the model of Equation (2) and the evolution of capacities, as presented in Equation (4).

Skills as Determinants of Outcomes

- Cunha et al. (2010) present conditions under which the outcome Equation (2) and technology Equation (4) are non-parametrically identified.
- They develop methods for accounting for the measurement error of inputs, anchoring estimated skills on adult outcomes (so that scales are defined in meaningful units), and accounting for the endogeneity of investments.

- Heckman et al. (2013a) develop and apply simple and easily implemented least-squares estimators of linear factor models to estimate equations for outcomes.

Multiple Skills Shape Human Achievement Across a Variety of Dimensions

- Figure 7 from (Eisenhauer et al., 2014) plots the probability and the return of enrolling in college immediately after having graduated high school as a function of the deciles of scalar summaries of cognitive and noncognitive skills.

See Appendix E

on **Evidence on The Predictive Power of Cognitive and Socioemotional Traits**

on Slide 292

Link

- The return is calculated over a 65-year-long working life. Lifecycle earning profiles are simulated using the estimated parameters.
- See Eisenhauer et al. (2014) for a precise description of the model, data, and computations.

Figure 7: The Probability and Returns of College Enrollment by Endowments Levels

Figure: Choice Probability, College Enrollment

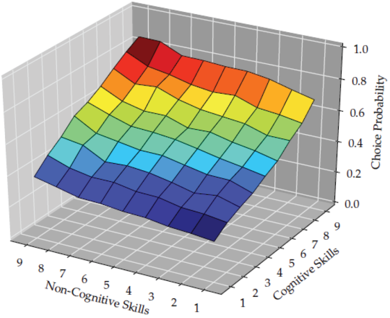
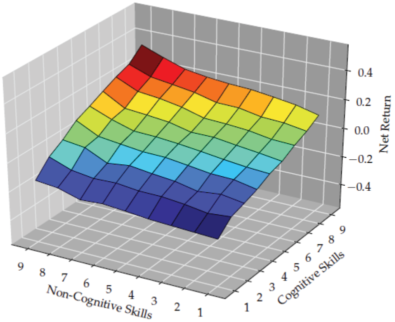


Figure: Net Return, College Enrollment



Source: Eisenhauer et al. (2014)

Note: College enrollment refers to the individuals who enroll in college immediately after having finished high school. Returns are expressed in units of millions of dollars. Higher deciles correspond to higher levels. See Eisenhauer et al. (2014) for greater details.

Estimates of the Technology of Skill Formation in the Literature

- The main features of the empirical models of the technology of skill formation are summarized in Table 2.

Table 2: Skill Production Functions

	Skill Output			Functional	
	Cognitive	Noncognitive	Health	Form	Anchoring
Todd and Wolpin (2003)	✓	X	X	Linear	X
Bernal and Keane (2010)	✓	X	X	Linear	X
Cunha and Heckman (2008a)	✓	✓	X	Linear	✓[a]
Cunha et al. (2010)	✓	✓	X	CES	✓
Todd and Wolpin (2007)	✓	X	X	Linear	X
Cunha (2007)	✓	X	X	CES	✓
Del Boca et al. (2014)	✓	X	X	Log-Linear	X
Caucutt and Lochner (2012)	✓	X	X	CES	✓
Bernal (2008)	✓	X	X	Linear	X
Gayle et al. (2013)	X[f]	X[f]	X	N/S	X
Bernal and Keane (2011)	✓	X	X	Linear	X

Table 2: Skill Production Functions (cont.)

	Self Productivity	
	Cognitive	**Noncognitive**
Todd and Wolpin (2003)	✓- N/A	X
Bernal and Keane (2010)	✓- N/A	X
Cunha and Heckman (2008a)	0.977	0.884
Cunha et al. (2010)	0.487/0.902[b]	0.649/0.868[b]
Todd and Wolpin (2007)	0.21 - 0.34[c]	X
Cunha (2007)	0.735/0.799 /0.872[d]	X
Del Boca et al. (2014)	(0.14, 0.503)/(0.172, 0.922)[e]	X
Caucutt and Lochner (2012)	✓- N/A	X
Bernal (2008)	✓- N/A	N/A
Gayle et al. (2013)	N/S	N/S
Bernal and Keane (2011)	✓- N/A	X

Table 2: Skill Production Functions (cont.)

	Cross Productivity		Increasing Investments / Skill
	Cognitive	Noncognitive	Complementarity over Time[g]
Todd and Wolpin (2003)	X		U
Bernal and Keane (2010)	X		U
Cunha and Heckman (2008a)	0.003	0.028	U
Cunha et al. (2010)	0.000/0.008[b]	0.083/0.011[b]	✓
Todd and Wolpin (2007)	X		U
Cunha (2007)	X		✓
Del Boca et al. (2014)	X		N/A
Caucutt and Lochner (2012)	X		N/A
Bernal (2008)	X		U
Gayle et al. (2013)	X		N/S
Bernal and Keane (2011)	X		U

Interpreting the Intervention Literature

Table 3a: Summary of Effects for Main Interventions

Program	Participant/Evaluation Characteristics						
	Age	Duration	Target	Selection	Follow-Up	Sample	RCT Eval
Elementary							
LA's Best	5–6	6Y	SES	Schl	12Y	19,320	No
CSP	5–13	5Y	Behav	Refer	35Y	510	Yes
SSDP	6–7	6Y	Crime	Prgrm	21Y	610	Yes
Adolescence							
BBBS	10-16	1Y	SES	Self	1Y	960	Yes
IHAD	11–12	7Y	SES	Prgrm	8Y	180	Yes
EPIS	13–15	3Y	Schl	Schl	2Y	45,070	No
xl club	14	2Y	Schl	Schl	2Y	261,420	No
SAS	14–15	5Y	Schl, SES	Schl	6Y	430	No
STEP	14–15	2Y	Schl, SES	Self	4Y	4,800	Yes
QOP	14–15	5Y	Schl	Prgrm	10Y	1,070	Yes
Academies	13–16	4Y	Schl, SES	Self	12Y	1,460	Yes
ChalleNGe	16–18	1Y	Dropout	Self	3Y	1,200	Yes
Job Corps	16–24	1Y	SES	Self	9Y	15,300	Yes
Year-Up	18–24	1Y	SES	Self	2Y	200	Yes

Table 3b: Summary of Effects for Main Interventions

	Components				
Program	Home	Health	Parental	On Site	Group
Elementary					
LA's Best	☐	☒	☒	☒	☒
CSP	☒	☒	☒	☒	☒
SSDP	☐	☒	☒	☒	☒
Adolescence					
BBBS	☐	☐	☐	☐	☐
IHAD	☐	☒	☒	☒	☒
EPIS	☐	☐	☐	☒	☒
xl club	☐	☐	☐	☒	☒
SAS	☐	☐	☐	☐	☐
STEP	☐	☒	☐	☒	☒
QOP	☐	☒	☐	☒	☒
Academies	☐	☐	☐	☒	☒
ChalleNGe	☐	☒	☐	☒	☒
Job Corps	☐	☒	☐	☒	☒
Year-Up	☐	☐	☐	☒	☒

Table 3c: Summary of Effects for Main Interventions

Program	Effects on Outcomes: IQ	School	Character	Education	Health	Crime	Earnings	Return/Benefits: Return	Benefit/Cost
Elementary									
LA's Best	.	◍	.	●	.	○	.		0.9
CSP	.	.	○	.	⊗	○	.		
SSDP	.	●	●	●	●	◍	○		3.1
Adolescence									
BBBS	.	◐	○	.	◐	○	.		1.0
IHAD	.	.	.	●	.	.	.		
EPIS	.	●	.	.	.	.	.		0.9–3.0
xl club	.	○	.	.	.	.	.		
SAS	.	◍	○	●	.	.	.		
STEP	.	○	.	○	.	.	○		
QOP	.	○	.	◍	○	⊗	○		0.42
Academies	.	◍	○	○	○	◍	◐		
ChalleNGe	.	.	◍	●	◐	◍	●	6.4	2.66
Job Corps	.	.	.	○	◍	◍	◍		0.22
Year-Up	.	.	.	.	.	.	●		

Table 3d: Summary of Effects for Main Interventions

	Participant/Evaluation Characteristics						
Program	Age	Duration	Target	Selection	Follow-Up	Sample	RCT Eval
Early							
NFP	< 0	2Y	SES	Prgrm	19Y	640	Yes
ABC	0	5Y	SES	Refer	30Y	90	Yes
IHDP	0	3Y	Health	Prgrm	18Y	640	Yes
FDRP	0	5Y	SES	Prgrm	15Y	110	No
PCDC	1	2Y	SES	Prgrm	15Y	170	Yes
JSS	1–2	2Y	Health	Prgrm	22Y	160	Yes
Perry	3	2Y	SES, IQ	Prgrm	37Y	120	Yes
Head Start	3	2Y	SES	Prnt	23Y	4,170	Yes
CPC	3–4	2Y	SES	Prnt	25Y	1,290	No
TEEP	3,5	2Y	SES	Prgrm	22Y	260	Yes
STAR	5–6	4Y	SES	Prgrm	22Y	11,000	Yes

Table 3e: Summary of Effects for Main Interventions

Program	Components				
	Home	Health	Parental	On Site	Group
Early					
NFP	☒	☒	☒	☐	☐
ABC	☐	☒	☒	☒	☒
IHDP	☒	☐	☒	☒	☒
FDRP	☒	☒	☒	☒	☒
PCDC	☒	☐	☒	☒	☒
JSS	☒	☒	☒	☐	☐
Perry	☒	☐	☒	☒	☒
Head Start	☒	☒	☒	☒	☒
CPC	☐	☒	☒	☒	☒
TEEP	☒	☒	☒	☒	☐
STAR	☐	☐	☐	☒	☒

Table 3f: Summary of Effects for Main Interventions

Program	Effects on Outcomes							Return/Benefits	
	IQ	School	Character	Education	Health	Crime	Earnings	Return	Benefit/Cost
Early									
NFP	●	◐	●	○	◍	◐	.		2.9
ABC	●	●	◐	◐	◍	◐	◐		3.8
IHDP	◐	◐	◐	○	○	○	.		
FDRP	○	◐	◍	.	.	●	.		
PCDC	◍	◍	●	.	.	.	.		
JSS	●	●	●	◍	●	.	●		
Perry	◍	●	●	◐	○	●	◐	7–10	7.1–12.2
Head Start	◍	◍	○	●	●	◐	●		
CPC	.	●	●	●	●	●	●	18	10.8
TEEP	◍	●	●	●	.	.	.		
STAR	.	◍	●	●	.	.	●	6.2	

- Three striking patterns emerge.
- First, many early childhood interventions have longer follow-ups (10 or 20 years) than do adolescent interventions.
- Second, evaluations of early childhood programs tend to measure cognitive and noncognitive skills in addition to a variety of later-life outcomes.

- Many evaluations of programs for adolescents focus solely on labor market outcomes.
- Examination of the curriculum of these programs is necessary to understand their primary program focus (e.g. cognitive or noncognitive stimulation).
- Third, the selection of children into early interventions is often dependent on parental choices, whereas adolescents participants decide themselves whether to opt in.

The Main Findings of the Literature

- Three main findings emerge.
- First, only very early interventions (before age 3) improve IQ in lasting ways consistent with the evidence that early childhood is a critical period for cognitive development.
- Second, programs targeting disadvantaged adolescents are less effective than are early intervention programs.
- This evidence is broadly consistent with dynamic complementarity.
- The few successful programs are a consequence of the direct effect of incentives put in place in these programs (versions of incapacitation effects), but they fail to have lasting effects.

- Third, the most promising adolescent interventions feature mentoring and scaffolding.
- They often integrate work with traditional education and attenuate the rigid separation between school and work that characterizes the American high school.
- Mentoring involves teaching valuable character (noncognitive) skills (showing up for work, cooperating with others, and persevering on tasks).

- The effectiveness of mentoring programs is consistent with the evidence on the importance of attachment, parenting, and interaction discussed below.
- Some form of mentoring and parenting is present in all successful intervention programs at all stages of childhood.

The Mechanisms Producing the Treatment Effects

- The literature on program evaluation usually focuses on estimating treatment effects and not on the mechanisms producing the treatment effects.
- The model of skill formation presented in this paper facilitates understanding of the mechanisms producing treatment effects by distinguishing the effect of interventions on the vector of skills $\boldsymbol{\theta_t}$ (Equation (4)) from the effects the skills themselves have on outcomes (Equation (2)).
- It facilitates unification of the family influence literature with the literature on treatment effects.

- Heckman et al. (2013a) use the dynamic factor approach discussed to study a major intervention with a long-term (age 40) follow-up of the Perry Preschool Program.

See Appendix I.2
on **Large Scale Programs**
on Slide 608

Link

Figure 8: Perry Preschool Program: IQ, by age and treatment group

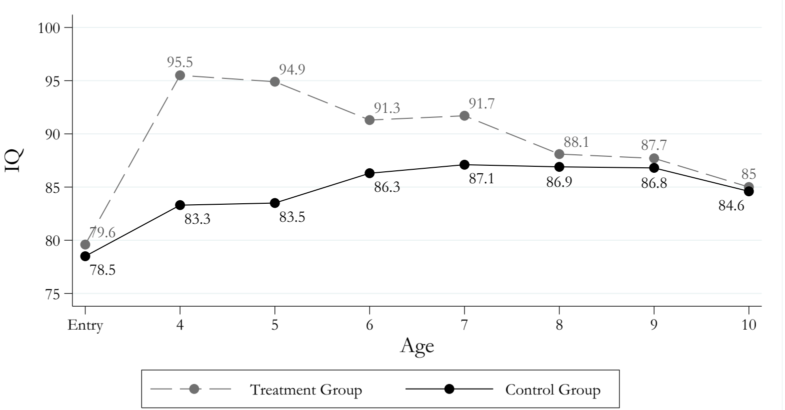
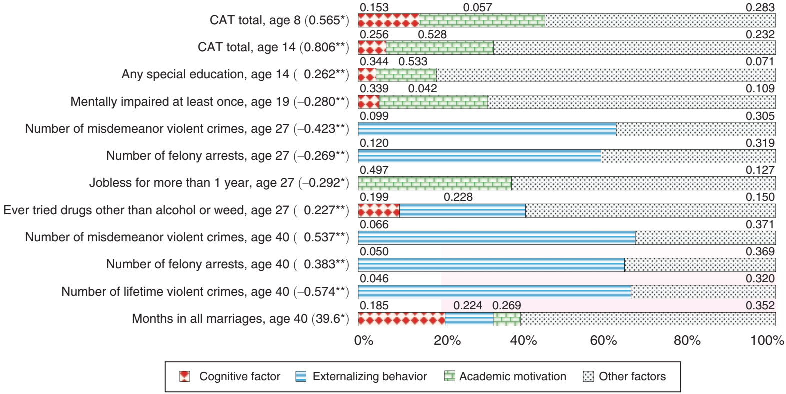


Figure 9: Perry Preschool Program: Decompositions of Treatment Effects on Outcomes, Females



Source: Heckman et al. (2013a).

See Appendix I
on **Summary of Empirical Evidence on the Efficacy of Interventions**
on Slide 554

Link

Attachment, Engagement, and Interaction: Toward a Deeper Understanding of Parenting, Mentoring, and Learning

An Economic Model of Parenting and Scaffolding

García, Heckman, & Setzler

Research Question

- How do child-parent interactions shape the formation of early character and cognitive skills?
- How child matures in this process?

How?

1. Model parent-child interactions
   - early-childhood, dynamic game
   - learning and skill development
   - technology depends on parental and child investment
2. Structurally estimate the model
   - Use data from the Infant Health and Development Program (IHDP)
     - Parent and child efforts
     - Character and cognitive skills
     - Parental expectations

- Skill formation with passive children:
- Cunha and Heckman (2008b); Cunha and Schennach (2010); Heckman et al. (2010, 2013b)
  - lots of results on skills and investment
    - self-productivity (of skills)
    - dynamic complementarity (of investment)
    - time without the mother hurts skill development
- Specific features of child-parent interactions:
- Akabayashi (2006a); Cosconati (2013a); Lizzeri and Siniscalchi (2008)
  - Child-maltreatment (theory only)
  - Optimal parenting styles (theory and estimation)
  - Parental guidance (theory only)

- Model and estimate parent-child interactions to understand how:
  - Skill forms
  - Child matures

- The parent has target skills and target investments
- Target skills evolve according to a predetermined skills production function
- The parent knows the technology of skill formation
- Parent observes a noisy skill realization –function of true skill and child's effort
- Parent chooses investment to minimize deviations from target

Parent's Problem

$$V_t(y_t) = \min_{u_t,\ldots,u_T} \mathbb{E}\left[\sum_{\tau=t}^{T} \beta^{\tau}\left(\widetilde{\theta_\tau}'Q\widetilde{\theta_\tau} + \widetilde{u_\tau}'R\widetilde{u_\tau}\right) + \widetilde{\theta_T}'Q_f\widetilde{\theta_T}|y_t\right] \quad (13)$$

- $Q, Q_f, R \geq 0$ are weighting matrices
- we define

$$\begin{aligned}
\widetilde{\theta_{t+1}} &= A\widetilde{\theta_t} + B\widetilde{u_t} + F\widetilde{a_t} + \omega_t \\
\theta_{t+1} &= \Phi(\theta_t, u_t, a_t); \quad \overline{\theta_{t+1}} = \Phi(\overline{\theta_t}, \overline{u_t}, \overline{a_t}) \\
y_t &= C\widetilde{\theta_t} + B\widetilde{a_t} + v_t \\
\widetilde{x_t} &= x_t - \overline{x_t} \text{ for } x_t = \theta, u_t, a_t
\end{aligned} \quad (14)$$

Child

- Enjoys parental investment and dislikes effort
- Her strategy could be "à la Cournot" or "à la Stackelberg"
- Uncertain on her ability and perfectly observes the rest of the components

$$
\begin{aligned}
J_t &= \max_{a_t,\ldots,a_T} \lambda_t J_t^1(y_t) + (1-\lambda_t) J_t^2(y_t) \\
J_t^1(y_t) &= \mathbb{E}\left[\sum_{\tau=t}^{T} \beta^{\tau} \left(-\widetilde{a_\tau} + \widetilde{u_\tau}\widetilde{a_\tau}\right) |y_t\right] \\
J_t^2(y_t) &= \mathbb{E}\left[\sum_{\tau=t}^{T} \beta^{\tau} \left(-\widetilde{a_\tau} + R_t^P \left(\widetilde{a_\tau}\right)^2\right) |y_t\right]
\end{aligned}
$$

- Extend Cunha and Heckman (2008) to include child inputs
- Linear technology, repeated measures are instrumental variables for measurement error
- Second moments from simultaneous parent and child optimization imply,

$$\lambda_t = \frac{2M_t \operatorname{cov}(a_t, u_t)}{\operatorname{var}(u_t) + 2M_t \operatorname{cov}(a_t, u_t)} \tag{15}$$

- where M_t is a function of technology parameters and preference parameters R, β.
- Property: $\frac{\partial}{\partial R}\lambda_t < 0$
- Technology identified $\Longrightarrow$ λ identified up to R, β

Estimation

- Technology: Instrumental variables regression or MLE under distributional assumption
- Requires repeated measures of child's cognitive and non-cognitive skills as well as child and maternal effort over short stages of child development
- λ: Given technology and preferences, plug-in estimator
- Inference: bootstrap the estimators, test for non-zero technology coefficients and positive λ_t

Data Source: IHDP

- Mid to late 1980s
- Eight sites across the US
- Site-specific, stratified randomization
- 985 families
- Low birth weight, premature infants
- Randomized intervention lasted first 3 years of child's life
- Data collected frequently from 0-8 years, also 18 years
- We do not make use of randomized treatment

Preparation of IHDP Data

- We use data from 5 ages: 1,3,5,8,18 years
- After attrition and non-response, sample size 833 of 985
- Partially-missing response ($<$20%): nonparametric imputation
- For each type of factor, measures chosen so that units are consistent over time
- Measures preserved by monotonic transforms, we use ranks
- Inference: 10,000 bootstrap samples

- Cognitive measures: IQ, PPVT, and math examinations
- Character Skills: Maternally-reported antisocial attitudes, social withdrawal, and depressive behavior indices
  - Example: Doesn't get along with other children? Not true, sometimes, often
- Child Effort/Compliance: Maternally-reported indices of rule-breaking behavior, aggression, and destruction indices
  - Example: Runs away from home? Not true, sometimes, often
- Maternal Effort/Investment: Learning material provision, time spent helping with reading/homework, and activity frequency/quality indices
  - Example: Read books, magazines together? Daily, weekly, etc.

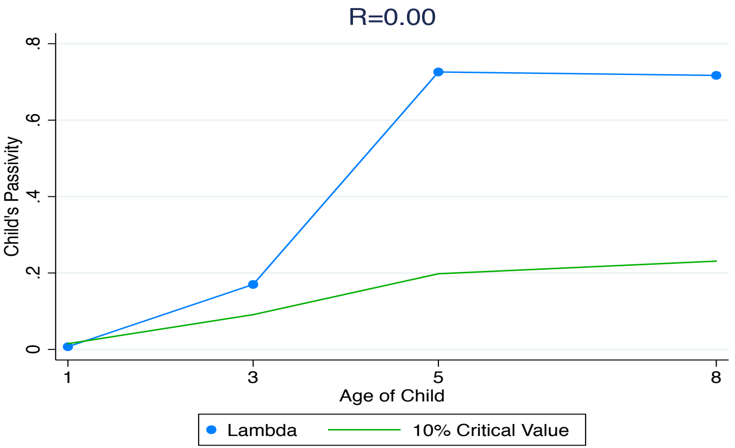
Cognitive Skills

Parameter	$t = 1$	$t = 3$	$t = 5$	$t = 8$
Self-Productivity	0.826	0.855	0.980	0.911
(SD)	(0.022)	(0.014)	(0.010)	(0.010)
Cross-Productivity	0.323	0.077	-0.006	-0.036
(SD)	(0.041)	(0.012)	(0.014)	(0.017)
Child's Effort Productivity	-0.045	0.000	0.000	0.096
(SD)	(0.027)	(0.011)	(0.011)	(0.012)
Mother's Effort Productivity	0.477	0.365	0.103	-0.071
(SD)	(0.012)	(0.015)	(0.018)	(0.020)

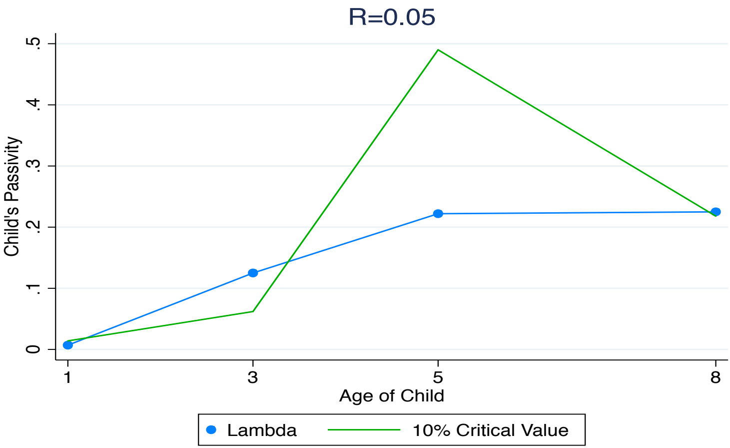
Non-cognitive Skills

Parameter	$t = 1$	$t = 3$	$t = 5$	$t = 8$
Self-Productivity	0.929	0.417	0.904	0.199
(SD)	(0.022)	(0.016)	(0.011)	(0.012)
Cross-Productivity	0.275	-0.014	-0.010	0.163
(SD)	(0.054)	(0.017)	(0.026)	(0.022)
Child's Effort Productivity	0.125	0.066	0.160	0.487
(SD)	(0.030)	(0.014)	(0.017)	(0.017)
Mother's Effort Productivity	0.118	0.022	-0.033	0.043
(SD)	(0.014)	(0.019)	(0.026)	(0.027)

Child's Maturity over Time



Child's Maturity over Time



What Parents Know and How They Parent

- There are two main explanations for the changes in parental behavior induced by successful interventions.
- First, intervention increases the child's skills, and this in turn induces a change in parental behavior.
- This is consistent with complementarity.

- Second, interventions may convey information to the parents about their child's skills, on successful investment strategies and on their returns, and thereby increase parental knowledge.
- The evidence on the effectiveness of the Nurse Family Partnership program shows that giving beneficial information to parents improves child outcomes and changes parenting behavior.

- The research of Cunha et al. (2013) directly investigates beliefs and information mothers have about parenting.
- They find considerable heterogeneity among less educated mothers.
- Compared with a benchmark estimated technology, socioeconomically disadvantaged mothers underestimate the responsiveness of child development with respect to investments.

A Simulation Exercise from Akabayshi 2006

García

- In this document I simulate the model that Akabayashi (2006) develops in his paper *An Equilibrium Model of Child Maltreatment*.
- The layout of the model is the following.
- The child's human capital development in each period follows a linear low of motion:

$$h_{\tau+1} = (1-\delta)h_\tau + \varphi s_\tau H^\gamma + \phi a_\tau \tag{16}$$

  for $\tau = 1, \ldots, T$.
- δ is a human capital depreciation parameter, φ, ϕ, γ are technology parameters, and H is the given and fixed parent's human capital.
- $s_\tau \in [0,1]$ and a_τ are endogenous variables.

- The parents are not able to observe either the true level of human capital of the children or the effort they make.
- Instead, at each time τ, they observe an outcome variable, y_τ, which evolves according to the following linear rule:

$$y_\tau = h_\tau + a_\tau + \nu_\tau \tag{17}$$

where $\nu_\tau \sim N(0, \sigma^2_{\nu\tau})$ for $\tau = 1, \ldots, T$.

- The author lets $\sigma^2_{\nu\tau} \equiv \frac{K}{s_\tau}$ because more time spent with the child reduces the uncertainty of the observation error.
- (16) is interpreted as the state equation and (17) as the observation equation.
- The author postulates a linear incentive schedule.

- The service, d_τ, is as follows:

$$d_\tau = (s_\tau + b_\tau \mathbb{E}[a_\tau | I_\tau])\, H^\gamma \tag{18}$$

  for $\tau = 1, \ldots, T$ where b_τ is defined as the slope of the incentive schedule and is an endogenous decision of the parent.
- $I_t \equiv \{y_t, \ldots y_1\}$ is the information set at t.
- Suppose that a parent picks a relatively high b_τ and that the observation of his daughter's performance, y_τ, deviates from his human capital forecast, $\hat{h}_\tau$, by a lot such that $y_\tau - \hat{h}_\tau$ is very negative.
- Then, d_τ is relatively low and the child suffers from a low service, which the author interprets as abuse.

- The child's utility function is

$$\max_{\{a_\tau\}_{\tau=1}^T} \mathbb{E}\left[u\left(\sum_{\tau=t}^{T} \frac{1}{1+\rho_{ct}}^{\tau-t}(d_\tau - v(a_\tau)) + \frac{1}{1+\rho_{ct}}^{T-t+1} Bh_{T+1}\right)|I_{t-1}\right] \tag{19}$$

subject to (16) and (18) and given $\{s_\tau, b_\tau\}$.
- The parent's utility function is

$$\max_{\{b_\tau, s_\tau\}_{\tau=1}^T} \mathbb{E}\left[U\left(\sum_{\tau=t}^{T} \frac{1}{1+\rho_{pt}}^{\tau-t}[c_\tau + \alpha u(\cdot, a_\tau))]\right)|I_{t-1}\right] \tag{20}$$

subject to $c_\tau = \pi(1-s_\tau)H^\gamma$, (16), (17), (18) and to the child's optimal decision rule, and where c_τ is consumption at τ, and π efficiency unit wage.
- The Nash Equilibrium of the model can be solved easily.

- The child decides the optimal level of effort to solve her utility maximization problem by taking parent's choices, $\{b_\tau, s_\tau\}_{\tau=1}^{T}$, as given.
- The parent solves his utility maximization problem to choose the optimal level of time and incentive slope by taking the optimal decision rule of the kid as given.

- First, when the parent receives a new observation, y, he updates his contemporaneous belief about the child's current level of human capital by taking an average of the previous belief and the new observation weighted by the degree of uncertainty:

$$\hat{h}^u = \hat{h} + \frac{A'(\hat{h})\sigma_h^2}{A'(\hat{h})^2\sigma_h^2 + \sigma_v^2}(y - A(\hat{h}) - C(\sigma_h^2)) \tag{21}$$

- Then, the parent uses the updated belief, $\hat{h}^u$, and the human capital formation rule to forecast the child's human capital level in next period:

$$\hat{h}' = F(\hat{h}^u) + G(\sigma_h^2) \tag{22}$$

- Finally, the parent updates the uncertainty regarding the child's human capital:

$$(\sigma_h^2)' = \Phi \sigma_h^2 \tag{23}$$

where

$$A(\hat{h}) = \hat{h} + \phi\psi D_t(\hat{h}) \tag{24}$$

$$A'(\hat{h}) = 1 + \phi\psi D_t'(\hat{h}) \tag{25}$$

$$C(\sigma_h^2) = \underline{a} + \frac{\psi}{R\alpha\sigma_h^2 - \psi}(\underline{a} + \psi\phi D_t(H) - KR\alpha Q_t) \tag{26}$$

$$F(\hat{h}^u) = (1-\delta)\hat{h}^u + \phi^2\psi D_t(\hat{h}^u) \tag{27}$$

$$G(\sigma_h^2) = \phi[\underline{a} + \frac{\psi}{R\alpha\sigma_h^2 - \psi}(\underline{a} + \psi\phi D_t(H) - KR\alpha Q_t)] + \psi s^* H^\gamma \tag{28}$$

$$\Phi = \frac{F'(\hat{h}^u)^2\sigma_v^2}{A'(\hat{h}^u)^2\sigma_h^2 + \sigma_v^2} \tag{29}$$

$$F'(\hat{h}^u) = (1-\delta) + \phi^2\psi D_t'(\hat{h}^u) \tag{30}$$

Simulation Parametrization

- I use the following parameters and functional forms to simulate the model:
  - Time Horizon: $T = 80$.
  - Technology parameters: $\phi = .7, \varphi = .01, \delta = .001, \gamma = 0.5$
  - Preference parameters:
    $\psi =, 7, \underline{a} = 7, K = 1.5, R = 2, \alpha = .9, B = 50$
  - Human Capital Parameters: $h_1 = 100, H = 40000$.
  - Filter Initial Values: $\hat{h}_1 = 200, \sigma^2_{h1} = 5000$.
  - Other parameters: $K = 1.5, \pi = 2$.
  - Discount Rates: $\rho_i(h) = \exp(-.02 * h)$ for $i = p, c$.

Simulation Results

Figure 10: log Incentive Slope and log Time Spent with the Child

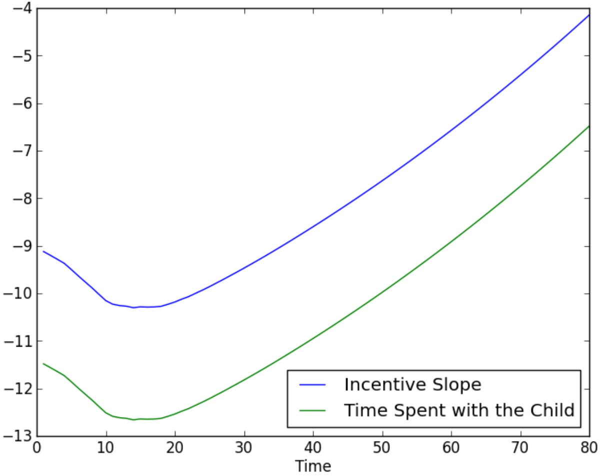


Figure 11: Child's Effort

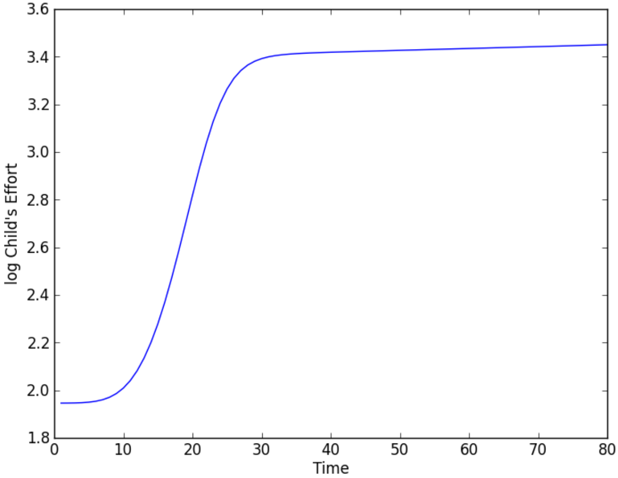


Figure 12: Human Capital

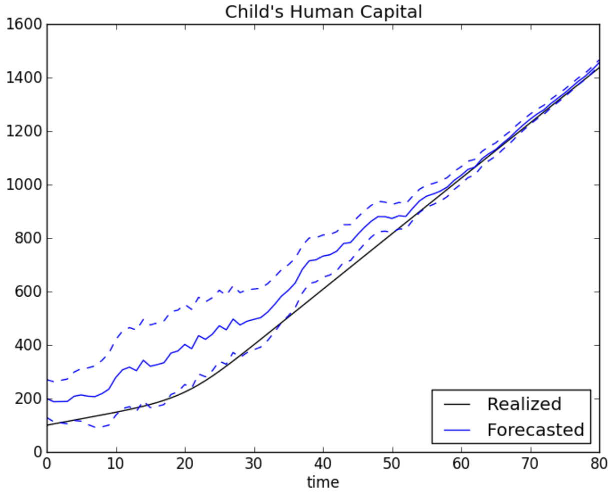
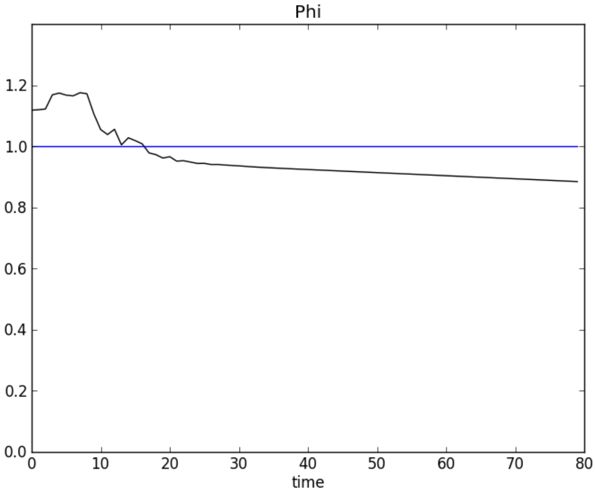


Figure 13: Phi



Parental Responses to High-quality Interventions

García & Heckman

Program Design

- Implemented years: 1962–1967
- 5 cohorts of 3–4 year olds; 123 participants
- Target population: African American children at risk for cultural deprivation
- Treatment lasted 1–2 years and included center-based care and home visits & parenting instruction

- Implemented years: 1972–1982
- 4 cohorts beginning at birth; 111 participants
- Target population fulfilled High Risk Index, including parents' IQ, father at home, etc.
- Treatment lasted 5 years and included center-based care, formula, diapers, health check-ups, and medical care

Table 4: Eligibility Criteria

Criteria	ABC	Perry
African-American		✓
Own IQ	✓	✓
Special circumstances	✓[1]	
Mother's Education	✓	✓
Mother's Employment		✓[2]
Mother's IQ	✓	
Father's Education	✓	✓
Father's Presence	✓	✓
Family Income	✓	
Father's Employment	✓	✓
Father's IQ	✓	
Housing Density		✓
Family on Welfare	✓	
Absence of Maternal Relatives	✓	
Sibling's IQ	✓[3]	
Sibling behind in School	✓	
Agency Referral	✓	
Mental Health Help	✓	

1. Three children were classified as being in special health circumstances by the program administrators and were automatically placed in the treatment group –not taken into account in 13 items index.

Selected Treatment Effects on Later-life Outcomes

Table 5: Selected Treatment Effects: ABC

	Treatment Effect	Asy, 1 Tail	Asy, 2 Tails	Perm, 1 Tail	Perm 2 Tails
			Females		
HS Grad	0.156	0.125	0.249	0.098	0.257
Years of Education	2.182	0.001	0.003	0.000	0.006
Works	0.039	0.378	0.756	0.256	0.759
Income	4939.819	0.251	0.503	0.257	0.530
			Males		
HS Grad	0.186	0.090	0.181	0.029	0.223
Years of Education	0.881	0.076	0.151	0.022	0.172
Works	0.291	0.007	0.013	0.006	0.016
Income	15968.022	0.079	0.157	0.021	0.096

Note: this tables displays treatment effects of ABC in outcomes at age 30, as measured by the mean differences between the control and treatment groups. In all the calculations we control for a high-risk index of 13 items at baseline. Individuals were eligible to the program if they comply with 11 of these items. We present one and two-tailed asymptotic and permutation $p - value$'s. The permutation $p - value$'s are analogous to those in Heckman et al. (2010). We use number of siblings and a "mother works" indicator at baseline to construct the permutation orbits.

Table 5: Selected Treatment Effects Cont'd: Perry

	Treatment Effect	Asy, 1 Tail	Asy, 2 Tails	Perm, 1 Tail	Perm 2 Tails
			Females		
HS Grad at Age 40	0.233	0.047	0.094	0.008	0.059
(-) Teen Parent	0.159	0.083	0.165	0.000	0.406
Income at 27	4828.682	0.189	0.378	0.061	0.329
			Males		
HS Grad at Age 40	0.053	0.333	0.665	0.389	0.615
(-) Felonies at 27	0.870	0.048	0.096	0.038	0.054
Income at 27	2986.292	0.289	0.578	0.362	0.545

Note: this tables displays treatment effects of Perry in later life outcomes, as measured by the mean differences between the control and treatment groups. Felonies at age 27 and Teen Parent are reversed. In all the calculations we control for a socio-economic index, which was used in the randomization protocol, based on household density and parental education at baseline. We present one and two-tailed asymptotic and permutation $p - value$'s. The permutation $p - value$'s are analogous to those in Heckman et al. (2010). We use number of siblings and a "mother works" indicator at baseline to construct the permutation orbits.

Methodology

Overview

- Construct principal components to measure
  - Non-cognitive or Character Skills
  - Parenting Behavior
- Measure cognitive skills through IQ tests
- Laspeyres decomposition of treatment effects later in life
  - Parenting behavior, character, and cognitive skills as mediators

- D_i indicator of treatment for individual i
- $Y^d_{i,k}, M^d_{i,k}, V^d_{i,k}$ denote outcomes, measures, and an unobserved term for outcome k, in either treatment or control $d \in \{0,1\}$
- Write counterfactual outcomes as

$$\begin{aligned} Y^0_{i,k} + \beta^0_0 + \beta^0_k M^0_{i,k} + V^0_{i,k} \\ Y^1_{i,k} + \beta^1_0 + \beta^0_k M^1_{i,k} + V^1_{i,k} \end{aligned} \tag{31}$$

- for $J = Y, M, V$, write outcomes, measures, and the observed term as

$$J_{i,k} = J^0_{i,k}(1 - D_i) + J^1_{i,k} D_i \tag{32}$$

- Write kth outcome as

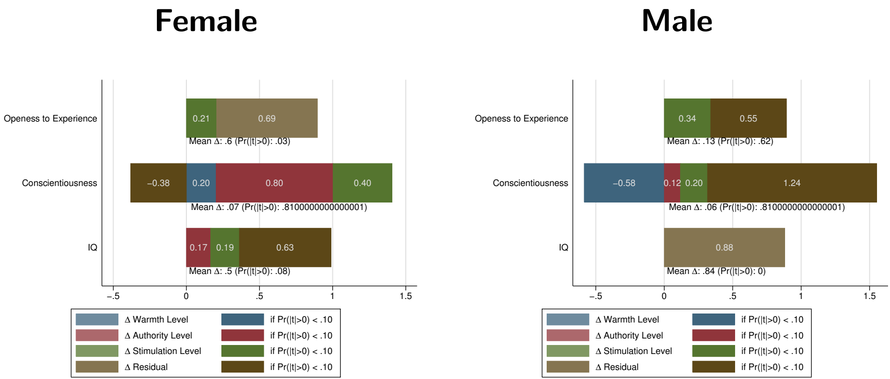
$$\begin{aligned} Y_{i,k} = \beta^0_{0,k}(1 - D_i) &+ \beta^1_{0,k} D_i + \left[\beta^0_k M^0_{i,k}\right](1 - D_i) \\ &+ \left[\beta^1_k M^1_{i,k}\right] D_i + V_{i,k} \end{aligned} \tag{33}$$

- Asumme $\beta_k^0 = \beta_k^1 \equiv \beta_k$
- Decompose the conditional mean as follows:

$$\begin{aligned}\underbrace{\mathbb{E}[Y_{i,k}^1 - Y_{i,k}^0 | D_i]}_{\text{Mean } \Delta} &= \underbrace{\mathbb{E}[M_{i,k}^1 - M_{i,k}^0]\beta_k}_{\Delta \text{ Level}} \\ &+ \underbrace{\left(\beta_{0,k}^1 - \beta_{0,k}^0\right)}_{\Delta \text{ Residual}} \end{aligned} \tag{34}$$

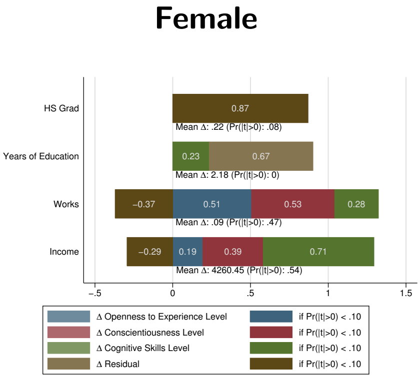
Results for ABC

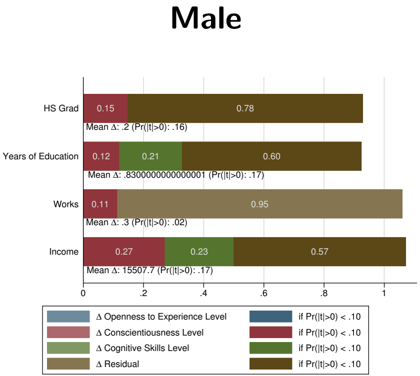
Parenting Behavior as Mediator of Early Skills



Note: this plot is a graphical display of a Laspeyres decomposition of the outcomes in the the y-axis in three different measures of parenting behavior. Below the bar we display the mean difference in the outcome. Then, we decompose the length of these changes, which we normalize to one, in the experimentally induced treatment effects in parenting behavior. We measure the outcomes as factors of extensive behavior batteries at ages 6, 7, and 8. We measure parenting behavior as factors of extensive parenting batteries at age 5.

Early Skills as Mediators of Later Life Outcomes

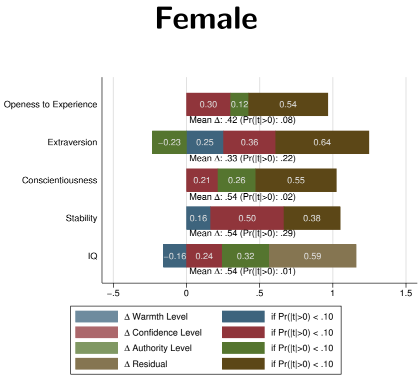


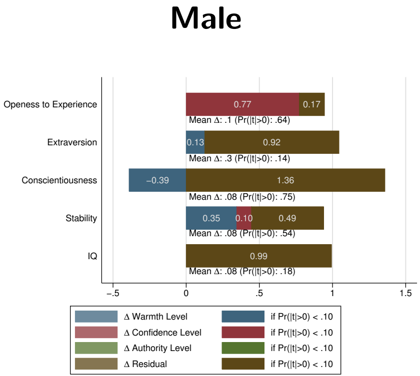


Note: this plot is a graphical display of a Laspeyres decomposition of the outcomes in the the y-axis in three different skills. Below the bar we display the mean difference in the outcome. Then, we decompose the length of these changes, which we normalize to one, in the experimentally induced treatment effects in skills. All the outcomes are at age 30. We measure skills based on extensive behavior and intelligence measures at age 15.

Results for Perry

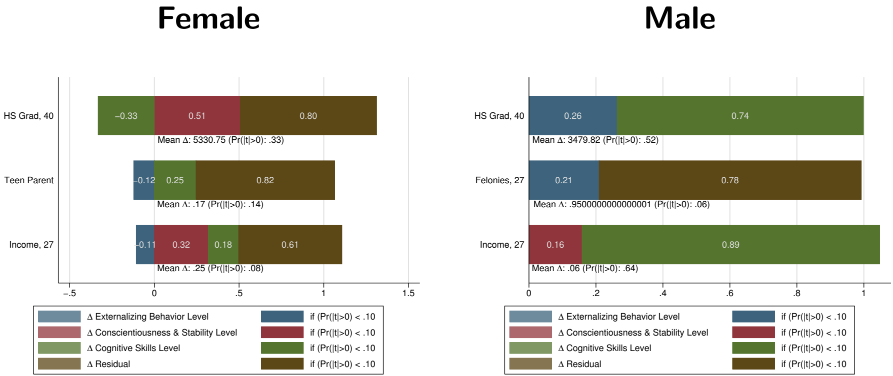
Parenting Behavior as Mediator of Early Skills





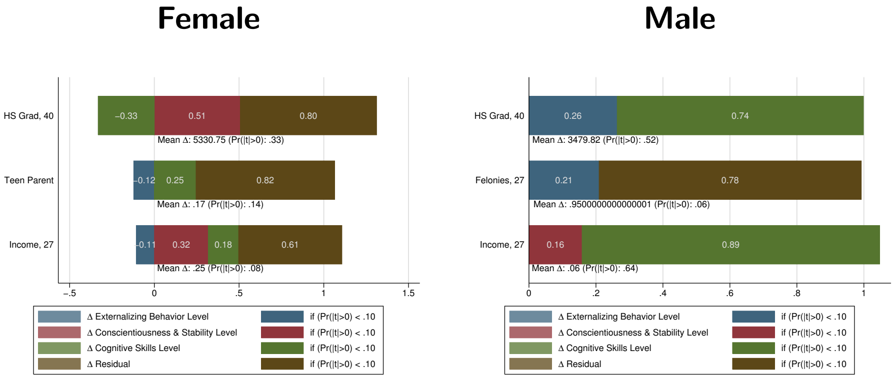
Note: this plot is a graphical display of a Laspeyres decomposition of the outcomes in the the y-axis in three different measures of parenting behavior. Below the bar we display the mean difference in the outcome. Then, we decompose the length of these changes, which we normalize to one, in the experimentally induced treatment effects in parenting behavior. We measure the outcomes as factors of extensive behavior batteries at ages 6, 7, and 8. We measure parenting behavior as factors of extensive parenting batteries at age 5.

Early Skills as Mediators of Later Life Outcomes



Note: this plot is a graphical display of a Laspeyres decomposition of the outcomes in the the y-axis in three different skills. Below the bar we display the mean difference in the outcome. Then, we decompose the length of these changes, which we normalize to one, in the experimentally induced treatment effects in skills. All the outcomes are at age 30. We measure skills based on extensive behavior and intelligence measures at ages 6, 7, and 8.

Early Skills and Parenting as Mediators of Later Life Outcomes



Note: this plot is a graphical display of a Laspeyres decomposition of the outcomes in the the y-axis in three different skills. Below the bar we display the mean difference in the outcome. Then, we decompose the length of these changes, which we normalize to one, in the experimentally induced treatment effects in skills and parenting behavior. All the outcomes are at age 30. We measure character skills based on extensive behavior measures assessing openness to experience, conscientiousness, extraversion, and emotional stability at ages 6, 7, and 8. We measures cognitive skills through IQ. We measure parenting behavior as factors of extensive parenting batteries at age 5.

Parental Responses to High Quality Interventions: Data Construction

Data Construction

ABC

Age 5, Parenting Behavior

Table 6: Warmth, HOME, Age 5

Item Number	Item Wording
50	Child is not punished or ridiculed for speech
56	Parent holds child close ten to fifteen minutes per day, e.g. during TV, story time, visiting
59	Child's art work is displayed some place in house (anything that child makes)
61	Mother converses with child at least twice during visit (scolding and suspicions comments not counted)
62	Mother answers child's questions or requests verbally
63	Mother usually responds verbally to child's talking
65	Mother spontaneously praises child's qualities or behavior twice during visit
66	When speaking of or to child, mother's voice conveys positive feeling
67	Mother caresses, kisses or cuddle child at least once during visit
68	Mother sets up situation that allows child to show off during visit

Table 7: Authority, HOME, Age 5

Item Number	Item Wording
33	Some delay of food gratification is demanded for the child, e.g. not to whine or demand food unless within 1/2 hour of meal time
46	Mother does not scold or derogate child more than once during visit
47	Mother does not use physical restrain, shake, grab, pinch child during visit
48	Mother neither slaps nor spanks child during visit
49	Mother does not express over-annoyance with or hostility toward child–complain, say child is 'bad' or won't mind
51	No more than one instance of physical punishment occurred during the past week (accept parental report)
52	Child does not get slapped or spanked for spilling food or drink
75	Child is permitted to choose some of his clothing to be worn except on very special occasions
76	Child is permitted some choice in lunch or breakfast menu
77	Parent lets child choose certain favorite food products or brands at grocery store?
78	Child is permitted to go to another house to play without having the caregiver accompany him
79	Child can express negative feelings without harsh reprisal
80	Child is permitted to hit parent without harsh reprisal

Table 8: Stimulation, HOME, Age 5

Item Number	Item Wording
16	Family member has taken child on one outing (picnic, shopping excursion) at least every other week
17	Child has been taken out to eat in some kind of restaurant three-four times in the past year
18	Child has been taken by a family member to the following within the past year: Airport
19	Child has been taken by a family member to the following within the past year: A trip more than 50 miles from home (50 mile radial distance, not total distance)
20	Child has been taken by a family member to the following within the past year: A scientific, historical, or art museum
21	Child is taken to grocery store at least once a week
22	Child is encouraged to learn the following: Colors
23	Child is encouraged to learn the following: Shapes
24	Child is encouraged to learn the following: Patterned speech (nursery rhymes, prayers, songs, TV commercials, etc.)

Table 9: Stimulation, HOME, Age 5

Item Number	Item Wording
25	Child is encouraged to learn the following: The alphabet
26	Child is encouraged to learn the following: To tell time
27	Child is encouraged to learn the following: Spatial relationships (up, down, under, big, little, etc.)
28	Child is encouraged to learn the following: Numbers
29	Child is encouraged to learn the following: To read a few words
31	Child is taught rules of social behavior which involve recognition of rights of others
32	Parent coaches child some simple manners – to say, ‘Please,’ ‘Thank you’, ‘I’m sorry’
42	Mother used complex sentence structure and some long words in conversing
43	Mother uses correct grammar and pronunciation
44	Mother’s speech is distinct clear and audible
53	Parent turns on special TV program regarded as good for children (Captain Kangaroo, Magic Toy Shop, Walt Disney, Flipper, Lassie, Educational TV, etc

Table 10: Stimulation, HOME, Age 5

Item Number	Item Wording
54	Someone reads stories to child or shows and comments on pictures in magazines five times weekly
55	Parent encourages child to relate experiences or takes time to listen to him relate experiences
57	Parent occasionally sings to child, or sings in presence of child
60	Mother introduces interviewer to child
64	Mother provides toys or interesting activities or in other ways structures situation for child during visit when her attention will be elsewhere (To score yes mother must make an active guiding gesture or suggestion to structure child's play)
69	Child sees and spends some time with father or father figure four days a week
70	Child eats at least one meal per day, on most days, with mother (or mother figure) and father (or father figure) (One-parent families get an automatic 'no')

Ages 5 to 15, Skill Measures

Table 11: Conscientiousness

Instrument	Ages
Achenbach	8, 12, 15
CBI	5y6m, 5y9m, 6, 6y6m, 7, 7y6m, 8, 12
Kohn & Rosman	5, 12
Walker	7y6m

Table 12: Openness

Instrument	Ages
Achenbach	8, 12, 15
CBI	5y6m, 5y9m, 6, 6y6m, 7, 7y6m, 8, 12

Table 13: IQ

Instrument	Ages
Stanford Binet	2, 3, 4, 5, 6
McCarthy	3y6m, 4y6m, 7
Wechsler	5, 6y6m, 8, 12, 15

Age 15, Personality Measures

Table 14: Conscientiousness, Achenbach Age 15

Item Number	Item Wording
2	Hums or makes other odd noises in class
4	Fails to finish things he/she starts
20	Destroys his/her own things
21	Destroys property belonging to others
22	Difficulty following directions
23	Disobedient at school
24	Disturbs other pupils
28	Breaks school rules
39	Hangs around with others who get in trouble
41	Impulsive or acts without thinking
43	Lying or cheating
44	Bites fingernails
49	Has difficulty learning
53	Talks out of turn

Table 15: Conscientiousness, Achenbach Age 15

Item Number	Item Wording
59	Sleeps in class
60	Apathetic or unmotivated
61	Poor school work
67	Disrupts class discipline
72	Messy work
73	Behaves irresponsibly
82	Steals
90	Swearing or obscene language
92	Underachieving, not working up to potential
98	Tardy to school or classes
99	Smokes, chews, or sniffs tobacco
100	Fails to carry out assigned tasks
101	Truancy or unexplained absence
105	Uses drugs for non-medical purposes (does not include tobacco)
107	Dislikes school

Table 16: Openness to Experience, Achenbach Age 15

Item Number	Item Wording
5	There is very little he/she enjoys
11	Clings to adults or too dependent
47	Over-conforms to rules

Perry

Parenting Behavior

Table 17: Parent Authority, PARI

Item Number	Item Wording
Fostering Dependency	
2	A good mother should shelter her child from life's little difficulties.
25	A mother should do her best to avoid any disappointment for her child.
48	A child should be protected from jobs which might be too hard or tiring for him.
71	Parents should know better than to allow their children to be exposed to difficult situations.
94	Children should be kept away from all hard jobs which might be discouraging.
Excluding Outside Influences	
10	It's best for the child if he never gets started wondering whether his mother's views are right.
33	A parent should never be made to look wrong in a child's eye.
56	Children should never learn things outside the home which make them doubt their parents' ideas.
79	The children should not question the thinking of his parents.
102	There is nothing worse than letting a child hear criticisms of his mother.

Table 18: Parent Authority, PARI

Item Number	Item Wording
Suppression of Sexuality	
18	A young child should be protected from hearing about sex.
41	It is very important that young boys and girls not be allowed to see each other completely undressed.
64	Children who take part in sex play become sex criminals when they grow up.
87	Sex is one of the greatest problems to be contended with in all children.
110	There is usually something wrong with a child who asks a lot of questions about sex.
Encouraging Verbalization	
1	Children should be allowed to disagree with their parents if they feel their own ideas are better.
24	Children should be encouraged to tell their parents about it whenever they feel family rules are unreasonable.
47	A child has a right to his own point of view, and ought to be allowed to express it.
70	A childs' ideas should be seriously considered in making family decisions.
93	When a child is in trouble, he ought to know he won't be punished for talking about it with his parents.

Table 19: Parent Authority, PARI

Item Number	Item Wording
Equalitarianism	
14	Parents should adjust to the children some rather than always expecting the children to adjust to the parents.
37	Parents must earn the respect of their children by the way they act.
60	Children are too often asked to do all the compromising and adjustment and that is not fair.
83	As much as is reasonable, a parent should try to treat a child as an equal.
106	There is no reason parents should have their own way all the time, any more than that children should have their own way all the time.
Approval of Activity	
15	There are so many things a child has to learn in life there is no excuse for him sitting around with time on his hands.
38	Children who dont try hard for success will feel they have missed out on things later on.
61	Parents should teach their children that the way to get ahead is to keep busy and not waste time.
84	A child who is "on the go" all the time will most likely be happy.
107	The sooner a child learns that a wasted minute is lost forever the better off he will be.

Table 20: Parent Authority, PARI

Item Number	Item Wording
Breaking the Will	
4	Some children are just so bad they must be taught to fear adults for their own good.
27	It is frequently necessary to drive the mischief out of a child before he will behave.
50	A wise parent will teach a child early just who is boss.
73	Children need some of the natural meanness taken out of them.
96	It is sometimes necessary for the parents to break the child's will.
Deification	
11	More parents should teach their children to have unquestioning loyalty to them.
34	A child should be taught to revere his parents above all other grown-ups.
57	Children soon learn that there is no greater wisdom than that of his parents.
80	Parents deserve the highest esteem and regard of their children.
103	Loyalty to parents comes before anything else.

Table 21: Parent Authority, PARI

Item Number	Item Wording
Intrusiveness	
20	A mother should make it her business to know everything her children are thinking.
43	A child should never keep a secret from his parents.
66	An alert parent should try to learn all her child's thoughts.
89	A mother has a right to know everything going on in her child's life because her child is part of her.
112	It is a mother's duty to make sure she knows her child's innermost thoughts.
Strictness	
8	A child will be grateful later on for strict training.
31	Strict discipline develops a fine strong character.
54	Children who are held to firm rules grow up to be the best adults.
77	Most children should have more discipline.
100	Children are actually happier under strict training.

Table 22: Parent Confidence, PARI

Item Number	Item Wording
Rejecting of the Homemaking role	
13	One of the worst things about taking care of a home is a woman feels that she can't get out.
36	Having to be with the children all the time gives a woman the feeling that her wings have been clipped.
59	Most young mothers are bothered more by the feeling of being shut up in the home than by anything else.
82	One of the bad things about raising children is that you aren't free enough of the time to do just as you like.
105	A young mother feels "held down" because there are lots of things she wants to do while she is young.
Acceleration of Development	
22	Most children are toilet trained by 15 months of age.
45	The sooner a child learns to walk the better he's trained.
68	The earlier a child is weaned from its emotional ties to its parents the better it will handle its own problems.
91	A mother should make an effort to get her child toilet trained at the earliest possible time.
114	A child should be weaned away from the bottle or breast as soon as possible.

Table 23: Parent Confidence, PARI

Item Number	Item Wording
Dependency of the Mother	
23	There is nothing worse for a young mother than being alone while going through her first experience with a baby.
46	It isn't fair that a woman has to bear just about all the burdens of raising children by herself.
69	A wise woman will do anything to avoid being by herself before and after a new baby.
115	Taking care of a small baby is something that no woman should be expected to do all by herself.
6	You must always keep tight hold of baby during his bath for in a careless moment he might slip.
Fear of Harming the Baby	
29	All young mothers are afraid of their awkwardness in handling and holding the baby.
52	Mothers never stop blaming themselves if their babies are injured in accidents.
75	Most mothers are fearful that they may hurt their babies in handling them.
98	A mother's greatest fear is that in a forgetful moment, she might let something happen to the baby.

THE UNIVERSITY OF CHICAGO

Table 24: Parent Conflict, PARI

Item Number	Item Wording
Seclusion of the Mother	
3	The home is the only thing that matters to a good mother.
26	The woman who want lots of parties seldom make good mothers.
49	A woman has to choose between having a well-run home and hobnobbing around with neighborhood friends.
72	Too many women forget that a mother's place is in the home.
95	A good mother will find enough social life within the family.
Marital Conflict	
7	People who think they can get along in marriage without arguments just don't know the facts.
30	Sometimes it's necessary for a wife to tell off her husband in order to get her rights.
53	No matter how well a married couple love one another, there are always differences which cause irritation and lead to arguments.
76	There are some things which just can't be settled by a mild discussion.
99	It's natural to have quarrels when two people how have minds of their own get married.

THE UNIVERSITY OF CHICAGO

Table 25: Parent Conflict, PARI

Item Number	Item Wording
Ascendancy of the Mother	
19	If a mother doesn't go ahead and make rules for the home the children and husband will get into troubles they don't need to.
42	Children and husbands do better when the mother is strong enough to settle most of the problems.
65	A mother has to do the planning because she is the one who knows what's going on in the home.
88	The whole family does fine if the mother puts her shoulders to the wheel and takes charage of things.
111	A married woman knows that she will have to take the lead in family matters.
Inconsiderateness of the Husband	
17	Mothers would do their job better with the children if fathers were more kind.
40	Husbands could do their part if they were less selfish.
63	When a mother doesn't do a good job with children, it's probably because the father doesn't do his part around the home.
86	If mothers could get their wishes, they would most often ask that their husband be more understanding.
109	Few men realize that a mother needs some fun in life too.

Table 26: Parent School Involvement, PARI

Item Number	Item Wording
School Dedication	
61 (1964 edition)	A parent can't make a child do homework if he doesn't want to.
65 (1964 edition)	Some children are always late for school no matter what the mother does.
67 (1964 edition)	A mother can't be sure that a child will go to school once he leaves home in the morning.
A	A child can probably get a good job if he's willing to work hard even though he does not graduate from high school.
C	A busy mother does not have time to read to her children.
E	It is important for parents to know what their children are learning in school. In form 1964, a busy mother doesn't have time to find out what her children are learning in school.)
G	A child will probably do better in school if his mother looks at the papers he brings home from school.
I	It's more important for a child to learn to do things with his hands than to read books.
K	Many important people never finished high school.
L	There is nothing a mother can do with a child who wants to quit school.
N	It's not the parent's fault if a child quits school.
O	Few of the things you learn in high school are really practical after you grow up.
Q	If a child is needed to help at home, it is all right for the child to miss school.
R	If a child doesn't like school, he may as well quit when he is old enough.
S	It is not important for a girl to finish high school because she will get married soon anyway.
School Interaction	
B	Most mothers feel very comfortable when they go up to school.
D	The principal is an easy man to talk to.
H	Most parents are satisfied with the Ypsilanti Public Schools.

Table 27: Parent Warmth, PARI

Item Number	Item Wording
Irritability	
9	Children will get on any woman's nerves if she has to be with them all day
32	Mothers very often feel that they can't stand their children a moment longer.
55	It is a rare mother who can be sweet and even-tempered with her children all day.
78	Raising children is a nerve-wracking jobs.
101	It's natural for a mother to "blow her top" when children are selfish and demanding.
Comradeship and Sharing	
21	Children would be happier and better behaved if parents would show an interest in their affairs.
44	Laughing at children's jokes and telling children jokes makes things go more smoothly.
67	Parents who are interested in hearing about their children's parties, dates, and fun help them grow up right.
90	If parents should have fun with their children, the children would be more apt to take their advice.
113	When you do things together, children feel close to you and can talk easier.

THE UNIVERSITY OF CHICAGO

Table 28: Parent Warmth, PARI

Item Number	Item Wording
Avoidance of Communication	
16	If you let children talk about their troubles they end up complaining even more.
39	Parents who start a child talking about his worries don't realize that sometimes it's better to just leave well enough alone.
62	Parents should teach their children that the way to get ahead is to keep busy and not waste time.
85	If a child has upset feelings, it is best to leave him alone and not make it look serious.
108	The trouble with giving attention to children's problems is they usually just make up a lot of stories to keep you interested.
Martyrdom	
5	Children should realize how much parents have to give up for them.
28	A mother must expect to give up her own happiness for that of her child.
51	Few women get the gratitude they deserve for all they have done for their children.
74	Children should be more considerate of their mothers since their mothers suffer so much for them.
97	Mothers sacrifice almost all their own fun for their children.

Ages 3 to 14, Skill Measures

Table 29: Conscientiousness

Instrument	Age
Pupil Behavior Inventory	6, 7, 8, 9

Table 30: Openness to Experience

Instrument	Age
Pupil Behavior Inventory	6, 7, 8, 9
Ypsilanti Rating Scale	6, 7, 8, 9

Table 31: Extraversion

Instrument	Age
Pupil Behavior Inventory	6, 7, 8, 9
Ypsilanti Rating Scale	6, 7, 8, 9

Table 32: Emotional Stability

Instrument	Age
Pupil Behavior Inventory	6, 7, 8, 9
Ypsilanti Rating Scale	6, 7, 8, 9

Table 33: IQ

Instrument	Age
Stanford Binet	3, 4, 5, 6, 7, 8, 9, 10
Wechsler	14

Towards a More General Model of Parent-Child Interactions

- The productivity of any investment or parental stimulus is influenced by the child's response to it.
- Parents and children can have different goals.
- For example, the child can be more shortsighted than the parent (Akabayashi, 2006b) or have different values for leisure and future human capital (Cosconati, 2013b).
- The parent may act as a principal whose goal is to maximize the effort from an agent—their child.

Summary

- Recent literature: multiple-generation models with multiple periods of childhood and adulthood.
- It emphasizes the dynamics of skill formation.
- Central to the literature are the concepts of *complementarity*, *dynamic complementarity*, the *multiplicity of skills*, and *critical* and *sensitive periods* for different skills.
- These concepts account for a variety of empirical regularities that describe the process of human development.

- Family environments during the early years and parenting are critical determinants of human development because they shape the lifetime skill base.
- Through dynamic complementarity, they enhance the productivity of downstream investments.
- Establish conditions under which it is socially productive to invest in the early years of disadvantaged children.

- Mentoring, parenting, and human interaction are the unifying themes of successful skill-development strategies across the entire life cycle.
- The study of parent-child interactions as an emergent system is a promising approach to human development.
- Effective early life interventions promote beneficial changes in parenting.

- The analysis of parent-child interactions and parental learning; the formalization of the notions of attachment, mentoring, and scaffolding; and their integration into life-cycle overlapping generations models with dynamic skill accumulation constitute the research frontier in the field.

Appendix E: Evidence on The Predictive Power of Cognitive and Socioemotional Traits

- The Big Five Traits are considered the "latitude and longitude of personality by personality" psychologists.
- They are defined in Table 34.

Table 34: The Big Five Domains and Their Facets

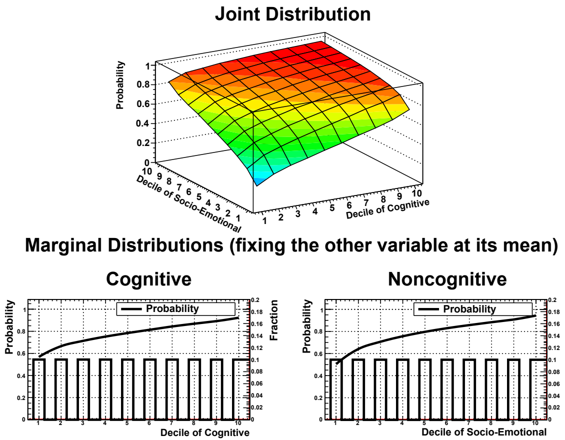
Big Five Personality Factor	American Psychology Association Dictionary Description	Facets (and correlated skill adjective)	Related Skills	Analogous Childhood Temperament Skills
Conscientiousness	"The tendency to be organized, responsible, and hardworking"	Competence (efficient), Order (organized), Dutifulness (not careless), Achievement striving (ambitious), Self-discipline (not lazy), and Deliberation (not impulsive)	Grit, Perseverance, Delay of gratification, Impulse control, Achievement striving, Ambition, and Work ethic	Attention/(lack of) distractibility, Effortful control, Impulse control/delay of gratification, Persistence, Activity*
Openness to Experience	"The tendency to be open to new aesthetic, cultural, or intellectual experiences"	Fantasy (imaginative), Aesthetic (artistic), Feelings (excitable), Actions (wide interests), Ideas (curious), and Values (unconventional)		Sensory sensitivity, Pleasure in low-intensity activities, Curiosity
Extraversion	"An orientation of one's interests and energies toward the outer world of people and things rather than the inner world of subjective experience; characterized by positive affect and sociability"	Warmth (friendly), Gregariousness (sociable), Assertiveness (self-confident), Activity (energetic), Excitement seeking (adventurous), and Positive emotions (enthusiastic)		Surgency, Social dominance, Social vitality, Sensation seeking, Shyness*, Activity*, Positive emotionality, and Sociability/affiliation
Agreeableness	"The tendency to act in a cooperative, unselfish manner"	Trust (forgiving), Straight-forwardness (not demanding), Altruism (warm), Compliance (not stubborn), Modesty (not show-off), and Tender-mindedness (sympathetic)	Empathy, Perspective taking, Cooperation, and Competitiveness	Irritability*, Aggressiveness, and Willfulness
Neuroticism/ Emotional Stability	Emotional stability is "Predictability and consistency in emotional reactions, with absence of rapid mood changes." Neuroticism is "a chronic level of emotional instability and proneness to psychological distress"	Anxiety (worrying), Hostility (irritable), Depression (not contented), Self-consciousness (shy), Impulsiveness (moody), Vulnerability to stress (not self-confident)	Internal versus External, Locus of control, Core self-evaluation, Self-esteem, Self-efficacy, Optimism, and Axis I psychopathologies (mental disorders) including depression and anxiety disorders	Fearfulness/behavioral inhibition, Shyness*, Irritability*, Frustration, (Lack of) soothability, Sadness

Notes: *These temperament attributes may be related to two Big Five factors. Facets specified by the NEO-PI-R personality inventory (Costa and McCrae, 1992). Adjectives in parentheses from the Adjective Check List (Gough and Heilbrun, 1983).
Source: Table adapted from John and Srivastava (1999).

- Borghans et al. (2008) and Almlund et al. (2011) present evidence on the predictive power of cognitive and social and emotional traits outcomes.
- The following figures taken from Heckman et al. (2011) shows the effect of child capacities on diverse outcomes correcting for the effect of schooling on capacities and the effect of capacities on schooling.

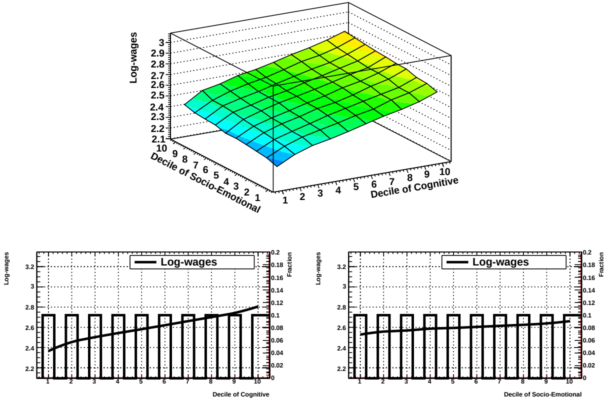
- There is a causal effect of schooling on these capacities.
- These empirical relationships account for reverse causality — measured capacities may be determined in part by schooling.
- The graphs show outcomes graphed against deciles of the cognitive and personality distributions.
- For a detailed description of the methodology see Heckman et al. (2011) and Almlund et al. (2011).

Figure 14: The Probability of Educational Decisions, by Endowment Levels, Dropping from Secondary School vs. Graduating



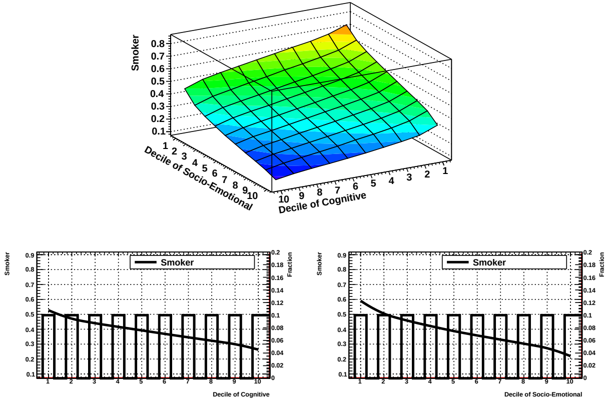
Source: Heckman, Humphries, Urzúa, and Veramendi (2011).

Figure 15: The Effect of Cognitive and Socio-emotional endowments, (log) Wages



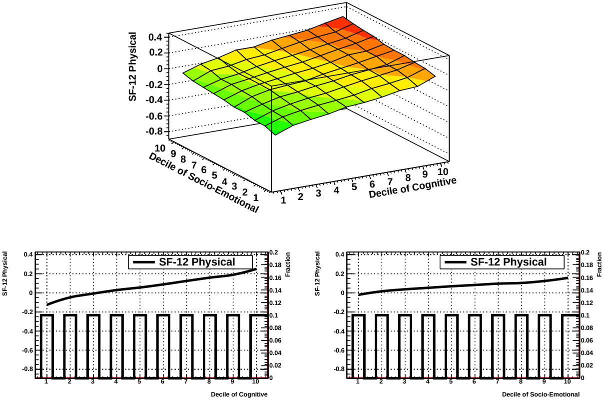
Source: Heckman, Humphries, Urzúa, and Veramendi (2011).

Figure 16: The Effect of Cognitive and Socio-emotional endowments, Daily Smoking



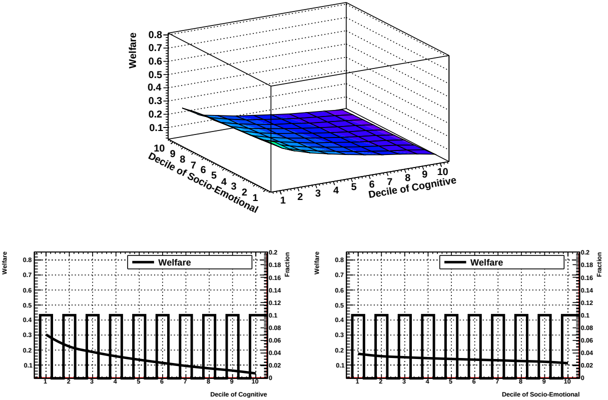
Source: Heckman, Humphries, Urzúa, and Veramendi (2011).

Figure 17: The Effect of Cognitive and Socio-emotional endowments on Physical Health at age 40 (PCS-12)



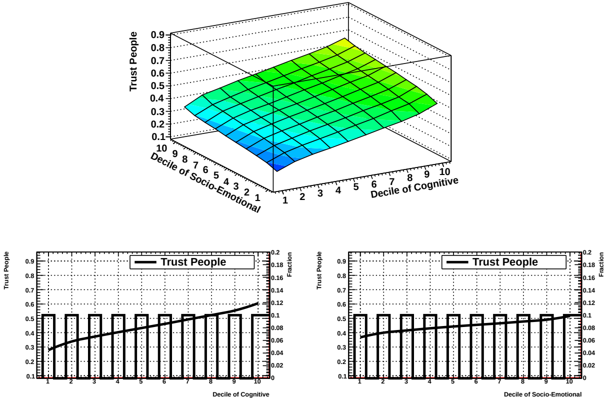
Source: Heckman, Humphries, Urzúa, and Veramendi (2011).

Figure 18: The Effect of Cognitive and Socio-emotional endowments on Ever Participated in Welfare (1996-2006)



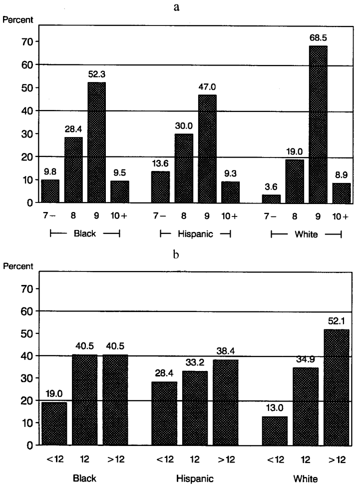
Source: Heckman, Humphries, Urzúa, and Veramendi (2011).

Figure 19: The Effect of Cognitive and Socio-emotional endowments on Trusting People (2008)



Source: Heckman, Humphries, Urzúa, and Veramendi (2011).

Figure 20: *a*, Highest grade completed at age 15. 7- denotes grade 7 or lower, and 10+ denotes grade 10 or higher. *b*, Highest grade completed at age 24. <12 denotes grade 11 or lower, and 112 denotes college attendance



Source: Cameron and Heckman (2001).

Figure 21: The Probability and Returns of College Enrollment by Endowments Levels

Figure: Choice Probability, Early College Enrollment

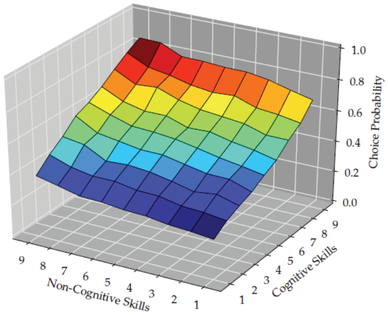
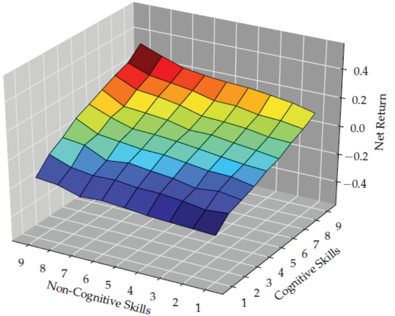
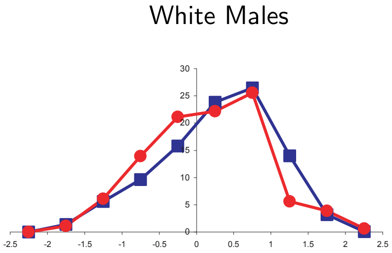


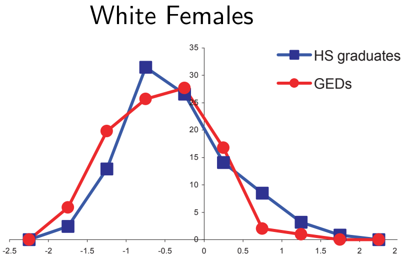
Figure: Net Return, Early College Enrollment



Source: Eisenhauer et al. (2014)
Note: Early college enrollment refer to the individuals who enroll in college immediately after having finished high school. Returns are expressed in units of millions of dollars.

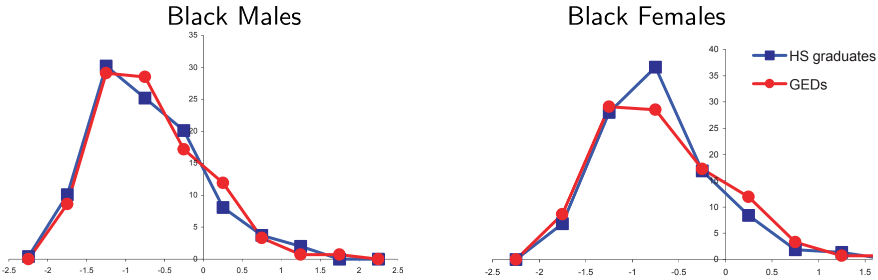
Figure 22: Density of age adjusted AFQT scores, GED recipients and high school graduates with twelve years of schooling





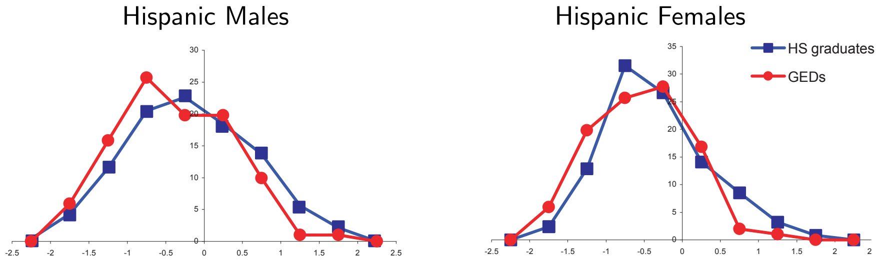
Source: Heckman, Hsee and Rubinstein (2001).

Figure 23: Density of age adjusted AFQT scores, GED recipients and high school graduates with twelve years of schooling



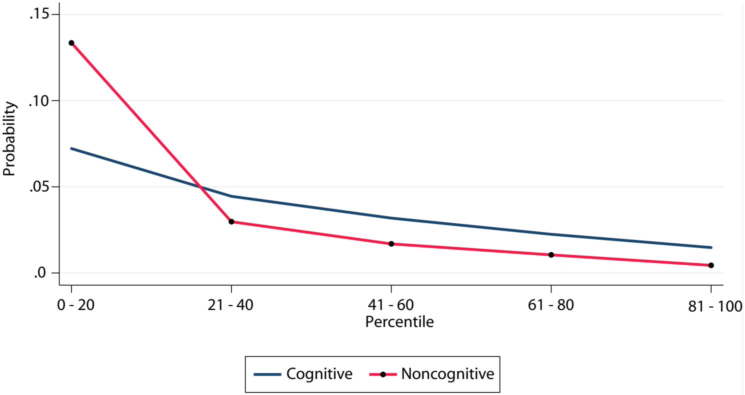
Source: Heckman, Hsee and Rubinstein (2001).

Figure 24: Density of age adjusted AFQT scores, GED recipients and high school graduates with twelve years of schooling



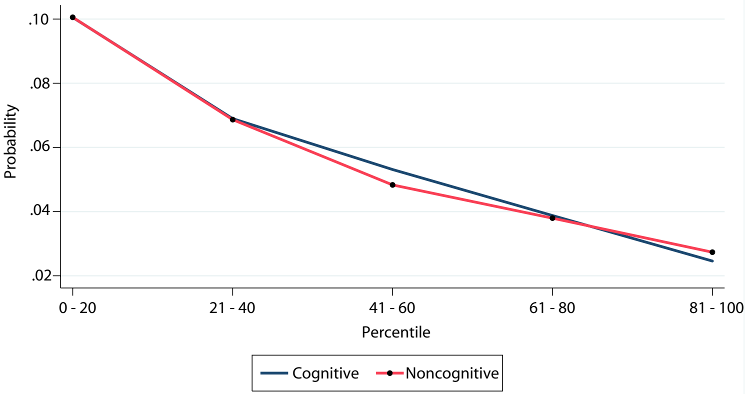
Source: Heckman, Hsee and Rubinstein (2001).

Figure 25: Ever been in jail by age 30, by ability (males)



Note: This figure plots the probability of a given behavior associated with moving up in one ability distribution for someone after integrating out the other distribution. For example, the lines with markers show the effect of increasing noncognitive ability after integrating the cognitive ability.
Source: Heckman et al. (2006).

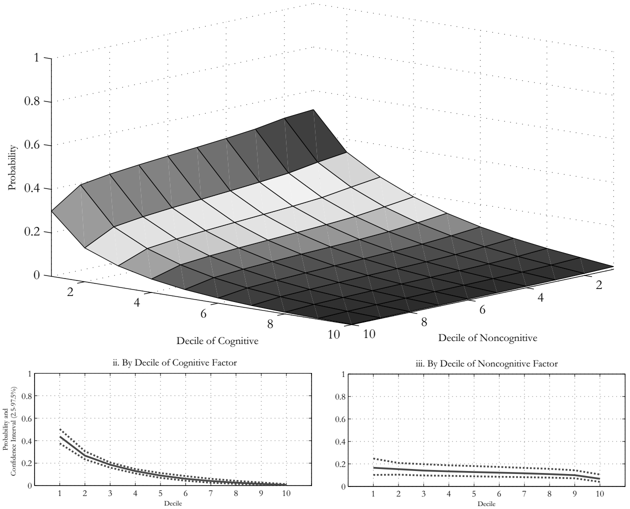
Figure 26: Probability of being single with children (females)



Note: This figure plots the probability of a given behavior associated with moving up in one ability distribution for someone after integrating out the other distribution. For example, the lines with markers show the effect of increasing noncognitive ability after integrating the cognitive ability.

Source: Heckman et al. (2006).

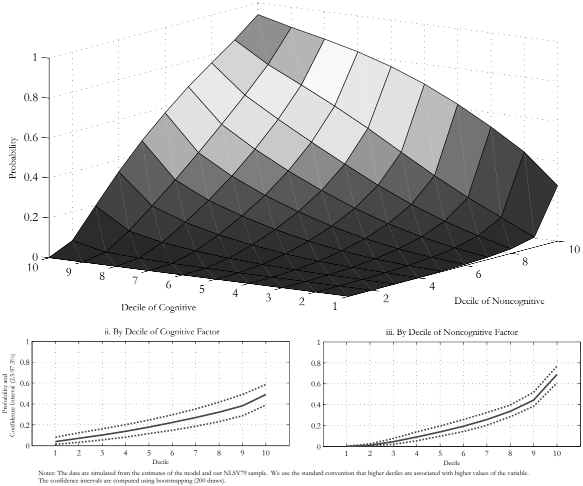
Figure 27: Probability of being a high school dropout by age 30 (males)



Notes: The data are simulated from the estimates of the model and our NLSY79 sample. We use the standard convention that higher deciles are associated with higher values of the variable. The confidence intervals are computed using bootstrapping (200 draws).

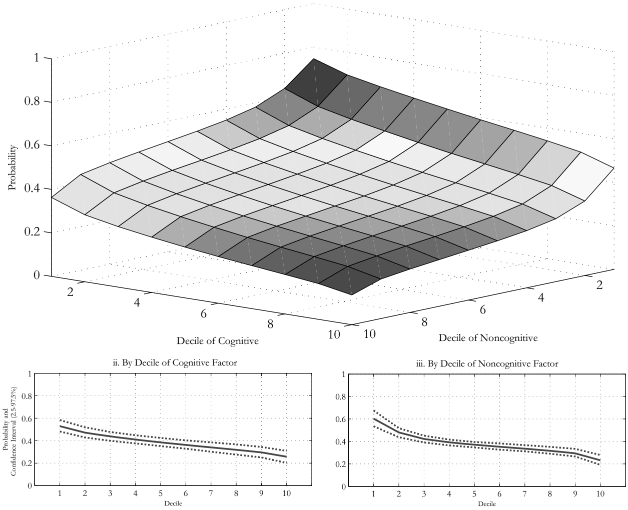
Source: Heckman et al. (2006).

Figure 28: Probability of being a 4-year college graduate by age 30 (males)



Source: Heckman et al. (2006).

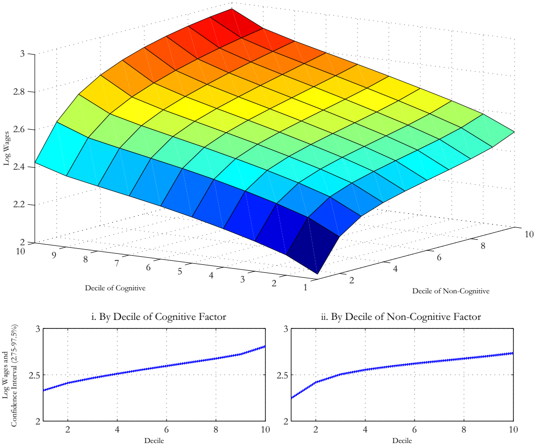
Figure 29: Probability of daily smoking by age 18 (males)



Notes: The data are simulated from the estimates of the model and our NLSY79 sample. We use the standard convention that higher deciles are associated with higher values of the variable.
The confidence intervals are computed using bootstrapping (200 draws).

Source: Heckman et al. (2006).

Figure 30: Mean log wages by age 30 (males)



Notes: The data are simulated from the estimates of the model and our NLSY79 sample. We use the standard convention that higher deciles are associated with higher values of the variable. The confidence intervals are computed using bootstrapping (50 draws).

Source: Heckman et al. (2006).

Return to Slide 10

Return to Slide 103

Return to Slide 160

Literature on Credit Constraints

Table 35a: Studies of the Role of Parental Income on Child Outcomes

Study	Dataset	Outcome Studied	Timing of Income (Developmental Stage of the Child at Which Income Effects are Studied)	Separates the Effect of Income from Changes in Labor Supply or Family Environment?
Akee et al. (2010)	**GSMS**	Schooling outcomes and crime	Yearly family income in adolescence (ages 12-16)	No
Belley and Lochner (2007)	NLSY79, NLSY97	High school completion and college enrollment	Family income during adolescence (at age 16 or 17 for the NLSY79 cohort or 16 for the NLSY97 cohort)	No
Carneiro and Heckman (2002)	NLSY79, C-NLSY79	College enrollment	Family income at age 16 or 17 (using data from NLSY79) Discounted family income (using data from C-NLSY79) during childhood and adolescence (ages 0-18) broken up by stage of the child's lifecycle (ages 0-5; 5-16; 16-18)	No
Carneiro et al. (2013)	Norwegian Registry	Multiple outcomes (schooling, health, IQ, teenage pregnancy) studied	Average discounted family income during childhood and adolescence (ages 0-17) broken up by stage of the child's lifecycle (ages 0-6; 6-11; 12-17)	No

Table 35a (continued): Studies of the Role of Parental Income on Child Outcomes

Study	Dataset	Outcome Studied	Timing of Income (Developmental Stage of the Child at Which Income Effects are Studied)	Separates the Effect of Income from Changes in Labor Supply or Family Environment?
Dahl and Lochner (2012)	NLSY79, C-NLSY79	PIAT test scores	Yearly family income during preadolescence (ages 8-14)	No[a]
Duncan et al. (1998)	PSID	Multiple schooling outcomes and hazard of non marital birth	Average family income during childhood and adolescence (ages 0-15)	No
Duncan et al. (2011)	Randomized Interventions on Welfare Support	Achievement test scores	Yearly family income during childhood (ages 2-5)	No
Gennetian and Miller (2002)	**Multiple sources on families involved in the Minnesota Family Investment Program (MFIP)**	Multiple schooling and behavioral outcomes	Yearly family income during childhood (ages 8-9)	No

Table 35a (continued): Studies of the Role of Parental Income on Child Outcomes

Study	Dataset	Outcome Studied	Timing of Income (Developmental Stage of the Child at Which Income Effects are Studied)	Separates the Effect of Income from Changes in Labor Supply or Family Environment?
Loken (2010)	Norwegian Administrative Data	Multiple schooling outcomes	Average family income during childhood and preadolescence (ages 0-13)	Yes[c]
Loken et al. (2012)	Norwegian Administrative Data	Multiple schooling outcomes and adults' IQ	Average family income during childhood (ages 0-11)	No
Mallar (1977)	**New Jersey Income Maintenance Experiment**	Multiple schooling outcomes	Yearly family income during adolescence (ages of high school enrollment	No
Maynard (1977)	**Rural Income Maintenance Experiment (North Carolina and Iowa)**	Multiple schooling outcomes	Yearly family income during childhood and preadolescence (ages 7-14, grades 2-8)	No

Table 35a (continued): Studies of the Role of Parental Income on Child Outcomes

Study	Dataset	Outcome Studied	Timing of Income (Developmental Stage of the Child at Which Income Effects are Studied)	Separates the Effect of Income from Changes in Labor Supply or Family Environment?
Maynard and Murnane (1979)	**Gary Income Maintenance Experiment**	Multiple schooling outcomes	Yearly family income during childhood and preadolescence (ages 9-13, grades 4-6) and adolescence (ages 13-16, grades 7-10)	No
Milligan and Stabile (2011)	Rural Income Maintenance Experiment (North Carolina and Iowa)	Multiple schooling outcomes	Yearly family income during childhood and preadolescence (ages 7-14, grades 2-8)	No
Morris and Gennetian (2003)	**Multiple sources on families involved in the Minnesota Family Investment Program (MFIP)**	Multiple schooling and behavioral outcomes	Yearly family income during childhood (ages 2-9)	No

Table 35b: Studies of the Role of Parental Income on Child Outcomes

Study	Distinguishes the Effects of Contemporaneous vs. Permanent Income?	Sources of Income Whose Effects are Studied	Instrument Used
Akee et al. (2010)	Yes	Total family income	Experimental Assignment
Belley and Lochner (2007)	No	Total family income	None
Carneiro and Heckman (2002)	Yes	Total family income	None
Carneiro et al. (2013)	Yes	Total family income	None
Dahl and Lochner (2012)	No[b]	Total family income	Policy variation in EITC eligibility
Duncan et al. (1998)	Yes	Total family income	None
Duncan et al. (2011)	No	Total family income	Random assignment to programs offering welfare transfers conditional on employment or education related activities, or full time work

Table 35b (continued): Studies of the Role of Parental Income on Child Outcomes

Study	Distinguishes the Effects of Contemporaneous vs. Permanent Income?	Sources of Income Whose Effects are Studied	Instrument Used
Gennetian and Miller (2002)	Yes	Total family income	Experimental Assignment
Loken (2010)	No	Total family income	Oil discovery (inducing regional increase in wages)
Loken et al. (2012)	No	Total family income	Oil discovery (inducing regional increase in wages)
Mallar (1977)	Yes	Total family income	Experimental Assignment
Maynard (1977)	Yes	Total family income	Experimental Assignment
Maynard and Murnane (1979)	Yes	Total family income	Experimental Assignment
Milligan and Stabile (2011)	No	Child-related tax benefits and income transfers	Variation in benefits eligibility
Morris and Gennetian (2003)	Yes	Total family income	Experimental Assignment

Table 35c: Studies of the Role of Parental Income on Child Outcomes

Study	Effect of Income on Human Capital Investments
Akee et al. (2010)	$4,000 dollars per year to all adults tribal members of the Eastern Band of Cherokee Indians from Casino profits: 15% increase in high school graduation, one extra year of education by age 21 only for household in poverty prior to transfer, 22% reduction in probability of being arrested at age 16-17, no effect when older. The results confound the increased parental income with the fact that children would become themselves eligible to receive the $4,000 per year by age 18 only if they finished high school on time, otherwise they would have to wait until age 21. The results are consistent with children responding to the short-term monetary incentive for graduating high school on time rather than with a positive long-term effect induced by the increased parental income.
Belley and Lochner (2007)	High school completion increased by 8.4% for highest-income quartile compared to lowest in 1979 and increased by 6.7 in 1997 (cannot reject equal effect of income). College enrollment increased by 9.3% for highest-income quartile compared to lowest in 1979 and increased by 16% in 1997 (cannot reject equal effect of income).
Carneiro and Heckman (2002)	Conditioning on ability and family background factors, the role of income in determining schooling decisions is minimal. The strongest evidence is in the low-ability group. The test for credit constraints is not robust to accounting for parental preferences and paternalism. Observed differences in attendance might result from a differential consumption value of the child's schooling for parents rather than from credit constraints. Percentage of people constrained = weighted gap in educational outcome to highest-income group (calculations on NLSY79 data): 5.1% are constrained in college enrollment (1.2% among low income, low ability and 0.2% among low income, high ability), 9% in completion of two-year college (5.3% among low income, low ability and 0.3% low income, high ability). There is no evidence of a independent effect on college enrollment of early or late income once permanent income is accounted for (calculations on C-NLSY79 data). The claim that higher IV than OLS estimates of the Mincer coefficient implies that credit constraints are incorrect: Instruments used are invalid, the quality margin is ignored, and self-selection and comparative advantage can produce the result also in the absence of financial constraints.

Table 35c (continued): Studies of the Role of Parental Income on Child Outcomes

Study	Effect of Income on Human Capital Investments
Carneiro et al. (2013)	For all outcomes, there is a monotone and concave relationship with permanent income. A £100,000 increase in permanent father's earnings results in a gain of 0.5 years of schooling. For the timing of income, a balanced profile between early (ages 0–5) and late childhood (ages 6–11) is associated with the best outcomes; shifting income to adolescence is associated with better outcomes in dropping out of school, college attendance, earnings, IQ and teen pregnancy. Early and late childhood income are complements in determining schooling attainment, whereas early and adolescent income are substitutes.
Dahl and Lochner (2012)	An additional \$1,000 per year for two years results in a gain of 6% of a standard deviation in a math and reading combined PIAT score.
Duncan et al. (1998)	A \$10,000 increase in average (ages 0–15) family income results in a gain of 1.3 years of schooling in low-income (¡\$20,000) families and a gain of 0.13 years in high-income ones. The relevance of income is stronger in the early years (ages 0–5): A \$10,000 increase in average (ages 0–5) family income leads to an additional 0.8 years of schooling in low-income families and an additional 0.1 years in high-income ones. There is no significant effect for income at ages 6–10 and 11–15. There are similar results in a sibling differences model.
Duncan et al. (2011)	An additional \$1,000 per year in family income (ages 2–5) results in a gain of 6% of a standard deviation in a child's achievement score.

Table 35c (continued): Studies of the Role of Parental Income on Child Outcomes

Study	Effect of Income on Human Capital Investments
Gennetian and Miller (2002)	Treated (MFIP "Incentives") families (single-mothers at eligibility) received greater welfare benefits (benefits kept when working until income reached 140% of the federal poverty level), child-care expenses fully subsidized and directly paid to the provider. MFIP "plus" families also received employment and training activities. Children of MFIP families (both groups) showed greater engagement in school, a reduction in the likelihood of performing below average and reduced behavioral problems with the effect particularly pronounced for girls and during the school age. Children in MFIP "full" families however showed no benefits on the positive behavior scale. In both MFIP group marriage rates increased and domestic abuse rates decreased. Earnings increased only in the MFIP "full" group, while the increased income in the MFIP "incentive group is due to greater welfare transfers. Mothers in the MFIP "full" group greatly increase the use of child-care arrangements. While employments rates increased in both groups (twice more in the "full" one), the mothers in the "incentive" group reduced their working hours. The authors do not isolate a pure income effect as they do not separate the effect from income transfers from the effect of increased time out of work (for the "incentive" group) or from the effect of the increased use of child-care subsidies (for the "full" group).
Loken (2010)	With OLS, there is a positive relationship of average (ages 1–13) family income on children's education. With IV, there is no causal effect. Results are robust to different specifications and splitting the sample by parental education.
Loken et al. (2012)	With nonlinear IV (quadratic model), an increase of $17,414 in family income results in a gain of 0.74 years of education for children in poor families and a gain of 0.05 years of education for children in rich families.[d]

THE UNIVERSITY OF CHICAGO

Table 35c (continued): Studies of the Role of Parental Income on Child Outcomes

Study	Effect of Income on Human Capital Investments
Mallar (1977)	Positive effect of the negative income tax for the children of the families enrolled in one of the medium generosity plan: probability of high school graduation increased by 20% to 50% and number of completed school years increased by between 0.5 and 1. Negative results for the children of families enrolled in the most generous plan: probability of high school graduation decreased by 25% and number of completed school years decreased by 0.4.
Maynard (1977)	North Carolina: positive effect from negative income tax on multiple schooling outcomes (-30.5% absenteeism, 6.2% increase in GPA) for youngest group; no effects for older group. Iowa: null or negative effects on all outcomes.
Maynard and Murnane (1979)	Grades 4 to 6: positive effect from the negative income tax only on reading test scores (6 to 9 months difference on a grade equivalent measure). No effect on GPA and absenteeism. Grades 7 to 10: negative effects on GPA (all grades) and on absenteeism (9^{th} grade).
Milligan and Stabile (2011)	For low-education mothers, there are positive effects of child benefits on cognitive outcomes for boys and on emotional outcomes for girls, weak on health. Results are non-robust to the exclusion of Quebec.
Morris and Gennetian (2003)	Performing multiple IV regressions of children's school and behavioral outcomes on income and employment using treatment assignment to the MFIP program as instruments shows positive effects of income on school engagement and positive behavior (no effects on school achievement and behavior problems) if variables are measured one year after random assignment. In the three years follow-up no significant effects are found. The modest significance of the one year results (p-values around 0.08), however, is unlikely to survive a careful control for multiple hypothesis testing (a required procedure in this set up unfortunately not used by the authors). These results also cast doubts on the validity of the conclusions from the mean differences analysis on the same data of Gennetian and Miller (2002).

Table 36a: Studies of Credit Constraints

	Dataset	Outcome Studied	Timing of Income (Developmental Stage of the Child at Which Constraints are Studied)	Explicit Dynamic Model?
Keane and Wolpin (2001)	NLSY79	Schooling and adult outcomes	Family income during adolescence (at age 16 or 17)	Yes
Cameron and Taber (2004)	NLSY79	Schooling outcomes	Family income during adolescence (at age 16 or 17)	No
Caucutt and Lochner (2012)	NLSY79, C-NLSY79	Test scores and schooling outcomes	Family income during childhood and adolescence (ages 0-23)	Yes

Table 36b: Studies of Credit Constraints

	Who is Affected by Constraints: Parent of the Agent (P), Agent / Child (C)	Method to Test for Credit Constraints	Find Presence of Credit Constraints?
Keane and Wolpin (2001)	C	Structural estimation of the lower bound on asset level	Yes, but irrelevant for schooling decisions
Cameron and Taber (2004)	C	IV estimation of "returns" to schooling using costs of schooling or foregone earnings as instruments	No
Caucutt and Lochner (2012)	P	Structural estimation of the lower bound on asset level	Yes; stronger effect on high-skilled parents

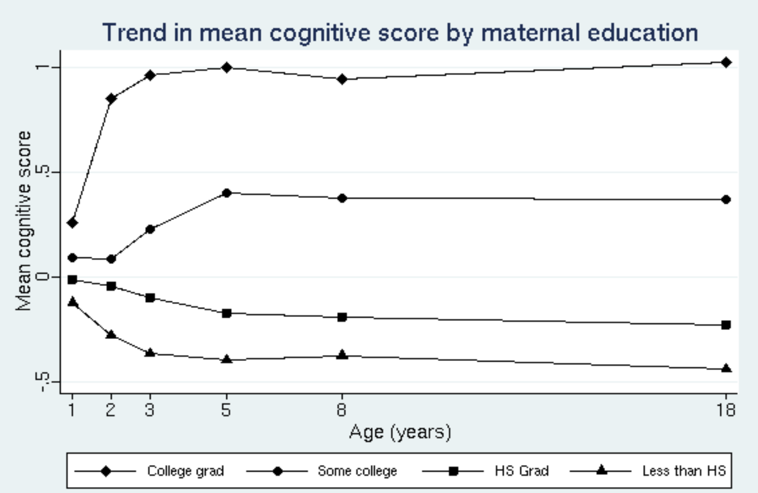
Table 36b (continued): Studies of Credit Constraints

	Effect of Income or Constraints on Human Capital Investments
Keane and Wolpin (2001)	An increase in the borrowing limit to $3,000 (three times the max estimated) results in no change in the mean highest grade completed; an increase of 0.2% in college enrollment; a decrease of $0.2 in mean hourly wage rate; an increase in consumption and reduction in market hours; and a moderate reduction in parental transfers, especially for the least-educated parents.
Cameron and Taber (2004)	For the theoretical prediction, if there are borrowing constraints, IV estimates using direct costs of schooling are higher than those using opportunity costs. For the data, IV estimates using the presence of a local college are smaller than those using foregone earnings. Regressions that interact college costs and characteristics potentially related to credit availability find no evidence of excess sensitivity to costs for a potentially constrained sample. For the structural model, almost 0% of the population is found to borrow at a rate higher than the market one.
Caucutt and Lochner (2012)	50% of young parents are constrained: high school dropouts (50%), high school graduates (38%), college dropouts (60%), and college graduates (68%). 12% of old parents are constrained. Families with college-graduate parents benefit the most from a reduction in credit constraints.

Return to Slide 123

Appendix A: Evidence on Achievement Gaps by Age for Different Socio-economic Groups

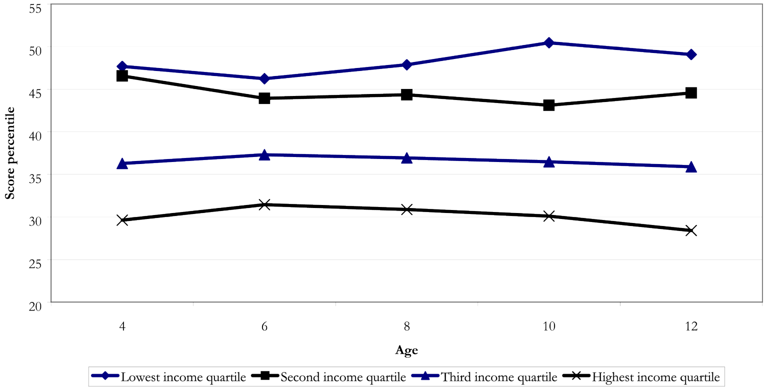
Figure 31: Trend in Mean Cognitive Score by Maternal Education



Source: Brooks-Gunn et al., (2006).

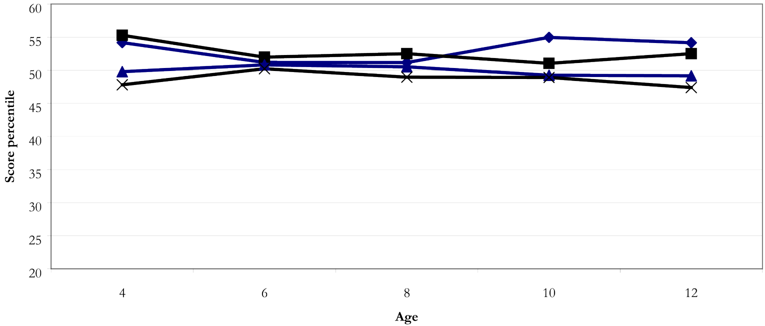
THE UNIVERSITY OF CHICAGO

Figure 32: Children of NLSY
Average percentile rank on anti-social behavior score, by income quartile



Source: Cunha et al. (2006).

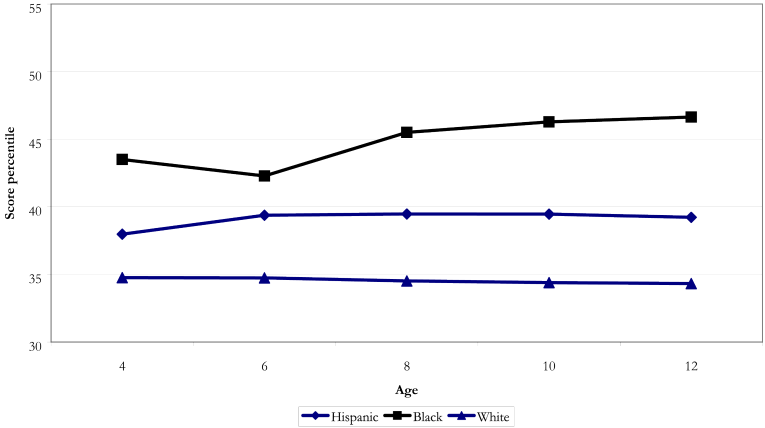
Figure 33: Children of NLSY
Adjusted average anti-social behavior score percentile by income quartile*



*** Adjusted by maternal education, maternal AFQT (corrected for the effect of schooling) and broken home at each age**

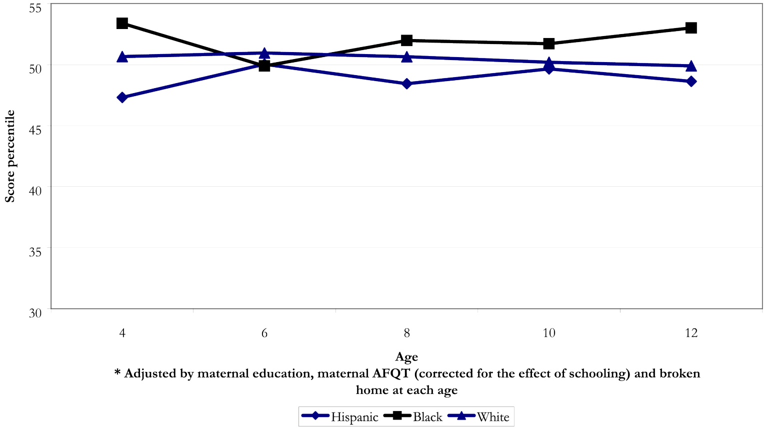
Source: Cunha et al. (2006).

Figure 34: Children of NLSY
Average percentile rank on anti-social behavior score, by race



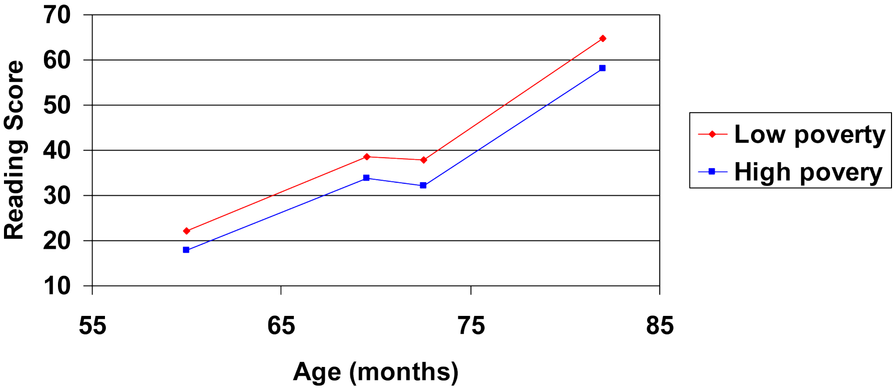
Source: Cunha et al. (2006).

Figure 35: Adjusted average anti-social behavior score percentile by race



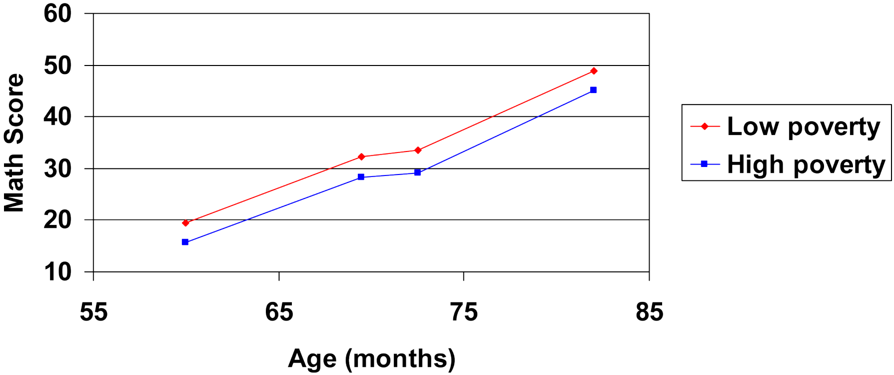
Source: Cunha et al. (2006).

Figure 36: Early Childhood Longitudinal Study (ECLS)
(a) Reading



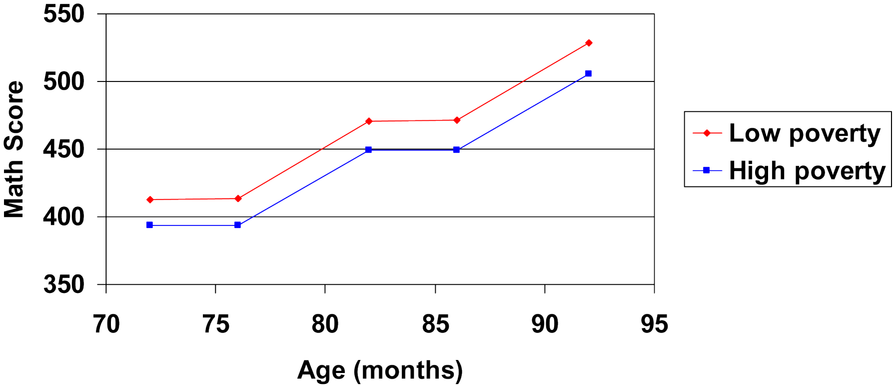
Source: Raudenbush (2006).

Figure 37: Mean Trajectories, high and low poverty schools (ECLS)
(b) Math



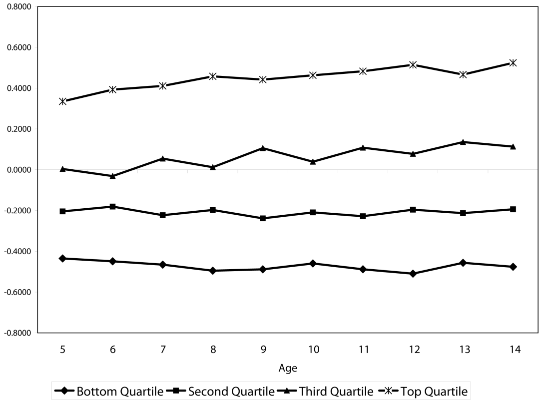
Source: Raudenbush (2006).

Figure 38: Average trajectories, Grades 1-3, high and low poverty schools (Sustaining Effects Study)
(b) Math



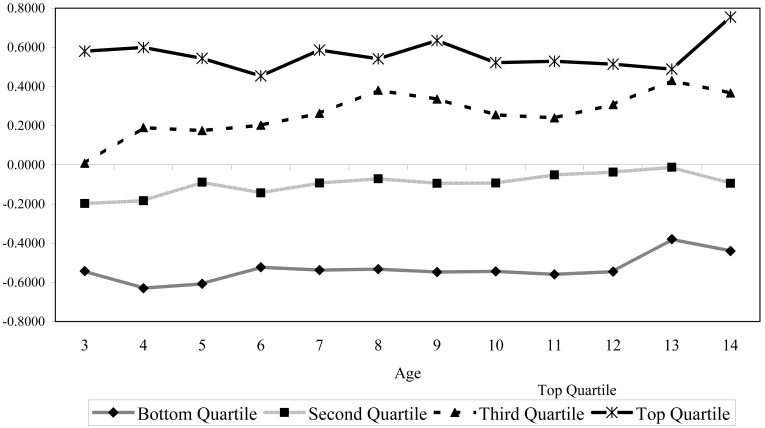
Source: Raudenbush (2006).

Figure 39: Children of the NLSY: Average Standardized Score for PIAT Math by Permanent Income Quartile



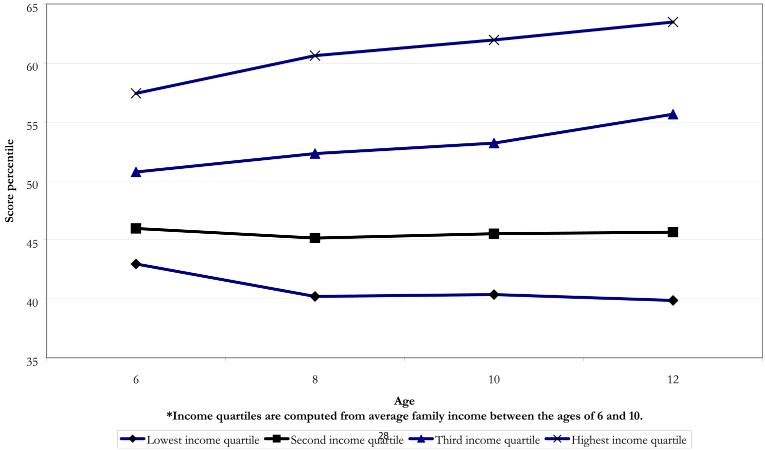
Source: Cunha et al. (2006).

Figure 40: Children of NLSY: Average Standardized Score//Peabody Picture Vocabulary Test by Permanent Income Quartile



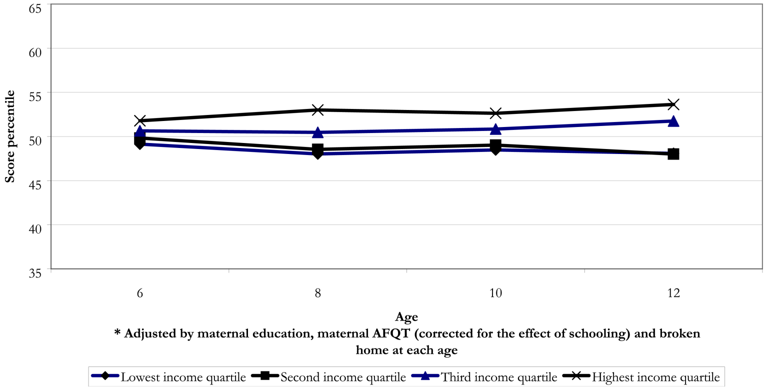
Source: Cunha et al. (2006).

Figure 41: Children of NSLY
Average Percentile Rank on PIAT math score, by income quartile*



Source: Cunha et al. (2006).

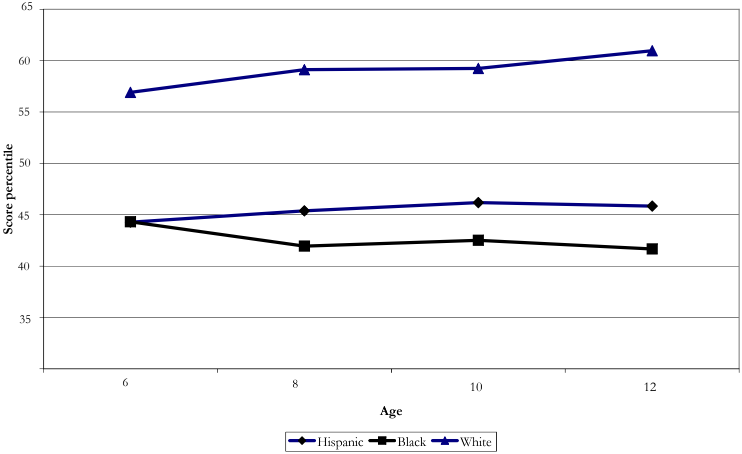
Figure 42: Children of NSLY
Adjusted average PIAT-math score percentiles, by income quartile*



* Adjusted by maternal education, maternal AFQT (corrected for the effect of schooling) and broken home at each age

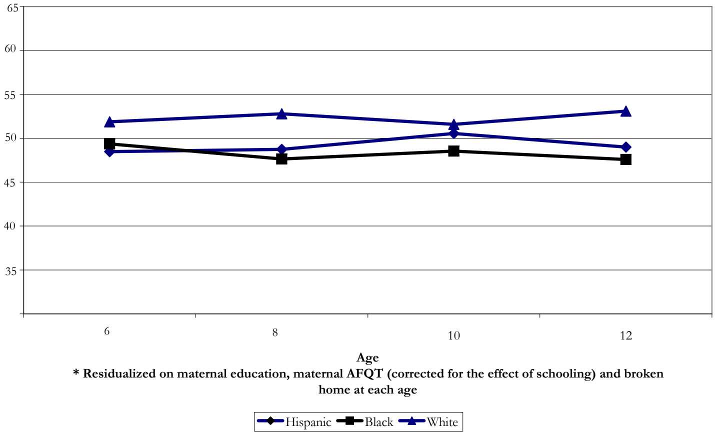
Source: Cunha et al. (2006).

Figure 43: Average percentile rank on PIAT-Math score, by race



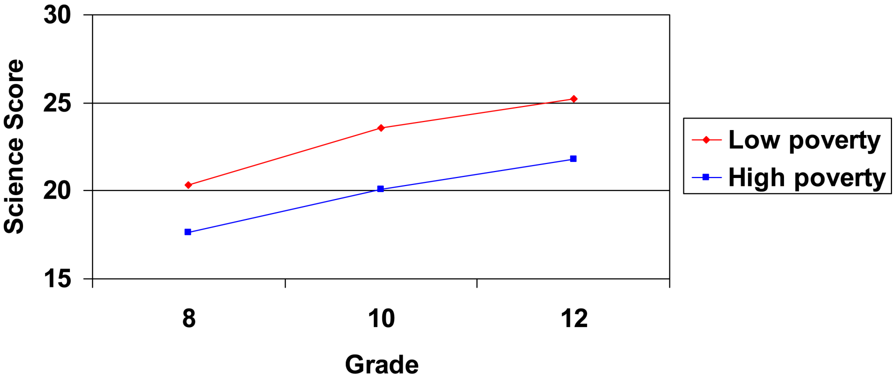
Source: Cunha et al. (2006).

Figure 44: Adjusted average PIAT-Math score percentiles, by race



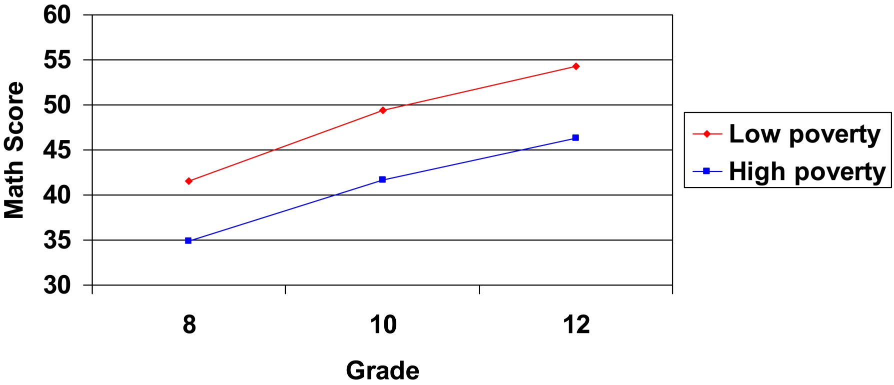
Source: Cunha et al. (2006).

Figure 45: Average trajectories, Grades 8-12 (NELS 88).
(a) Science



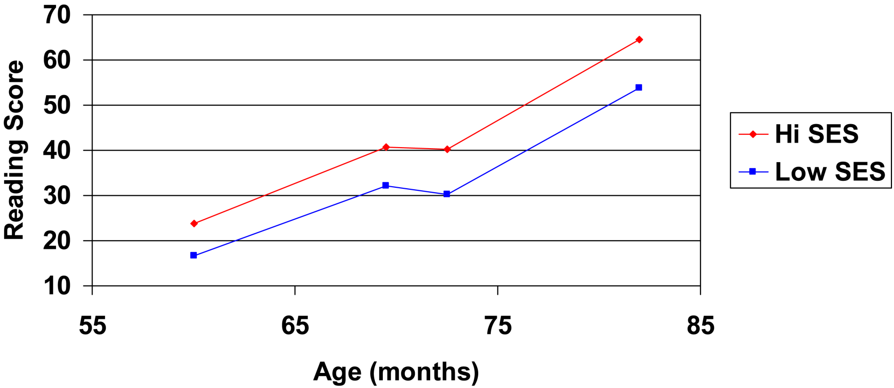
Source: Raudenbush (2006).

Figure 46: Average trajectories, Grades 8-12 (NELS 88).
(b) Math



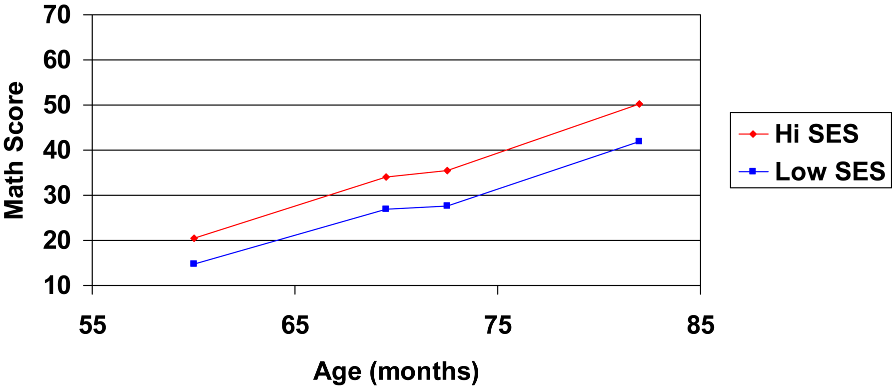
Source: Raudenbush (2006).

Figure 47: Growth as a function of student social background: ECLS
(a) Reading



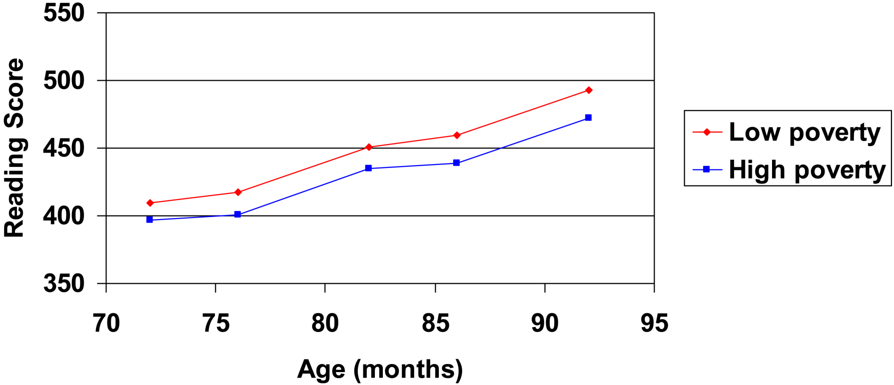
Source: Raudenbush (2006).

Figure 48: Growth as a function of student social background: ECLS (b) Math



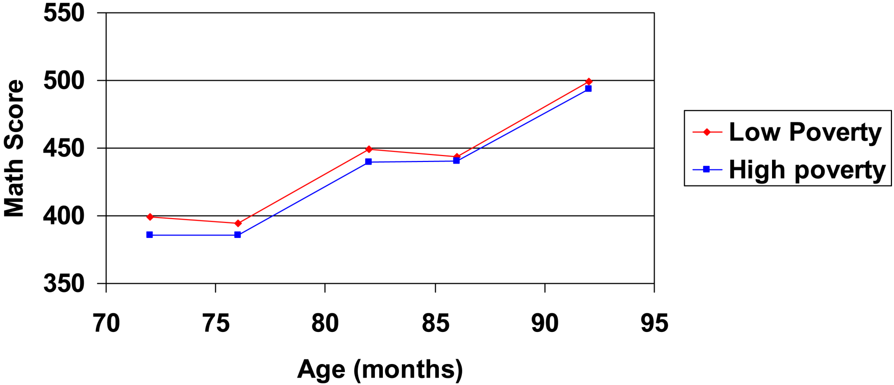
Source: Raudenbush (2006).

Figure 49: Growth as a Function of School Poverty for Poor Children: Sustaining Effects Data
(a) Reading



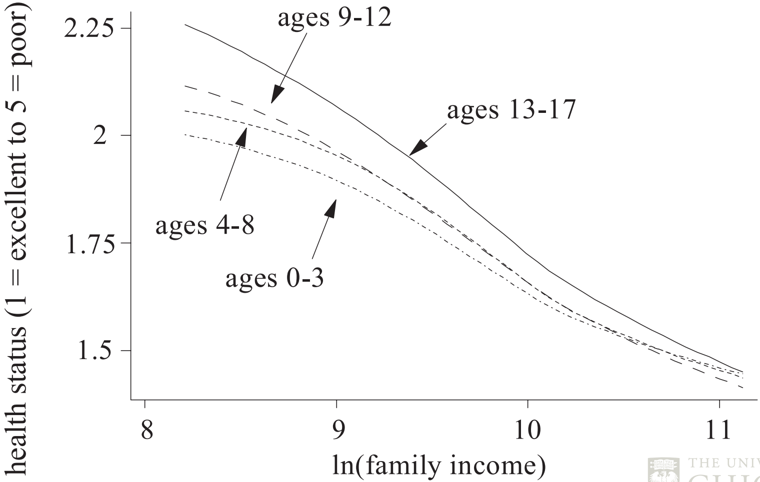
Source: Raudenbush (2006).

Figure 50: Growth as a Function of School Poverty for Poor Children: Sustaining Effects Data
(b) Math



Source: Raudenbush (2006).

Figure 51: Health and income for children and adults, U.S. National Health Interview Survey 1986–1995. From Case, A., Lubotsky, D. & Paxson, C. (2002), American Economic Review, Vol. 92, 1308-1334.



Children's Test Scores by Age and Mother's Education (CNLSY)

Methods

Test Score Definitions

1. **Raw Score** is the unadjusted total raw score.
2. **Sample Standardized Score** is the total raw score standardized at a particular age using the CNLSY estimation sample. This score is calculated by subtracting the mean of the score at the age and dividing by the standard deviation.

3. **Population Standardized Score** is a score that has been standardized at each age so that the mean is 100 and the standard deviation is 15 for a representative US sample. These norms are provided by the NLS and the year of the representative sample differs by test.
4. **Population Percentile** is a score that has been transformed so that it represents a percentile score at each age for a representative US sample. These norms are provided by the NLS and the year of the representative sample differs by test.

Data Notes

- As discussed in the National Longitudinal Survey's Topical Guide to the Data, the population norms for the Peabody Individual Achievement Test (PIAT) Reading Comprehension test are unreliable under age 7.
- For this reason, these ages are excluded from the analysis.
- The Behavior Problems Index total score provided by NLS appears to add subscores in a way that does not appropriately account for missing values.
- In particular, some of the questions of the BPI only apply to children who are in school.

- Children not enrolled in school appeared to receive a "positive" score on this field, and this score counted towards their overall score.
- Therefore, children who enrolled in school at earlier ages appeared to have worse overall scores.
- This bias made it seem that children from well-educated mothers had worse behavioral problems at young ages.
- To account for this bias, the BPI total score is calculated by averaging across the questions without missing values and multiplying the average by the number of questions without missing values.

Mother's Education

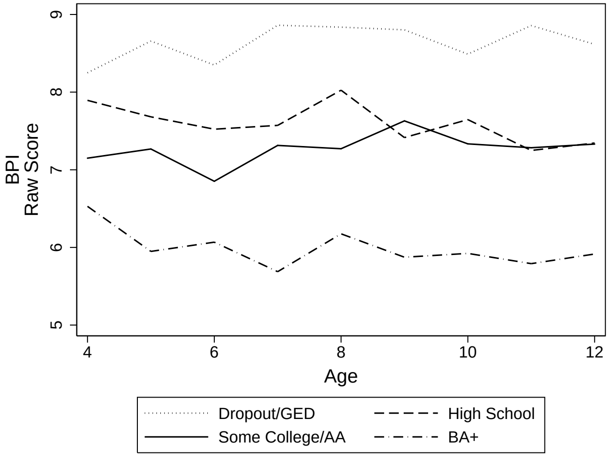
- Due to the sparsity of the data, several of the educational categories have been collapsed to the following four categories:
  1. **Dropout/GED** includes anyone who has dropped out of high school or earned a GED but has not attempted further post-secondary education.
  2. **High School Graduate** includes high school graduates who have not attempted college.

3. **Some College/AA** includes anyone who has ever attended a 2-or 4-year college or earned an associate's degree (AA) but has not earned a bachelor's degree or more. GED recipients who attempt college appear in this category.
4. **BA+** includes anyone has earned a BA degree or more. GED recipients who earn BA degrees appear in this category.

Results

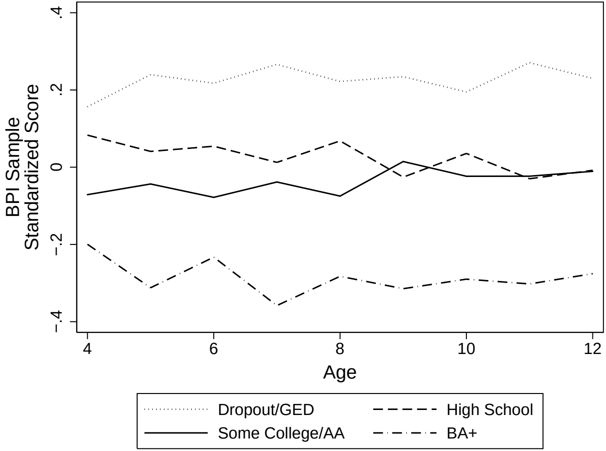
BPI

Figure 52: **Raw** Behavioral Problems Index (BPI) Scores by Age and Mother's Education at Birth



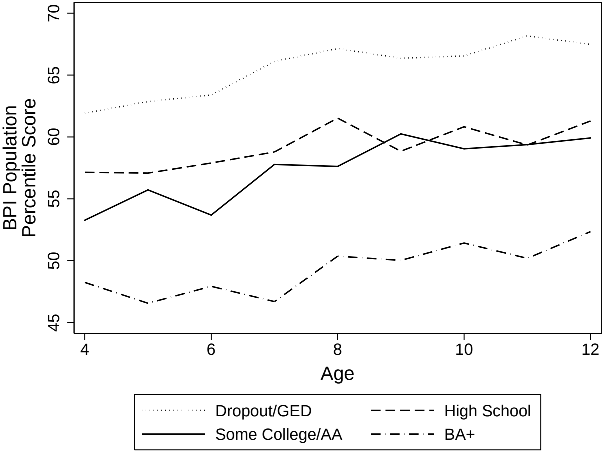
Source: Children of the National Longitudinal Survey of Youth (CNLSY).

Figure 53: **Sample Standardized** Behavior Problems Index (BPI) Scores by Age and Mother's Education at Birth



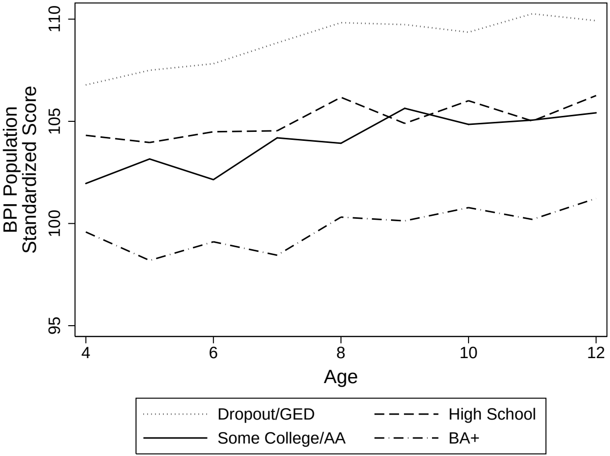
Source: Children of the National Longitudinal Survey of Youth (CNLSY).

Figure 54: **Population Percentile** Behavior Problems Index (BPI) Scores by Age and Mother's Education at Birth



Source: Children of the National Longitudinal Survey of Youth (CNLSY).

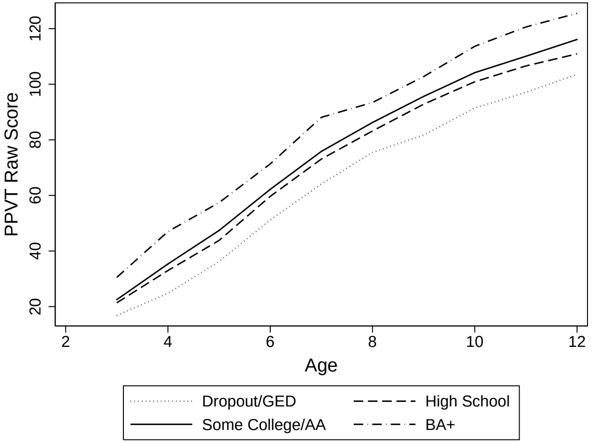
Figure 55: **Population Standardized** Behavior Problems Index (BPI) Scores by Age and Mother's Education at Birth



Source: Children of the National Longitudinal Survey of Youth (CNLSY).

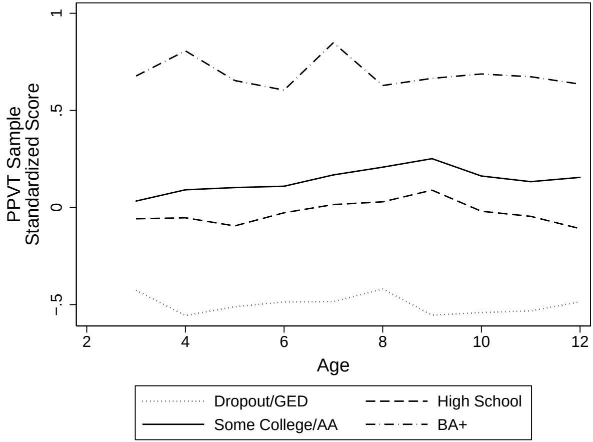
PPVT

Figure 56: **Raw** Peabody Picture Vocabulary Test (PPVT) Scores by Age and Mother's Education at Birth



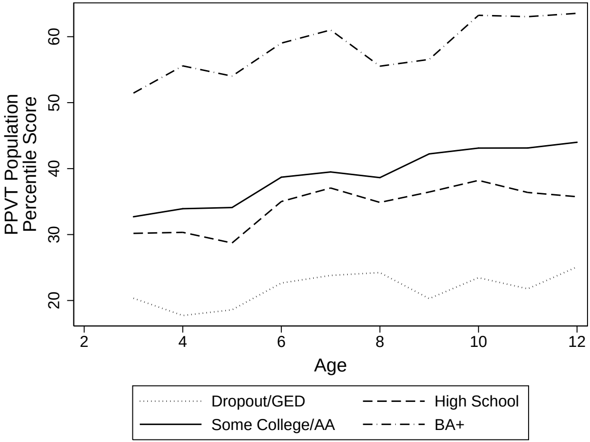
Source: Children of the National Longitudinal Survey of Youth (CNLSY).

Figure 57: **Sample Standardized** Peabody Picture Vocabulary Test (PPVT) Scores by Age and Mother's Education at Birth



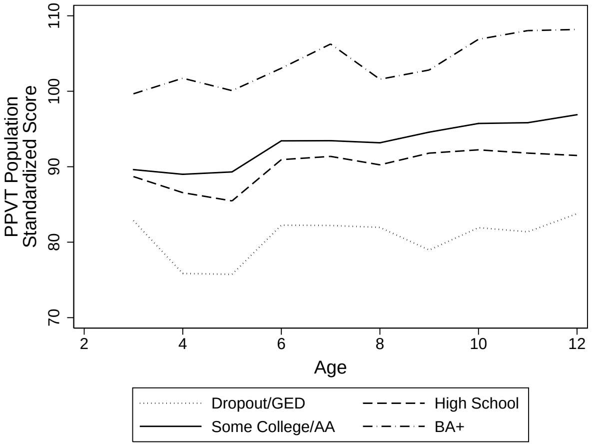
Source: Children of the National Longitudinal Survey of Youth (CNLSY).

Figure 58: **Population Percentile** Peabody Picture Vocabulary Test (PPVT) Scores by Age and Mother's Education at Birth



Source: Children of the National Longitudinal Survey of Youth (CNLSY).

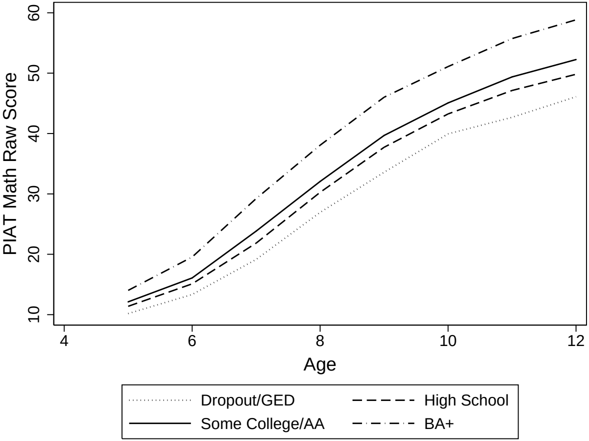
Figure 59: **Population Standardized** Peabody Picture Vocabulary Test (PPVT) Scores by Age and Mother's Education at Birth



Source: Children of the National Longitudinal Survey of Youth (CNLSY).

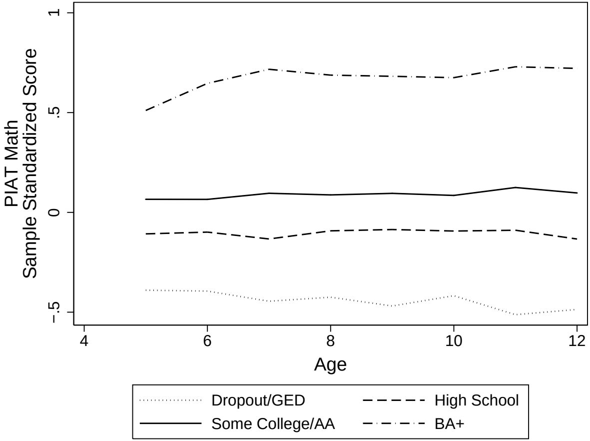
PIAT Math

Figure 60: **Raw** Peabody Individual Achievement Test (PIAT) Math Scores by Age and Mother's Education at Birth



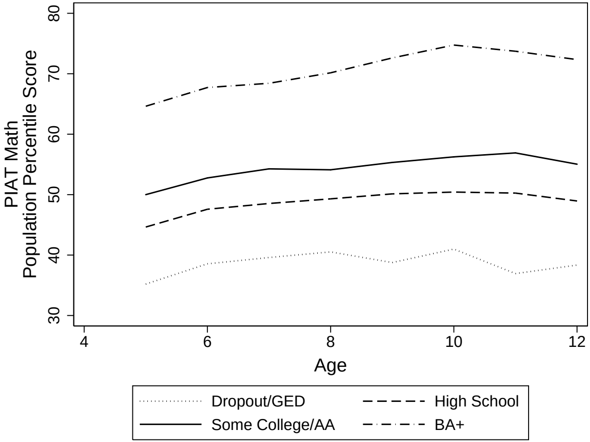
Source: Children of the National Longitudinal Survey of Youth (CNLSY).

Figure 61: **Sample Standardized** Peabody Individual Achievement Test (PIAT) Math Scores by Age and Mother's Education at Birth



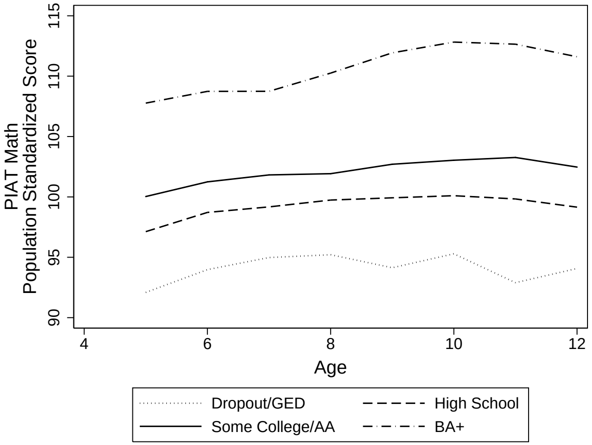
Source: Children of the National Longitudinal Survey of Youth (CNLSY).

Figure 62: **Population Percentile** Peabody Individual Achievement Test (PIAT) Math by Age and Mother's Education at Birth



Source: Children of the National Longitudinal Survey of Youth (CNLSY).

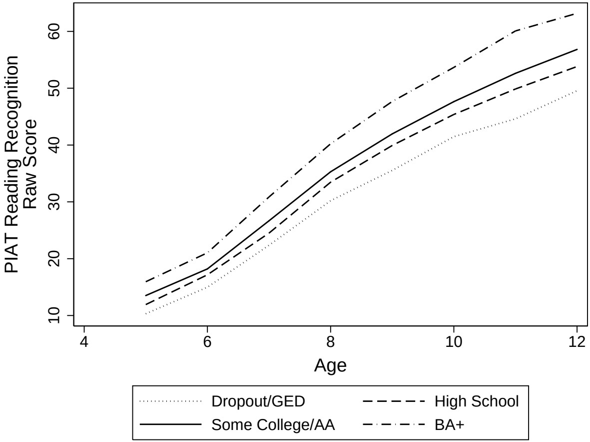
Figure 63: **Population Standardized** Peabody Individual Achievement Test (PIAT) Math Scores by Age and Mother's Education at Birth



Source: Children of the National Longitudinal Survey of Youth (CNLSY).

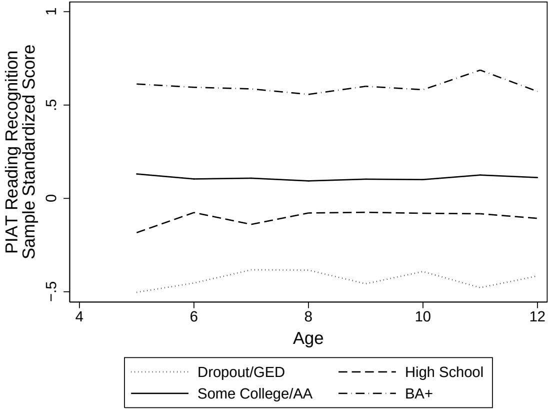
PIAT Reading Recognition

Figure 64: **Raw** Peabody Individual Achievement Test (PIAT) Reading Recognition Scores by Age and Mother's Education at Birth



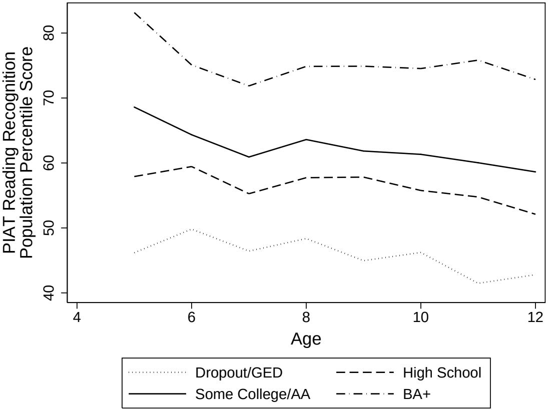
Source: Children of the National Longitudinal Survey of Youth (CNLSY).

Figure 65: **Sample Standardized** Peabody Individual Achievement Test (PIAT) Reading Recognition Scores by Age and Mother's Education at Birth



Source: Children of the National Longitudinal Survey of Youth (CNLSY).

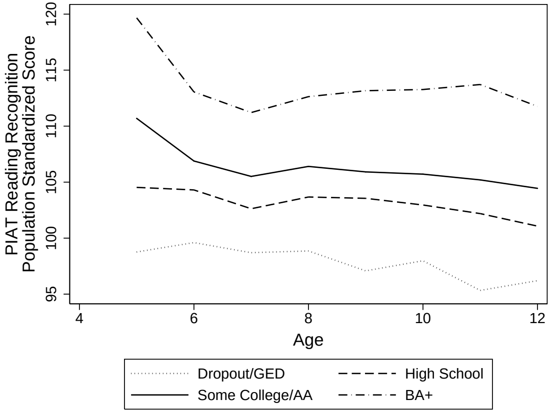
Figure 66: **Population Percentile** Peabody Individual Achievement Test (PIAT) Reading Recognition by Age and Mother's Education at Birth



Source: Children of the National Longitudinal Survey of Youth (CNLSY).

THE UNIVERSITY OF CHICAGO

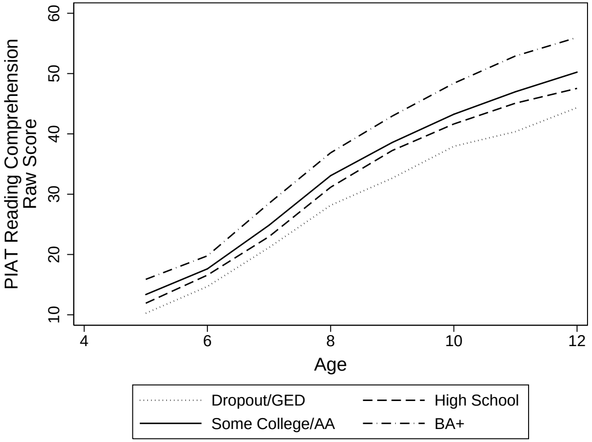
Figure 67: **Population Standardized** Peabody Individual Achievement Test (PIAT)Reading Recognition Scores by Age and Mother's Education at Birth



Source: Children of the National Longitudinal Survey of Youth (CNLSY).

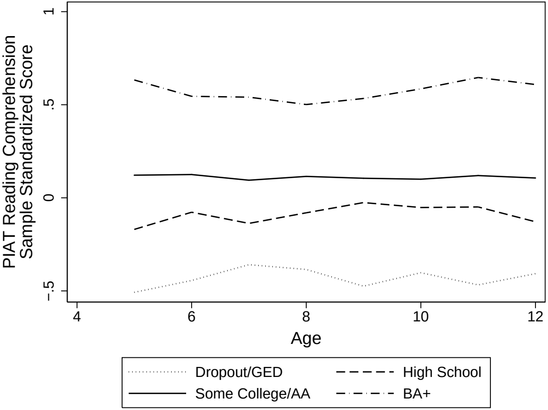
PIAT Reading Comprehension

Figure 68: **Raw** Peabody Individual Achievement Test (PIAT) Reading Comprehension Scores by Age and Mother's Education at Birth



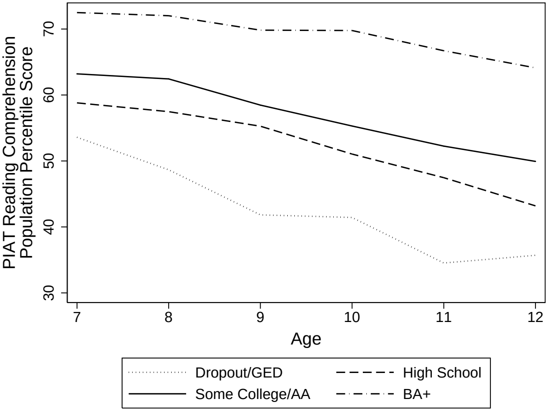
Source: Children of the National Longitudinal Survey of Youth (CNLSY).

Figure 69: **Sample Standardized** Peabody Individual Achievement Test (PIAT) Reading Comprehension Scores by Age and Mother's Education at Birth



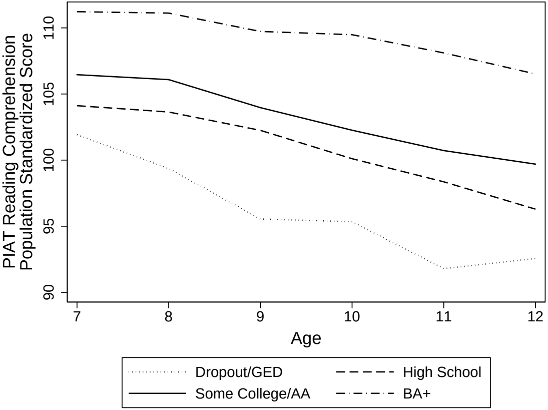
Source: Children of the National Longitudinal Survey of Youth (CNLSY).

Figure 70: **Population Percentile** Peabody Individual Achievement Test (PIAT) Reading Comprehension by Age and Mother's Education at Birth



Source: Children of the National Longitudinal Survey of Youth (CNLSY).

Figure 71: **Population Standardized** Peabody Individual Achievement Test (PIAT) Reading Comprehension Scores by Age and Mother's Education at Birth



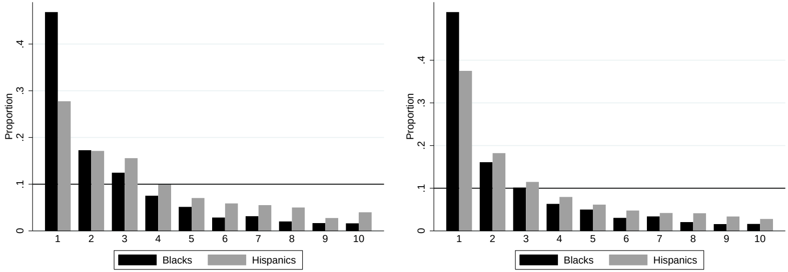
Source: Children of the National Longitudinal Survey of Youth (CNLSY).

Comparsion of AFQT Distributions

- Figure 72 places the Black and Hispanic scholastic ability distribution in the overall White distribution.
- The measures of ability is based on achievement tests for reading and math skills.
- The tests are taken in the teenage years.
- If abilities were distributed equally across groups, minorities would be distributed evenly across the deciles of the White ability distribution.
- (A decile is a measure of location in a distribution. The first decile is a measure of the average scores for persons in the bottom 10% of the White test score distribution. The tenth decile measures the average score for people at the top of the White distribution.)

- By construction, 10% of Whites are in each decile.
- Blacks and Hispanics are over-represented in the lower end of the White ability distribution with Blacks faring slightly worse than Hispanics.

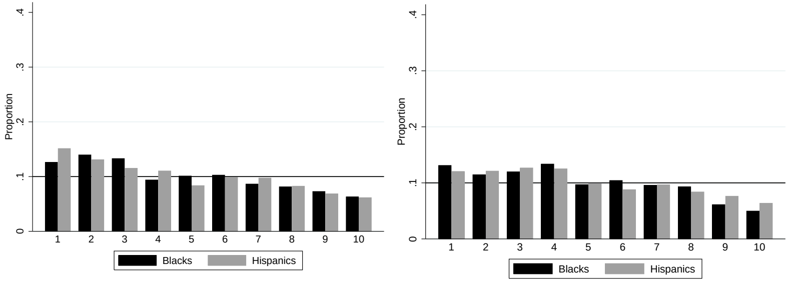
Figure 72: Minority AFQT Scores Placed in the White Distribution—Males (left) and Females (right)



Heckman (2011, Web Appendix).
Notes: Because individuals are at different ages when given the AFQT, the scores have been adjusted to reflect an estimated value at the time just prior to high school using the method described in Heckman et al. (2011).

Comparison of Rotter Locus of Control Distributions

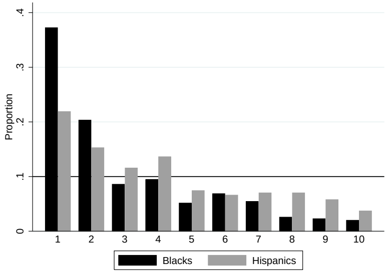
Figure 73: Minority Rotter Scores Placed in the White Distribution - Males (left) and Females (right)



Heckman (2011, Web Appendix).
Notes: Because individuals are at different ages when given the Rotter Locus of Control assessment, the scores have been adjusted to reflect an estimated value at the time just prior to high school using the method described in Heckman et al. (2011).

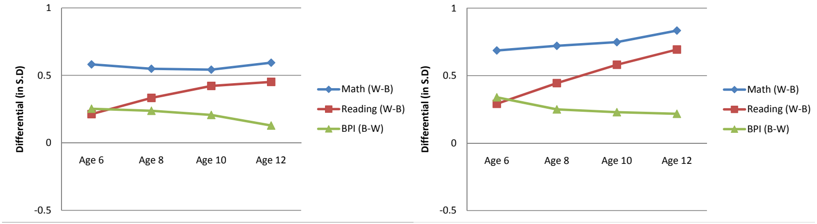
Comparison of PIAT Distributions

Figure 74: Minority PIAT Scores Placed in the White Distribution - Males (left) and Females (right)



Heckman (2011, Web Appendix).

Figure 75: Black-White Gaps in Skill Measures over Ages

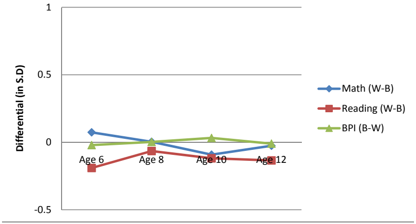


(a) Girls: Scores

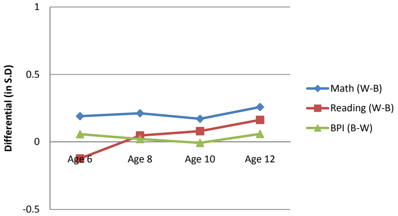
(b) Boys: Scores

Source: Moon (2014).
Data: A balanced panel from Children of National Longitudinal Survey of Youth 1979.

Figure 77: Black-White Gaps in Skill Measures over Ages Cont.



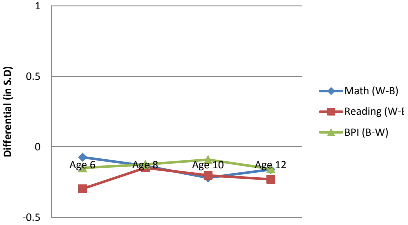
(a) Girls: Residuals (1) - w/o HOME



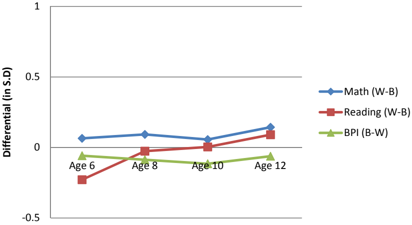
(b) Boys: Residuals (1) - w/o HOME

Source: Moon (2014).
Data: A balanced panel from Children of National Longitudinal Survey of Youth 1979.

Figure 79: Black-White Gaps in Skill Measures over Ages Cont.



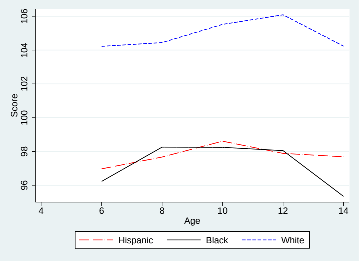
(a) Girls: Residuals (2) - w/ HOME



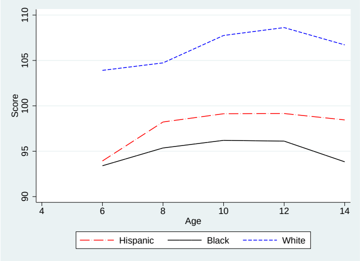
(b) Boys: Residuals (2) - w/ HOME

Source: Moon (2014).
Data: A balanced panel from Children of National Longitudinal Survey of Youth 1979.

Figure 81: Skill Measures over Childhood across Ethnic Groups



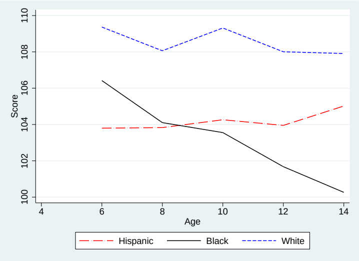
(a) Girls: Math Score (standardized)



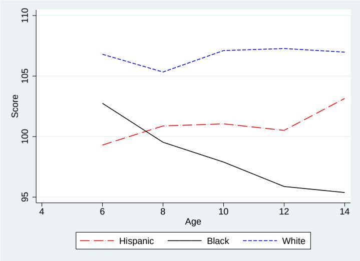
(b) Boys: Math Score (standardized)

Source: Moon (2014).
Data: A balanced panel from Children of National Longitudinal Survey of Youth 1979.

Figure 83: Skill Measures over Childhood across Ethnic Groups Cont.



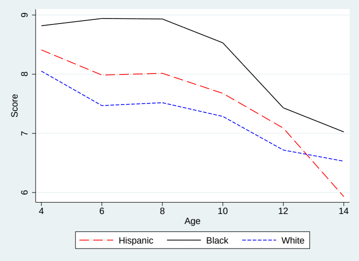
(a) Girls: Reading Score (standardized)



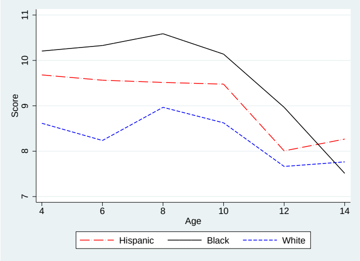
(b) Boys: Reading Score (standardized)

Source: Moon (2014).
Data: A balanced panel from Children of National Longitudinal Survey of Youth 1979.

Figure 85: Skill Measures over Childhood across Ethnic Groups Cont.



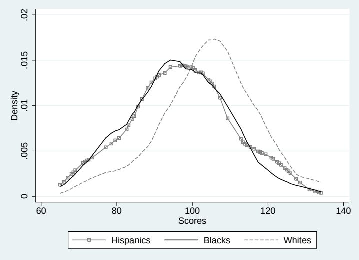
(a) Girls: BPI (Raw score)



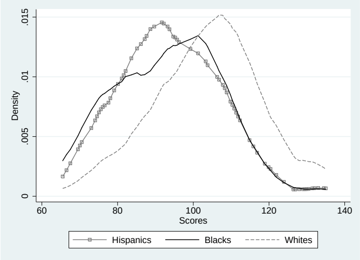
(b) Boys: BPI (Raw score)

Source: Moon (2014).
Data: A balanced panel from Children of National Longitudinal Survey of Youth 1979.

Figure 87: Distribution of Skill Measures across Ethnic Groups: Age 6



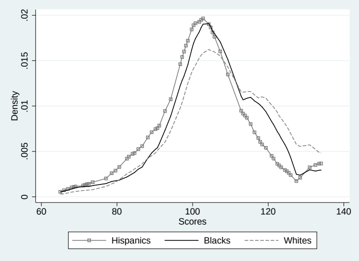
(a) Girls: Math Score (standardized)



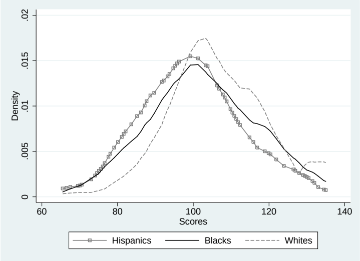
(b) Boys: Math Score (standardized)

Data: A balanced panel from Children of National Longitudinal Survey of Youth 1979.
Source: Moon (2014).

Figure 89: Distribution of Skill Measures across Ethnic Groups: Age 6 Cont.



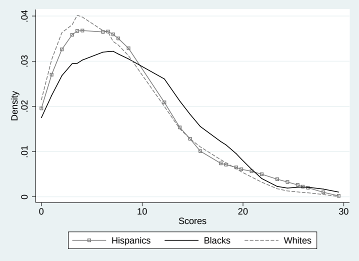
(a) Girls: Reading Score (standardized)



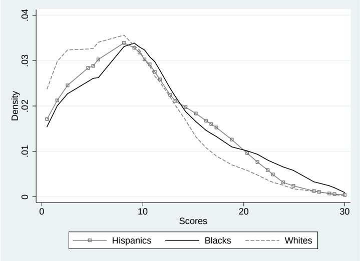
(b) Boys: Reading Score (standardized)

Data: A balanced panel from Children of National Longitudinal Survey of Youth 1979.
Source: Moon (2014).

Figure 91: Distribution of Skill Measures across Ethnic Groups: Age 6 Cont.



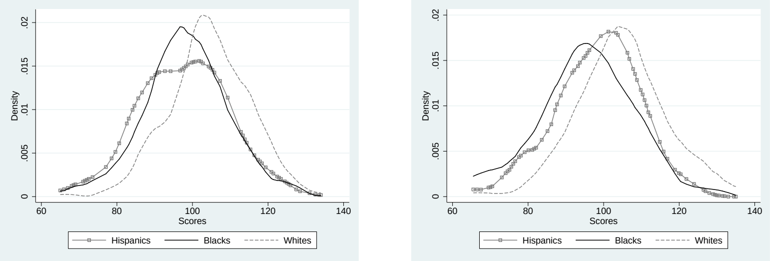
(a) Girls: BPI (Raw score)



(b) Boys: BPI (Raw score)

Data: A balanced panel from Children of National Longitudinal Survey of Youth 1979.
Source: Moon (2014).

Figure 93: Distribution of Skill Measures across Ethnic Groups: Age 8

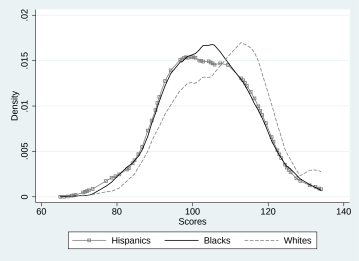


(a) Girls: Math Score (standardized)

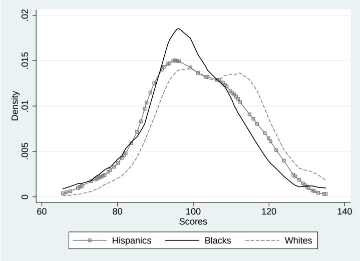
(b) Boys: Math Score (standardized)

Data: A balanced panel from Children of National Longitudinal Survey of Youth 1979.
Source: Moon (2014).

Figure 95: Distribution of Skill Measures across Ethnic Groups: Age 8 Cont.



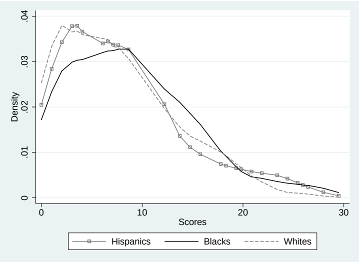
(a) Girls: Reading Score (standardized)



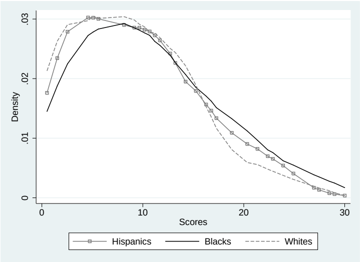
(b) Boys: Reading Score (standardized)

Data: A balanced panel from Children of National Longitudinal Survey of Youth 1979.
Source: Moon (2014).

Figure 97: Distribution of Skill Measures across Ethnic Groups: Age 8 Cont.



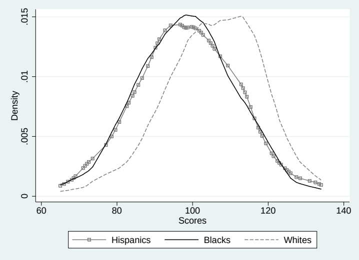
(a) Girls: BPI (Raw score)



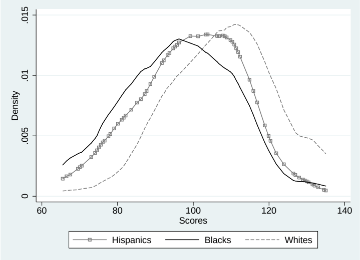
(b) Boys: BPI (Raw score)

Data: A balanced panel from Children of National Longitudinal Survey of Youth 1979.
Source: Moon (2014).

Figure 99: Distribution of Skill Measures across Ethnic Groups: Age 10



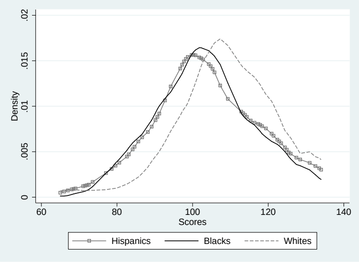
(a) Girls: Math Score (standardized)



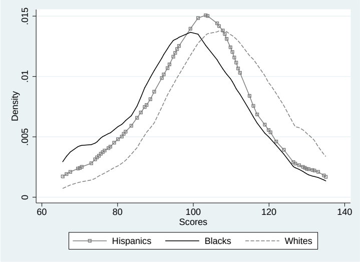
(b) Boys: Math Score (standardized)

Data: A balanced panel from Children of National Longitudinal Survey of Youth 1979.
Source: Moon (2014).

Figure 101: Distribution of Skill Measures across Ethnic Groups: Age 10 Cont.



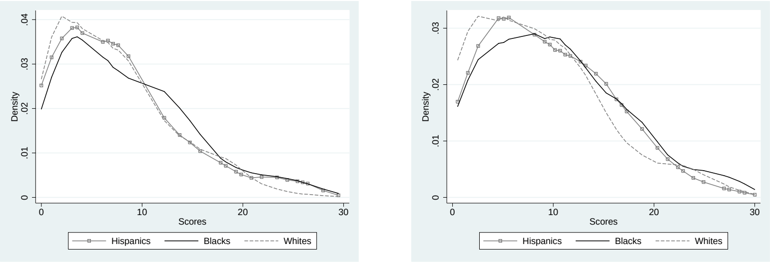
(a) Girls: Reading Score (standardized)



(b) Boys: Reading Score (standardized)

Data: A balanced panel from Children of National Longitudinal Survey of Youth 1979.
Source: Moon (2014).

Figure 103: Distribution of Skill Measures across Ethnic Groups: Age 10 Cont.

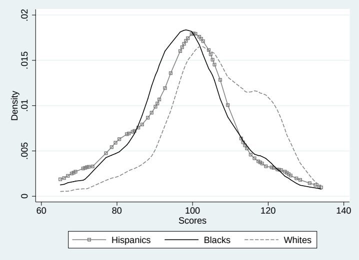


(a) Girls: BPI (Raw score)

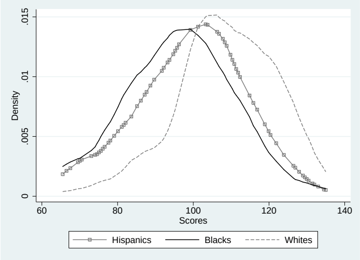
(b) Boys: BPI (Raw score)

Data: A balanced panel from Children of National Longitudinal Survey of Youth 1979.
Source: Moon (2014).

Figure 105: Distribution of Skill Measures across Ethnic Groups: Age 12



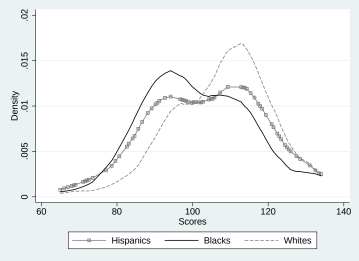
(a) Girls: Math Score (standardized)



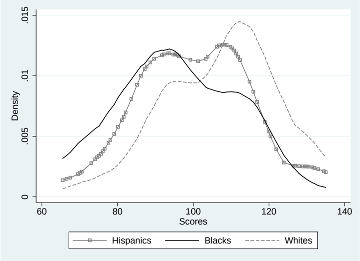
(b) Boys: Math Score (standardized)

Data: A balanced panel from Children of National Longitudinal Survey of Youth 1979.
Source: Moon (2014).

Figure 107: Distribution of Skill Measures across Ethnic Groups: Age 12 Cont.



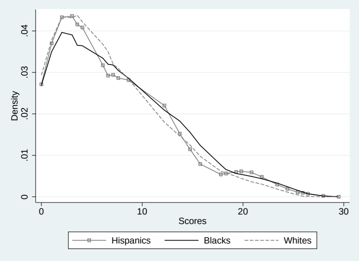
(a) Girls: Reading Score (standardized)



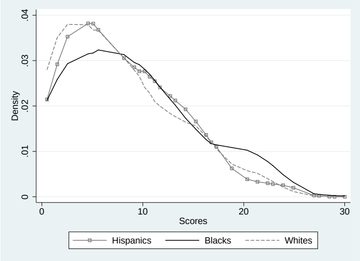
(b) Boys: Reading Score (standardized)

Data: A balanced panel from Children of National Longitudinal Survey of Youth 1979.
Source: Moon (2014).

Figure 109: Distribution of Skill Measures across Ethnic Groups: Age 12 Cont.



(a) Girls: BPI (Raw score)



(b) Boys: BPI (Raw score)

Data: A balanced panel from Children of National Longitudinal Survey of Youth 1979.
Source: Moon (2014).

Ability Comparisons by Parent Characteristics and Investments

Differences in Academic Ability by Race and Socioeconomic Stats - NLSY79 and CNLSY

Table 37: Comparison of Within-Race AFQT Gaps Across Socioeconomic Status - NLSY79 - Males and Females

	Average AFQT Score						Across-Race Difference			
	Whites		Blacks		Hispanics		W-B Gap		W-H Gap	
	Avg	SE	Avg	SE	Avg	SE	Diff	SE	Diff	SE
Unconditional AFQT Averages	0.52	(0.88)	-0.55	(0.87)	-0.16	(0.92)	1.07	(0.04)	0.68	(0.05)
Mother's Educational Status										
Mother is a dropout	0.11	(0.92)	-0.70	(0.75)	-0.33	(0.88)	0.81	(0.05)	0.44	(0.06)
Mother is a high school graduate	0.60	(0.81)	-0.36	(0.89)	0.22	(0.94)	0.96	(0.06)	0.38	(0.12)
Mother is a college graduate or more	0.91	(0.77)	0.01	(0.98)	0.70	(0.68)	0.90	(0.19)	0.21	(0.16)
Difference: college graduate - dropout	0.80	(1.20)	0.71	(1.24)	1.03	(1.12)	0.09	(0.19)	-0.23	(0.17)
Family Income										
Family income from 1979 in bottom tercile	0.28	(0.93)	-0.66	(0.82)	-0.38	(0.90)	0.94	(0.05)	0.66	(0.07)
Family income from 1979 in middle tercile	0.50	(0.85)	-0.40	(0.88)	-0.02	(0.90)	0.90	(0.08)	0.52	(0.11)
Family income from 1979 in top tercile	0.72	(0.82)	-0.16	(0.86)	0.36	(0.83)	0.88	(0.11)	0.36	(0.12)
Difference: top - bottom tercile	0.44	(1.24)	0.50	(1.19)	0.74	(1.22)	-0.06	(0.12)	-0.30	(0.14)
Family Structure										
Child raised in broken home	0.29	(0.91)	-0.54	(0.89)	-0.24	(0.88)	0.83	(0.06)	0.53	(0.09)
Child raised in intact home	0.58	(0.86)	-0.56	(0.84)	-0.12	(0.95)	1.14	(0.05)	0.70	(0.06)
Difference: intact - broken	0.29	(1.26)	-0.02	(1.23)	0.12	(1.29)	0.31	(0.08)	0.17	(0.11)

Source: Heckman (2011, Web Appendix).

Table 38: Comparison of Within-Race PIAT Gaps Across Socioeconomic Status - CNLSY - Males and Females

	Average PIAT Score						Across-Race Difference			
	Whites		Blacks		Hispanics		W-B Gap		W-H Gap	
	Avg	SE	Avg	SE	Avg	SE	Diff	SE	Diff	SE
Unconditional PIAT Averages	0.30	(0.93)	-0.45	(0.96)	-0.11	(0.94)	0.75	(0.04)	0.41	(0.05)
Mother's Educational Status										
Mother is a dropout	-0.28	(0.94)	-0.97	(0.83)	-0.50	(0.94)	0.69	(0.11)	0.22	(0.12)
Mother is a high school graduate	0.16	(0.89)	-0.46	(0.97)	-0.14	(0.89)	0.62	(0.07)	0.30	(0.08)
Mother is a college graduate	0.81	(0.83)	0.07	(0.87)	0.34	(0.80)	0.74	(0.10)	0.47	(0.12)
Difference: College Graduate - Dropout	1.09	(1.25)	1.04	(1.20)	0.84	(1.24)	0.05	(0.15)	0.25	(0.17)
Mother's AFQT										
Mother's AFQT is in the bottom tercile	-0.39	(0.92)	-0.76	(0.86)	-0.40	(0.91)	0.37	(0.09)	0.01	(0.10)
Mother's AFQT is in the middle tercile	0.07	(0.84)	-0.07	(0.91)	0.03	(0.84)	0.14	(0.07)	0.04	(0.08)
Mother's AFQT is in the top tercile	0.59	(0.87)	0.44	(0.93)	0.58	(0.83)	0.15	(0.14)	0.01	(0.11)
Difference: Top - Bottom Tercile	0.98	(1.26)	1.20	(1.26)	0.98	(1.23)	-0.22	(0.16)	0.00	(0.14)
Family Income										
Average family income in 1st quartile	-0.26	(1.10)	-0.77	(0.88)	-0.44	(1.00)	0.51	(0.11)	0.18	(0.13)
Average family income in 2nd quartile	0.10	(0.86)	-0.36	(0.89)	-0.14	(0.89)	0.46	(0.08)	0.24	(0.09)
Average family income in 3rd quartile	0.27	(0.87)	-0.07	(0.94)	-0.04	(0.84)	0.34	(0.10)	0.31	(0.09)
Average family income in 4th quartile	0.64	(0.84)	0.23	(1.03)	0.39	(0.82)	0.41	(0.14)	0.25	(0.10)
Difference: Top - Bottom Quartile	0.90	(1.39)	1.00	(1.36)	0.83	(1.29)	-0.10	(0.17)	0.07	(0.16)
Family Structure										
Single parent, never married	-0.06	(0.94)	-0.59	(0.94)	-0.20	(0.93)	0.53	(0.09)	0.14	(0.12)
Broken or blended family	0.14	(0.89)	-0.43	(0.95)	-0.35	(0.94)	0.57	(0.12)	0.49	(0.14)
Intact family	0.38	(0.92)	-0.21	(0.98)	0.00	(0.93)	0.59	(0.07)	0.38	(0.06)
Difference: Intact - Single Parent	0.44	(1.32)	0.38	(1.36)	0.20	(1.31)	0.06	(0.12)	0.24	(0.13)

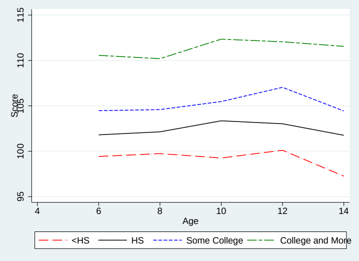
Source: Heckman (2011, Web Appendix).

Table 39: Comparison of Within-Race AFQT Gaps Across Socioeconomic Status—NLSY97—Males and Females

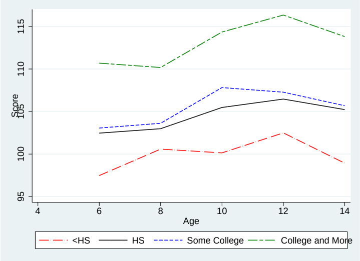
	Average AFQT Score						Across-Race Difference			
	Whites		Blacks		Hispanics		W-B Gap		W-H Gap	
	Avg	SE	Avg	SE	Avg	SE	Diff	SE	Diff	SE
Unconditional AFQT Averages	0.09	(1.00)	-0.19	(0.98)	-0.08	(1.01)	0.28	(0.05)	0.17	(0.06)
Mother's Educational Status										
Mother is a dropout	-0.08	(0.92)	-0.14	(0.96)	-0.21	(0.99)	0.06	(0.11)	0.13	(0.11)
Mother is a high school graduate	0.02	(0.99)	-0.21	(1.08)	-0.01	(1.01)	0.23	(0.09)	0.03	(0.10)
Mother is a college graduate	0.28	(1.07)	-0.07	(0.91)	0.21	(1.32)	0.35	(0.12)	0.07	(0.22)
Difference: College Graduate - Dropout	0.36	(1.41)	0.07	(1.32)	0.42	(1.65)	0.29	(0.17)	-0.06	(0.25)
Family Income										
Family income from 1997 in 1st quartile	0.05	(0.99)	-0.18	(0.91)	-0.01	(1.07)	0.23	(0.10)	0.06	(0.12)
Family income from 1997 in 2nd quartile	0.14	(1.03)	-0.22	(1.05)	-0.07	(0.88)	0.36	(0.11)	0.21	(0.12)
Family income from 1997 in 3rd quartile	0.10	(1.01)	-0.27	(0.92)	-0.11	(0.99)	0.37	(0.14)	0.21	(0.13)
Family income from 1997 in 4th quartile	0.09	(1.00)	-0.15	(1.05)	0.11	(1.20)	0.24	(0.17)	-0.02	(0.16)
Difference: Top - Bottom Quartile	0.04	(1.43)	0.03	(1.48)	0.12	(1.49)	0.01	(0.19)	-0.08	(0.20)

Source: Heckman (2011, Web Appendix).

Figure 111: Skill Measures over Childhood by Mother's Education: White



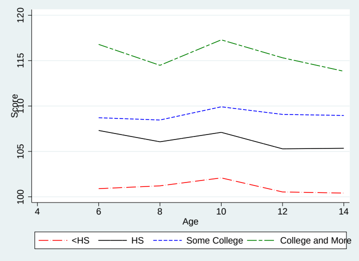
(a) Girls: Math Score (standardized)



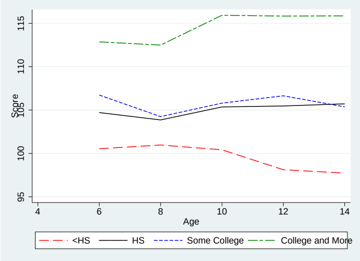
(b) Boys: Math Score (standardized)

Data: A balanced panel from Children of National Longitudinal Survey of Youth 1979.
Source: Moon (2014).

Figure 113: Skill Measures over Childhood by Mother's Education: White Cont.



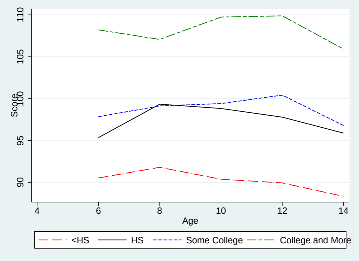
(a) Girls: Reading Score (standardized)



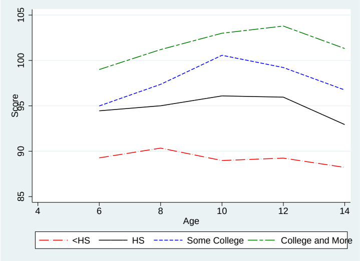
(b) Boys: Reading Score (standardized)

Data: A balanced panel from Children of National Longitudinal Survey of Youth 1979.
Source: Moon (2014).

Figure 115: Skill Measures over Childhood by Mother's Education : Black



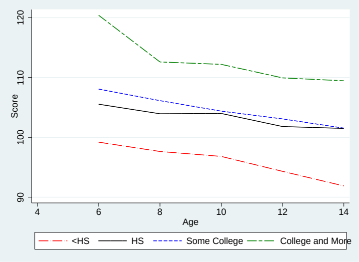
(a) Girls: Math Score (standardized)



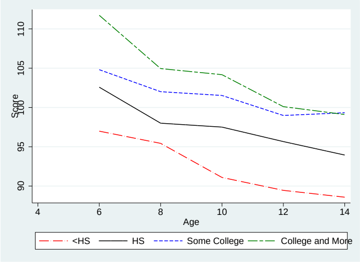
(b) Boys: Math Score (standardized)

Data: A balanced panel from Children of National Longitudinal Survey of Youth 1979.
Source: Moon (2014).

Figure 117: Skill Measures over Childhood by Mother's Education : Black Cont.



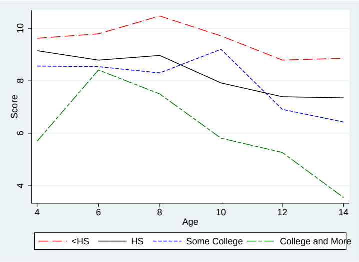
(a) Girls: Reading Score (standardized)



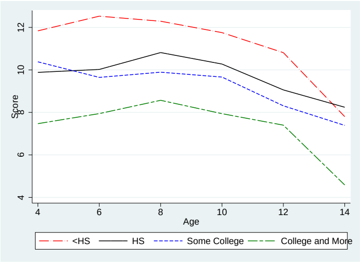
(b) Boys: Reading Score (standardized)

Data: A balanced panel from Children of National Longitudinal Survey of Youth 1979.
Source: Moon (2014).

Figure 119: Skill Measures over Childhood by Mother's Education : Black Cont.



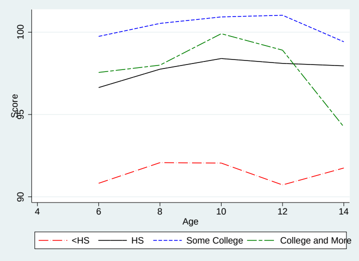
(a) Girls: BPI (Raw score)



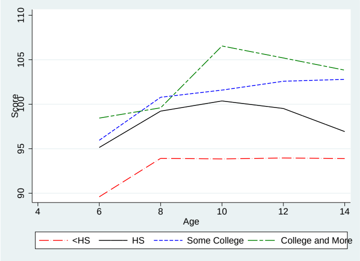
(b) Boys: BPI (Raw score)

Data: A balanced panel from Children of National Longitudinal Survey of Youth 1979.
Source: Moon (2014).

Figure 121: Skill Measures over Childhood by Mother's Education : Hispanic



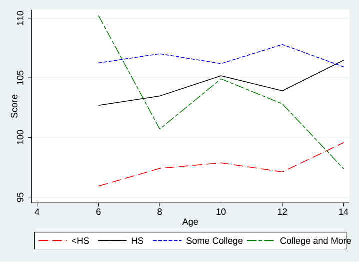
(a) Girls: Math Score (standardized)



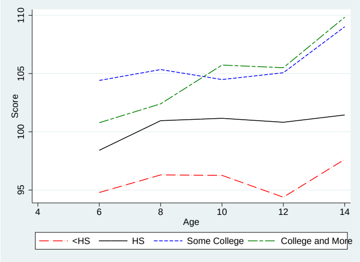
(b) Boys: Math Score (standardized)

Data: A balanced panel from Children of National Longitudinal Survey of Youth 1979.
Source: Moon (2014).

Figure 123: Skill Measures over Childhood by Mother's Education : Hispanic Cont.



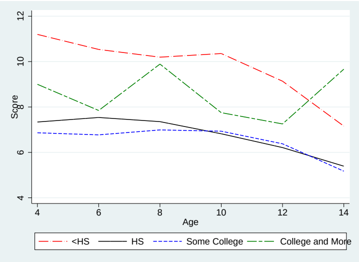
(a) Girls: Reading Score (standardized)



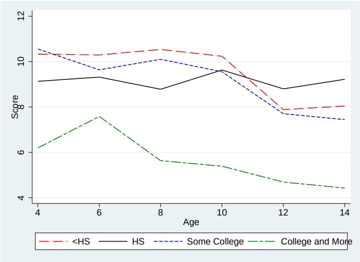
(b) Boys: Reading Score (standardized)

Data: A balanced panel from Children of National Longitudinal Survey of Youth 1979. Source: Moon (2014).

Figure 125: Skill Measures over Childhood by Mother's Education : Hispanic Cont.



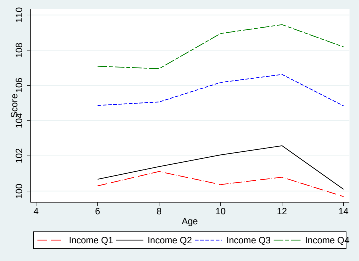
(a) Girls: BPI (Raw score)



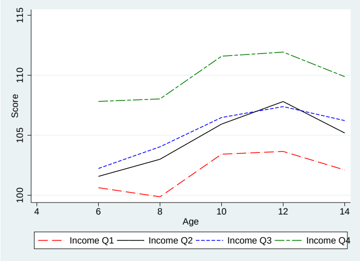
(b) Boys: BPI (Raw score)

Data: A balanced panel from Children of National Longitudinal Survey of Youth 1979. Source: Moon (2014).

Figure 127: Skill Measures over Childhood among Whites by Family Income Quartile



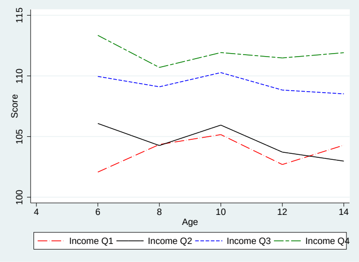
(a) Girls: Math Score (standardized)



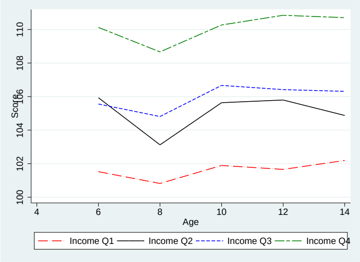
(b) Boys: Math Score (standardized)

Data: A balanced panel from Children of National Longitudinal Survey of Youth 1979.
Source: Moon (2014).

Figure 129: Skill Measures over Childhood among Whites by Family Income Quartile Cont.



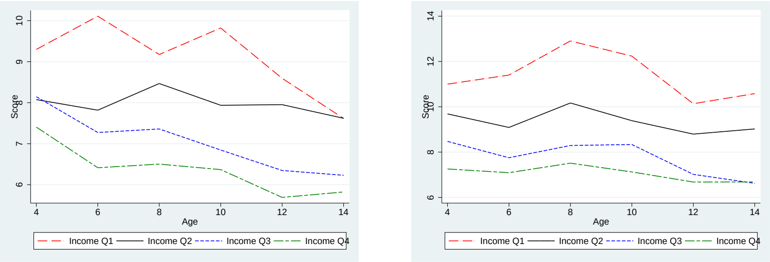
(a) Girls: Reading Score (standardized)



(b) Boys: Reading Score (standardized)

Data: A balanced panel from Children of National Longitudinal Survey of Youth 1979.
Source: Moon (2014).

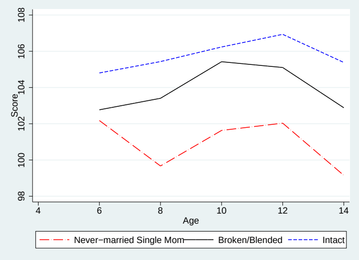
Figure 131: Skill Measures over Childhood among Whites by Family Income Quartile Cont.



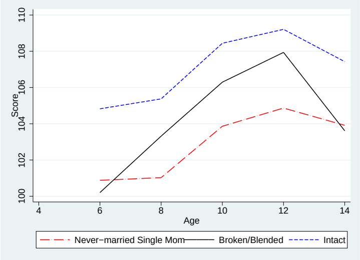
(a) Girls: BPI (Raw score) (b) Boys: BPI (Raw score)

Data: A balanced panel from Children of National Longitudinal Survey of Youth 1979.
Source: Moon (2014).

Figure 133: Skill Measures over Childhood among Whites by Family Type



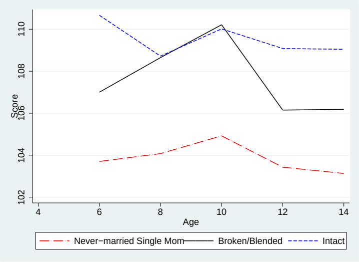
(a) Girls: Math Score (standardized)



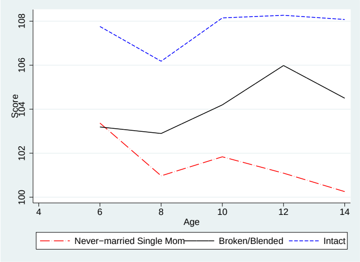
(b) Boys: Math Score (standardized)

Data: A balanced panel from Children of National Longitudinal Survey of Youth 1979.
Source: Moon (2014).

Figure 135: Skill Measures over Childhood among Whites by Family Type Cont.



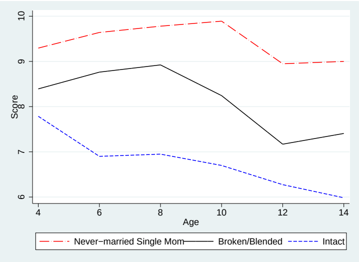
(a) Girls: Reading Score (standardized)



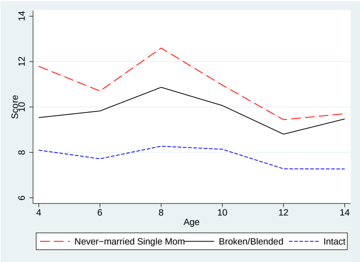
(b) Boys: Reading Score (standardized)

Data: A balanced panel from Children of National Longitudinal Survey of Youth 1979. Source: Moon (2014).

Figure 137: Skill Measures over Childhood among Whites by Family Type Cont.



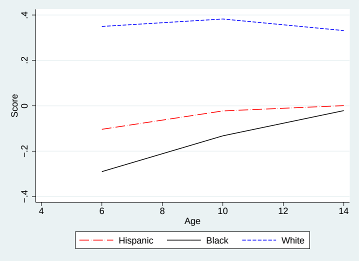
(a) Girls: BPI (Raw score)



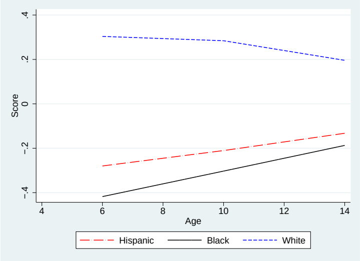
(b) Boys: BPI (Raw score)

Data: A balanced panel from Children of National Longitudinal Survey of Youth 1979.
Source: Moon (2014).

Figure 139: Parental Investment over Childhood across Ethnic Groups



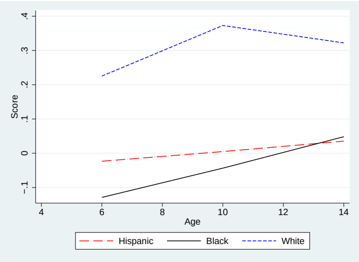
(a) Girls: Material Resource



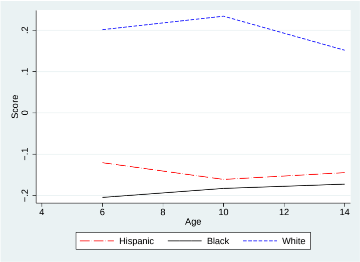
(b) Boys: Material Resource

Data: A balanced panel from Children of National Longitudinal Survey of Youth 1979.
Source: Moon (2014).

Figure 141: Parental Investment over Childhood across Ethnic Groups Cont.



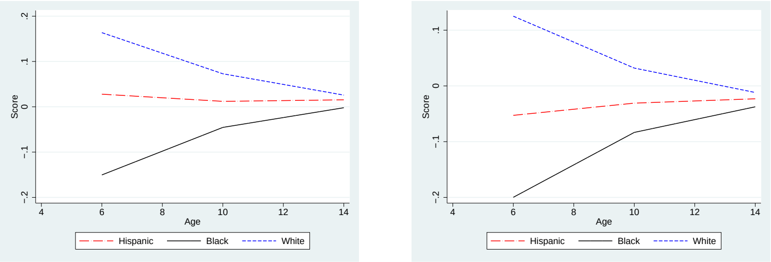
(a) Girls: Cognitive Stimulation



(b) Boys: Cognitive Stimulation

Data: A balanced panel from Children of National Longitudinal Survey of Youth 1979.
Source: Moon (2014).

Figure 143: Parental Investment over Childhood across Ethnic Groups Cont.



(a) Girls: Emotional Support (b) Boys: Emotional Support

Data: A balanced panel from Children of National Longitudinal Survey of Youth 1979.
Source: Moon (2014).

Table 40: Contributions by Components to Racial Skill Gaps at age 6: Static Decomposition, Raw Scores

	Age 6	Math Mean	Math s.e.		Math %Changes	Reading Mean	Reading s.e.		Reading %Changes
Girls	**Actual Gap (=W-B)**	3.0980	0.4870	***		1.2755	0.5055	***	
	Contribution by								
	Mother's Skill	3.3742	0.4675	***	**108.9%**	2.4673	0.3636	***	**193.4%**
	Mother's Cog.	3.1711	0.4366	***	**102.4%**	2.1490	0.3204	***	**168.5%**
	Mother's Non-cog.	0.1583	0.1027		5.1%	0.3776	0.0930	***	**29.6%**
	Parental Investment	1.1734	0.1667	***	**37.9%**	1.3495	0.2367	***	**105.8%**
	Material Resource	-0.1799	0.1312	**	**-5.8%**	0.5737	0.1539	***	**45.0%**
	Cognitive Stimulation	-0.4004	0.1099	***	**-12.9%**	0.7155	0.1607	***	**56.1%**
	Emotional Support	-0.4009	0.1101	***	**-12.9%**	0.7151	0.1565	***	**56.1%**
	Intact Family	0.2097	0.1901		6.8%	0.9881	0.1877	***	**77.5%**
	Family Income	-0.5796	0.1102	***	**-18.7%**	0.6688	0.1515	***	**52.4%**
	All Together Jointly	5.2503	0.4542	***	**169.5%**	4.1330	0.4446	***	**324.0%**
Boys	**Actual Gap (=W-B)**	4.1329	0.5130	***		1.7658	0.5244	***	
	Contribution by								
	Mother's Skill	-0.1985	0.6500		-4.8%	1.0583	0.2884	***	**59.9%**
	Mother's Cog.	0.2108	0.4260		5.1%	1.2406	0.2973	***	**70.3%**
	Mother's Non-cog.	-0.2191	0.1176		-5.3%	-0.1451	0.1060		-8.2%
	Parental Investment	1.6323	0.2001	***	**39.5%**	1.1938	0.1986	***	**67.6%**
	Material Resource	-0.2783	0.0802	***	**-6.7%**	0.0188	0.1257		1.1%
	Cognitive Stimulation	-0.3657	0.0851	***	**-8.8%**	-0.0863	0.1255		-4.9%
	Emotional Support	-0.3945	0.0892	***	**-9.5%**	-0.0861	0.1172		-4.9%
	Intact Family	0.2370	0.1811		5.7%	0.5829	0.1721	***	**33.0%**
	Family Income	-0.4645	0.1129	***	**-11.2%**	-0.0901	0.1061		-5.1%
	All Together Jointly	1.3216	0.6425	***	**32.0%**	1.0808	0.4401	***	**61.2%**

Source: Moon (2014)
Data: A balanced panel from Children of NLSY79.

Table 41: Contributions by Components to Racial Skill Gaps at age 8: Static Decomposition, Raw Scores

	Age 8	Math				Reading			
		Mean	s.e.		%Changes	Mean	s.e.		%Changes
Girls	**Actual Gap (=W-B)**	5.1382	0.6080	***		3.5628	0.6652	***	
	Contribution by								
	Mother's Skill	2.7338	0.5971	***	**53.2%**	3.2826	0.6781	***	**92.1%**
	Mother's Cog.	2.0687	0.4565	***	**40.3%**	2.4999	0.4463	***	**70.2%**
	Mother's Non-cog.	0.1091	0.2530		2.1%	0.5939	0.1534	***	**16.7%**
	Parental Investment	1.6231	0.4015	***	**31.6%**	0.5680	0.3167	***	**15.9%**
	Material Resource	0.7080	0.1620	***	**13.8%**	-0.3444	0.2347		-9.7%
	Cognitive Stimulation	0.1514	0.1946		2.9%	0.4042	0.2312		11.3%
	Emotional Support	-0.0113	0.2173		-0.2%	0.0922	0.1749		2.6%
	Intact Family	0.9514	0.2729	***	**18.5%**	0.2146	0.2404		6.0%
	Family Income	-0.0319	0.2054		-0.6%	0.4713	0.2168		13.2%
	All Together Jointly	8.4589	1.3849	***	**164.6%**	4.8014	1.2491	***	**134.8%**
Boys	**Actual Gap (=W-B)**	7.8927	0.6951	***		5.7689	0.7598	***	
	Contribution by								
	Mother's Skill	0.1581	0.4175		2.0%	1.3319	0.4175	***	**23.1%**
	Mother's Cog.	0.2596	0.4277		3.3%	1.4343	0.3437	***	**24.9%**
	Mother's Non-cog.	-0.0050	0.2447		-0.1%	0.0821	0.2251		1.4%
	Parental Investment	1.4969	0.4633	***	**19.0%**	1.3132	0.3847	***	**22.8%**
	Material Resource	0.6372	0.2557	***	**8.1%**	-0.2972	0.3007		-5.2%
	Cognitive Stimulation	0.2249	0.2361		2.9%	-0.4098	0.3123		-7.1%
	Emotional Support	-0.5604	0.2807		-7.1%	0.0465	0.2768		0.8%
	Intact Family	0.0615	0.4371		0.8%	0.0837	0.4296		1.5%
	Family Income	-0.0099	0.1697		-0.1%	0.7981	0.2578	*	**13.8%**
	All Together Jointly	1.0499	1.3322		13.3%	1.5758	1.6601	**	**27.3%**

Source: Moon (2014)
Data: A balanced panel from Children of NLSY79.

Table 42: Contributions by Components to Racial Skill Gaps at age 10: Static Decomposition, Raw Scores

	Age 10	Math				Reading			
		Mean	s.e.		%Changes	Mean	s.e.		%Changes
Girls	**Actual Gap (=W-B)**	4.9991	0.5573	***		5.4490	0.7313	***	
	Contribution by								
	Mother's Skill	2.4316	0.4193	***	**48.6%**	3.1203	0.4861	***	**57.3%**
	Mother's Cog.	1.5777	0.3434	***	**31.6%**	1.9647	0.4150	***	**36.1%**
	Mother's Non-cog.	0.5930	0.2144	**	**11.9%**	0.4168	0.3203	*	**7.6%**
	Parental Investment	1.2101	0.3112	***	**24.2%**	1.4945	0.2420	***	**27.4%**
	Material Resource	0.8562	0.3691	*	**17.1%**	0.9075	0.2961	*	**16.7%**
	Cognitive Stimulation	1.0006	0.3638	*	**20.0%**	0.5114	0.3193		9.4%
	Emotional Support	0.5475	0.2833		11.0%	0.2179	0.2407		4.0%
	Intact Family	0.9134	0.3906	**	**18.3%**	0.3798	0.5135		7.0%
	Family Income	0.0650	0.2297		1.3%	-0.3846	0.2187		-7.1%
	All Together Jointly	4.0526	0.9874	***	**81.1%**	3.9843	2.5116	***	**73.1%**
Boys	**Actual Gap (=W-B)**	8.0250	0.6575	***		8.6815	0.8423	***	
	Contribution by								
	Mother's Skill	1.3211	0.5350	**	**16.5%**	0.4754	0.4171		5.5%
	Mother's Cog.	1.2266	0.4371	***	**15.3%**	0.2970	0.6139		3.4%
	Mother's Non-cog.	0.1876	0.2032		2.3%	0.1242	0.2530		1.4%
	Parental Investment	1.6647	0.3630	***	**20.7%**	0.7054	0.3133	***	**8.1%**
	Material Resource	-0.1786	0.4423		-2.2%	0.8257	0.3458	**	**9.5%**
	Cognitive Stimulation	-0.4240	0.3327		-5.3%	0.5606	0.2828	**	**6.5%**
	Emotional Support	-0.2457	0.2440		-3.1%	0.3140	0.2844		3.6%
	Intact Family	-0.1441	0.3622		-1.8%	0.5578	0.4444		6.4%
	Family Income	0.1845	0.2943		2.3%	0.0647	0.2981		0.7%
	All Together Jointly	0.3526	1.0594		4.4%	1.7944	1.1283	***	**20.7%**

Source: Moon (2014)
Data: A balanced panel from Children of NLSY79.

Table 43: Contributions by Components to Racial Skill Gaps at age 12: Static Decomposition, Raw Scores

	Age 12	Math Mean	Math s.e.		Math %Changes	Reading Mean	Reading s.e.		Reading %Changes
Girls	**Actual Gap (=W-B)**	6.3731	0.2928	***		5.3663	0.3710	***	
	Contribution by								
	Mother's Skill	3.2826	0.6781	***	**51.5%**	4.1805	0.6452	***	**77.9%**
	Mother's Cog.	2.4999	0.4463	***	**39.2%**	3.2859	0.5356	***	**61.2%**
	Mother's Non-cog.	0.5939	0.1534	***	**9.3%**	0.7779	0.2289	***	**14.5%**
	Parental Investment	0.5680	0.3167	***	**8.9%**	1.4638	0.3502	***	**27.3%**
	Material Resource	-0.3444	0.2347		-5.4%	0.4033	0.2866		7.5%
	Cognitive Stimulation	0.4042	0.2312		6.3%	0.2156	0.2212		4.0%
	Emotional Support	0.0922	0.1749		1.4%	0.8420	0.2343	***	**15.7%**
	Intact Family	0.2146	0.2404		3.4%	1.0145	0.3455	***	**18.9%**
	Family Income	0.4713	0.2168		7.4%	-0.4191	0.2198		-7.8%
	All Together Jointly	4.8014	1.2491	***	**75.3%**	6.3158	0.8482	***	**117.7%**
Boys	**Actual Gap (=W-B)**	9.6089	0.3319	***		10.4059	0.4403	***	
	Contribution by								
	Mother's Skill	1.3319	0.4175	***	**13.9%**	-0.0897	0.7736		-0.9%
	Mother's Cog.	1.4343	0.3437	***	**14.9%**	0.0437	0.5204		0.4%
	Mother's Non-cog.	0.0821	0.2251		0.9%	-0.0802	0.2583		-0.8%
	Parental Investment	1.3132	0.3847	***	**13.7%**	0.7706	0.6831		7.4%
	Material Resource	-0.2972	0.3007		-3.1%	0.5569	0.2899	**	**5.4%**
	Cognitive Stimulation	-0.4098	0.3123		-4.3%	0.6429	0.4213		6.2%
	Emotional Support	0.0465	0.2768		0.5%	0.2388	0.2815	*	**2.3%**
	Intact Family	0.0837	0.4296		0.9%	1.2836	0.5101	*	**12.3%**
	Family Income	0.7981	0.2578	*	**8.3%**	0.4629	0.3622	*	**4.4%**
	All Together Jointly	1.5758	1.6601	*	**16.4%**	2.0414	2.3343		19.6%

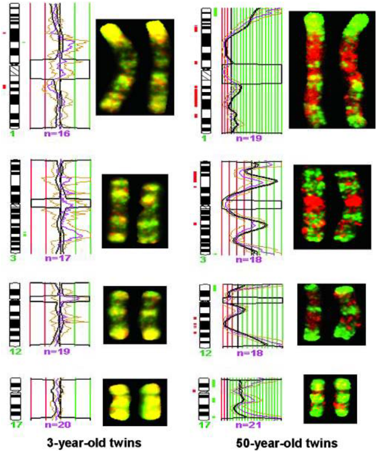
Source: Moon (2014)
Data: A balanced panel from Children of NLSY79.

Return to Slide 12

Appendix M: Evidence on Gene Environment Interactions

Genes, Biological Embedding of Experience, and Gene-Environment Interactions

Figure 145: DNA methylation and histone acetylation patterns in young and old twins



Source: Fraga et al. (2005).

- Tables 44 and 45 review the main studies in the behavioral genetics literature on the heritability of capabilities.
- However, the estimates presented are highly questionable.
- The first reason of skepticism is that the standard linear additive models (ACE) used in behavioral genetics and social sciences rely on highly questionable assumptions.
- In particular, they assume that child's genetic inheritance and parenting experience are uncorrelated.
- For this to hold, parent's genes have to be uncorrelated with the family environment they create.
- This is internally inconsistent given that the theory postulates that genes affect behavior.

- A second reason of skepticism is related to the fact that while the transmission of the genotype follows biologically determined mechanisms, the mapping of the genotype into phenotype is unclear and likely affected by the environment through epigenetic forces potentially affecting also future generations (Cole et al., 2012; Jablonka and Raz, 2009; Kuzawa and Quinn, 2009; Youngson and Whitelaw, 2008).
- We conclude that while genetic influences are likely important, the ways social scientists have developed to measure them fail to provide credible estimates.
- Table 44 and 45 consistently show that whenever the the role of environmental effects in mediating genes expressions is considered, the estimates of heritability are highly impacted (Krueger and Johnson, 2008; Nisbett et al., 2012; Tucker-Drob et al., 2009; Turkheimer et al., 2003).

Table 44: Heritability of Cognitive Abilities

Study	Data and Method	Genes-Environment Interactions	Findings
Jencks et al. (1972)	Meta-analysis: 18 studies considered on IQ correlations for twins and adoptive siblings and fraternal twins	X	*Correlations:* - siblings raised together: 0.54 - adoptive sibs: 0.42 - MZ twins: 0.86 - DZ twins: 0.58
Golberger (1977)	Meta-analysis: 7 studies considered on IQ correlations for twins and adoptive siblings	X	*Correlations:* - siblings raised together: 0.5 - adoptive sibs: 0.3 - MZ twins: 0.91
Bouchard and McGue (1981)	Meta-analysis: 69 studies considered on IQ correlations for twins and adoptive siblings	X	*Correlations:* - siblings raised together: 0.45 - adoptive sibs: 0.29; - MZ twins: 0.85

Table 44: Heritability of Cognitive Abilities

Study	Data and Method	Genes-Environment Interactions	Findings
Scarr et al. (1993)	426 members of 93 transracial adoptive families. Analysis of IQ correlations parent-child and across siblings measured at age 7 and 17	X	*Correlations at age 7* Transracial adoptees: with adoptive father 0.08, adoptive mother 0.14, adoptive midparent 0.13, birth father 0.42, birth mother 0.29, birth midparent 0.47 Biological offspring: correlation with father 0.25, mother 0.40, midparent 0.48 *Correlations at age 17* Transracial adoptees: with adoptive father 0.21, adoptive mother 0.21, adoptive midparent 0.27, birth father 0.28, birth mother 0.23, birth midparent 0.24 Biological offspring: correlation with father 0.13, mother 0.45, midparent 0.40

Table 44: Heritability of Cognitive Abilities

Study	Data and Method	Genes-Environment Interactions	Findings
Devlin et al. (1997)	Meta-analysis: 212 studies considered on IQ correlations for twins. Model comparison using Bayes factors. Allow for a role of maternal effects.	✓	*Correlations*: - siblings raised together: 0.44 - siblings raised apart: 0.27 - MZ twins raised together: 0.85 - MZ twins raised apart: 0.68 - DZ twins raised together: 0.59 *Variance decomposition*: - narrow sense heritability (additive genetic effects): 34% - broad-sense heritability (include non additive genetic factors): 48% - maternal effect (for twins): 20% - maternal effect (for siblings): 5% - common environment: 17%

Table 44: Heritability of Cognitive Abilities

Study	Data and Method	Genes-Environment Interactions	Findings
Turkheimer et al. (2003)	319 twins pairs from the National Collaborative Perinatal Project sample. Analysis on the relationship between socioeconomic status (SES) and heritability of IQ.	✓	*Variance decomposition*: - genes: 0.1 for low SES, 0.8 for high SES - shared environment: 0.55 for low SES, 0.1 for high SES - non-shared environment: 0.35 for low SES, 0.1 for high SES - parental environments matter more for low SES families often underrepresented in samples
Tucker-Drob et al. (2009)	319 pairs of twins in the National Collaborative Perinatal Project. Nonlinear factor analysis: account for the possibility that correlations in different cognitive abilities is different at different ability levels. Avoid bias in estimating the relationship of SES and heritability of cognitive abilities	✓	*Variance decomposition*: - genes, 0.15 for low SES, 0.6 for high SES - shared environment, 0.55 for low SES, 0.25 for high SES - non-shared environment, 0.3 for low SES, 0.15 for high SES. - SES gradient in heritability (Turkheimer et al., 2003) is less steep but still present when accounting for nonlinear effects
Haworth et al. (2009)	Twins of high ability (¿ 85th percentile) from samples in United States, Australia, Netherlands and United Kingdom	X	*Variance decomposition*: - genes 50% - shared environment 28% - non-share environment 0.22%

Table 44: Heritability of Cognitive Abilities

Study	Data and Method	Genes-Environment Interactions	Findings
Nisbett et al. (2012)	Meta-analysis: review of recent literature on different aspects of intelligence (IQ, fluid and crystallized) and its relationships with socioeconomic status, interventions and other environmental conditions	✓	IQ and SES: heritability of IQ is higher for higher SES families in the US. Less evident in Europe. IQ and environment: Increase from 12 to 18 points in IQ when children are adopted from working class to middle class homes. IQ and interventions: even if effects on IQ of interventions vanish, there are effects on educational achievements and life outcomes (limits of IQ as the only relevant characteristic)
Briley and Tucker-Drob (2013)	Meta-analysis: 16 articles with 11 unique samples. Total of 11,500 twin and siblings pairs reared together and with cognition measured at least twice between 6 months and 18 years old. Analysis of the changes in the role of genetic heritability over the phases of development.	X	IQ heritability increases over time even when controlling for cross sectional age differences. Innovative genetic influences (activation of new genes because of biological or environmental changes) are predominant until age 8 then genetic amplification (small initial genetic differences are amplified by transactional processes) dominates. Innovative influences are relevant also for the components of variance in IQ due to shared environment, but fades overtime and it is confounded with amplification from age 12.

Table 45: Heritability of Personality Traits

Study	Data and Method	Genes-Environment Interactions	Findings
Loehlin (2005)	Meta-analisis: correlations in personality measures between parents and children under different scenarios	X	*Biological parents raise children*: extraversion 0.14, agreeableness 0.11, conscientiousness 0.09, neuroticism 0.13, openness 0.17. *Adoptive parents and adopted children*: extraversion 0.03, agreeableness 0.01, conscientiousness 0.02, Neuroticism 0.05, openness 0.07. *Biological parents and adopted children*: extraversion 0.16, agreeableness 0.14, conscientiousness 0.11, neuroticism 0.11, openness 0.14.

Table 45: Heritability of Personality Traits

Study	Data and Method	Genes-Environment Interactions	Findings
Krueger and Johnson (2008)	Twins from Minnesota Twin Family Study. 556 male twin pairs and 604 female pairs. Method: allow for parenting style (measured by regard and conflict) as a form of gene-environment interaction. Parental actions mediate the role of genetic contribution to personality.	✓	*Positive emotionality (PEM)*: proportion of variance explained by genes (heritability) depends on level of parental regard. If low, environmental factors explain 64% of variance, genes 35%, if high, genes explain 76%, environment 23%. Conflict does not mediate genes, but environment. If low environment explains 29%, if high 50%. Il parental actions are ignored (standard ACE model) genes explain 52%. *Negative emotionality (NEM)*: low regard, genes explain 28%, high 56%. Low conflict, genes explain 0.67, high 0.31. If parental actions are ignored 40%. Shared environments explain little, but for high level of conflict 0.56%.

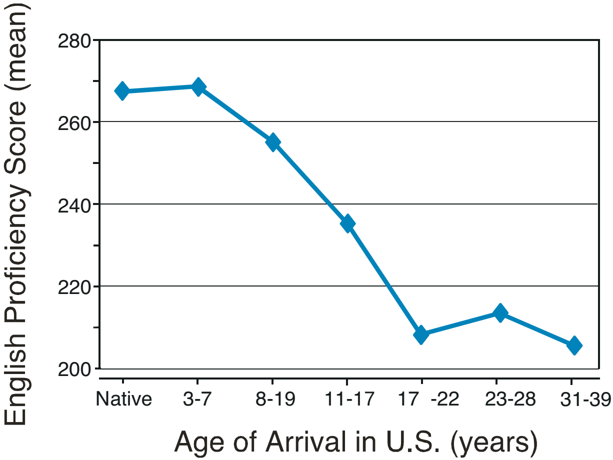
Table 45: Heritability of Personality Traits

Study	Data and Method	Genes-Environment Interactions	Findings
Caprara et al. (2009)	428 Twin Pairs in the Italian Twin Register. Genetic and environmental components of self-esteem, life satisfaction and optimism.	X	Self-esteem: genes explain 73% of the variance Life satisfaction: genes explain 59% of the variance Optimism: genes explain 28% of the variance
Belsky et al. (2012)	1,116 pairs of same sex twins in the E-Risk Longitudinal Twin Study followed from birth to age 12. Analysis of borderline personality related characteristics (BPRCs)	X	BRPCs scale correlation in MZ twins 0.66, in dizygotic (DZ) twins is 0.29. Genes account for 66% of variance in BRPCs. Early childhood physical maltreatment and exposure to maternal negative expressed emotions correlates with BRPCs. Family history of psychiatric disorders increase likelihood of BRPC more in presence of harsh treatment in childhood.

Return to Slide 14

Appendix G: Evidence of Critical and Sensitive Periods and of Dynamic Complementarities

Figure 146: Second language learning



Source: Johnson and Newport (1989).

Table 46: Return to one year of college for individuals at different percentiles of the math test score distribution
White males from high school and beyond

	5%	25%	50%	75%	95%
Average return in the population	0.1121 (0.0400)	0.1374 (0.0328)	0.1606 (0.0357)	0.1831 (0.0458)	0.2101 (0.0622)
Return for those who attend college	0.1640 (0.0503)	0.1893 (0.0582)	0.2125 (0.0676)	0.2350 (0.0801)	0.2621 (0.0962)
Return for those who do not attend college	0.0702 (0.0536)	0.0954 (0.0385)	0.1187 (0.0298)	0.1411 (0.0305)	0.1682 (0.0425)
Return for those at the margin	0.1203 (0.0364)	0.1456 (0.0300)	0.1689 (0.0345)	0.1913 (0.0453)	0.2184 (0.0631)

Source: Carneiro and Heckman (2003).

Return to Slide 16

Appendix B: Evidence on Gaps in Family Environments and Investments in Child Care Across Socioeconomic Classes

Comparison of Ability and Personality Measures by Race

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 Quantity of Words Heard	Actual Differences in Quality 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

Table 47: Gaps in HOME Scores between White and Black across Ages

(A)Females

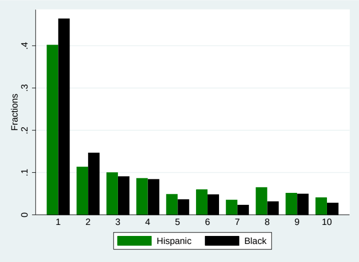
Data	Age	Obs	Means White	Means Black	Differences(in s.d.)	*p*-value
CNLSY	0-3	2587	102.1	91.2	0.686	0.000
	4-7	3186	102.6	89.2	0.820	0.000
	8-11	3054	103.0	90.5	0.796	0.000
CDS 1997	0-3	276	16.1	14.3	0.769	0.000
	4-7	382	21.4	18.4	1.006	0.000
	8-11	321	22.1	19.8	0.841	0.000

(B)Males

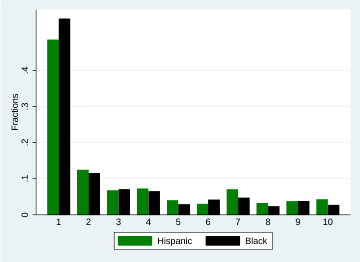
Data	Age	Obs	Means White	Means Black	Differences(in s.d.)	*p*-value
CNLSY	0-3	2644	100.9	90.0	0.677	0.000
	4-7	3289	101.5	87.0	0.881	0.000
	8-11	3118	101.5	89.4	0.731	0.000
CDS 1997	0-3	250	15.5	14.5	0.415	0.002
	4-7	406	21.3	18.3	1.049	0.000
	8-11	337	22.0	20.0	0.741	0.000

Source: Moon (2014).

Figure 147: Hispanic and Black Parental Investment in White Distribution: Unadjusted, Age 0-3



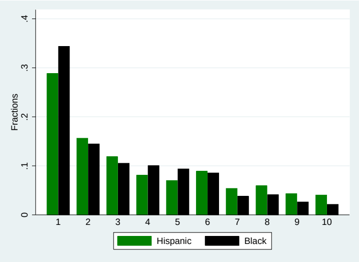
(a) Material Goods (Females)



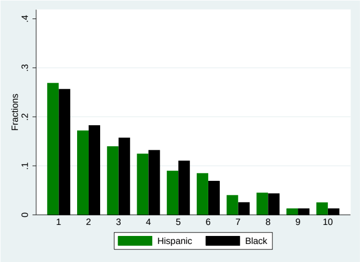
(b) Material Goods (Males)

Source: Moon (2014).

Figure 149: Hispanic and Black Parental Investment in White Distribution: Unadjusted, Age 0-3 Cont.



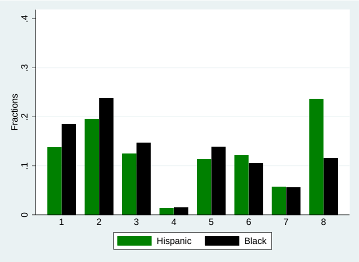
(a) Cognitive Stimulation (Females)



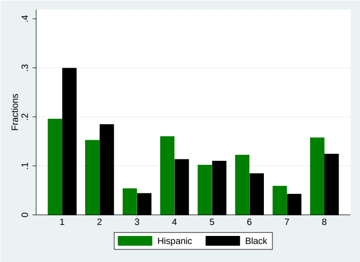
(b) Cognitive Stimulation (Males)

Source: Moon (2014).

Figure 151: Hispanic and Black Parental Investment in White Distribution: Unadjusted, Age 0-3 Cont.



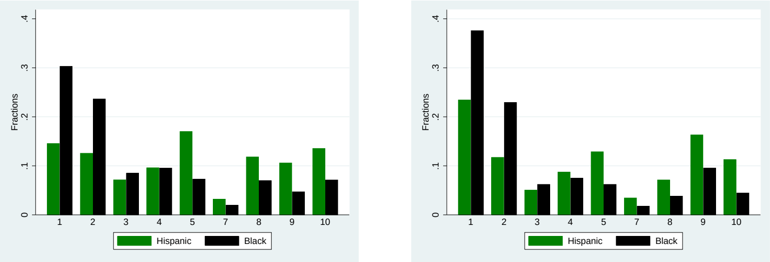
(a) Emotional Support (Females)



(b) Emotional Support (Males)

Source: Moon (2014).

Figure 153: Hispanic and Black Parental Investment in White Distribution: Unadjusted, Age 0-3 Cont.

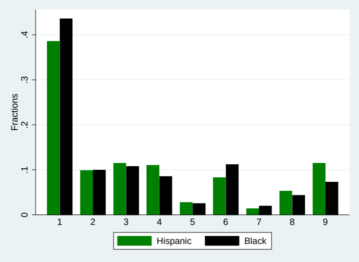


(a) Father Engagement (Females)

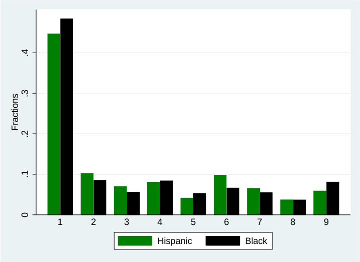
(b) Father Engagement (Males)

Source: Moon (2014).

Figure 155: Hispanic and Black Parental Investment in White Distribution: Unadjusted, Age 4-7



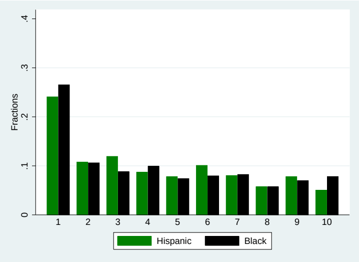
(a) Material Goods (Females)



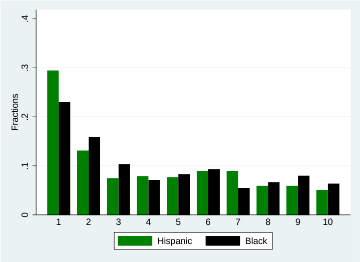
(b) Material Goods (Males)

Source: Moon (2014).

Figure 157: Hispanic and Black Parental Investment in White Distribution: Unadjusted, Age 4-7 Cont.



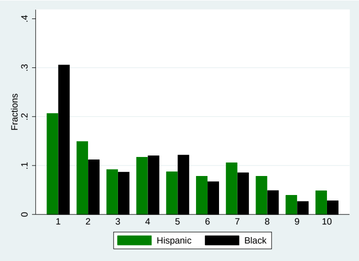
(a) Cognitive Stimulation (Females)



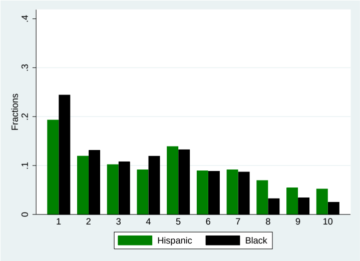
(b) Cognitive Stimulation (Males)

Source: Moon (2014).

Figure 159: Hispanic and Black Parental Investment in White Distribution: Unadjusted, Age 4-7 Cont.



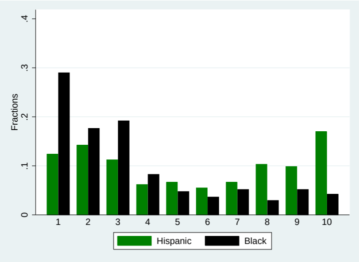
(a) Emotional Support (Females)



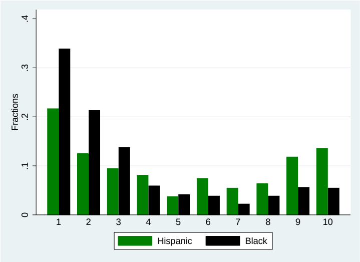
(b) Emotional Support (Males)

Source: Moon (2014).

Figure 161: Hispanic and Black Parental Investment in White Distribution: Unadjusted, Age 4-7 Cont.



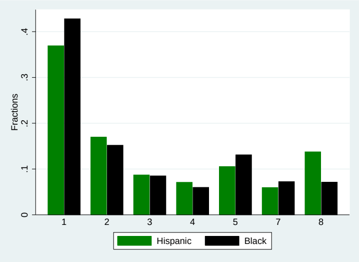
(a) Father Engagement (Females)



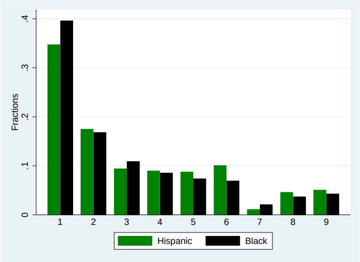
(b) Father Engagement (Males)

Source: Moon (2014).

Figure 163: Hispanic and Black Parental Investment in White Distribution: Unadjusted, Age 8-11



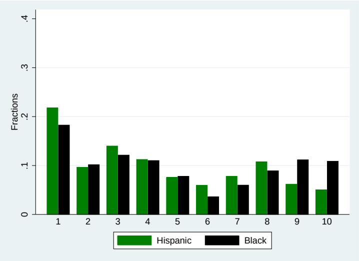
(a) Material Goods (Females)



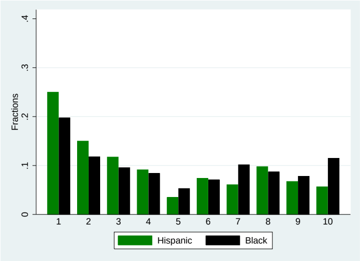
(b) Material Goods (Males)

Source: Moon (2014).

Figure 165: Hispanic and Black Parental Investment in White Distribution: Unadjusted, Age 8-11 Cont.



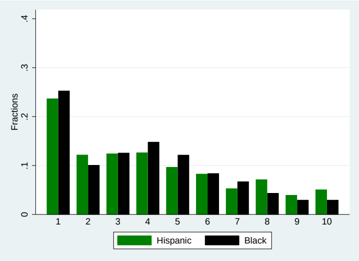
(a) Cognitive Stimulation (Females)



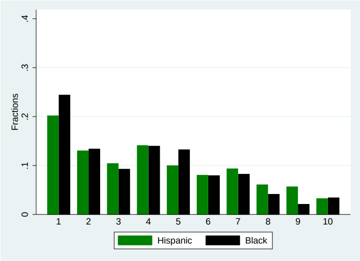
(b) Cognitive Stimulation (Males)

Source: Moon (2014).

Figure 167: Hispanic and Black Parental Investment in White Distribution: Unadjusted, Age 8-11 Cont.



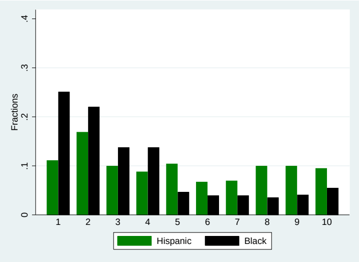
(a) Emotional Support (Females)



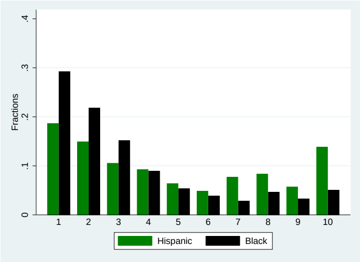
(b) Emotional Support (Males)

Source: Moon (2014).

Figure 169: Hispanic and Black Parental Investment in White Distribution: Unadjusted, Age 8-11 Cont.



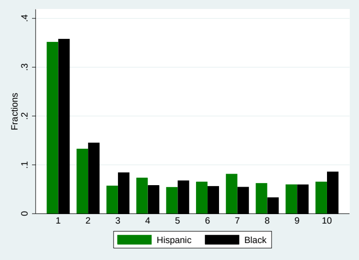
(a) Father Engagement (Females)



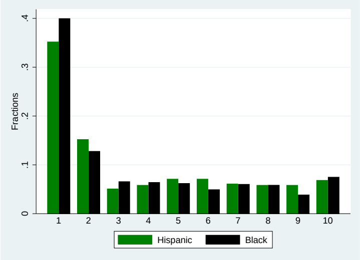
(b) Father Engagement (Males)

Source: Moon (2014).

Figure 171: Hispanic and Black Parental Investment in White Distribution: Adjusted for Mother's Education, Family Income, and Family Structure, Age 0-3



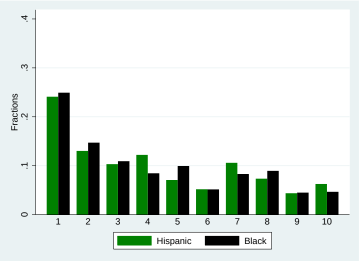
(a) Material Goods (Females)



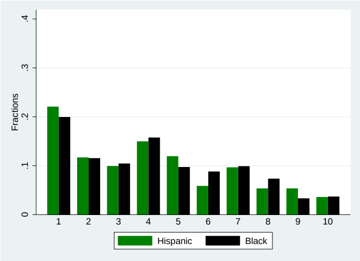
(b) Material Goods (Males)

Source: Moon (2014).

Figure 173: Hispanic and Black Parental Investment in White Distribution: Adjusted for Mother's Education, Family Income, and Family Structure, Age 0-3 Cont.



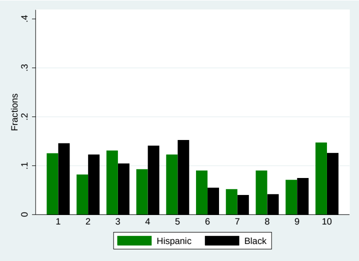
(a) Cognitive Stimulation (Females)



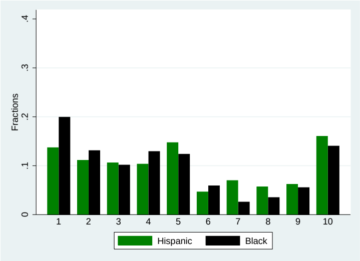
(b) Cognitive Stimulation (Males)

Source: Moon (2014).

Figure 175: Hispanic and Black Parental Investment in White Distribution: Adjusted for Mother's Education, Family Income, and Family Structure, Age 0-3 Cont.



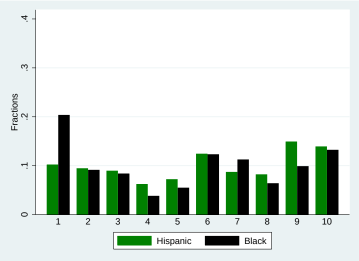
(a) Emotional Support (Females)



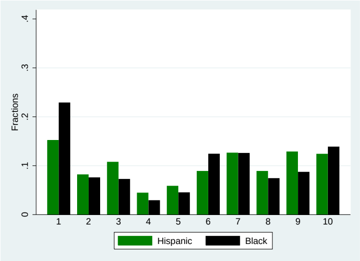
(b) Emotional Support (Males)

Source: Moon (2014).

Figure 177: Hispanic and Black Parental Investment in White Distribution: Adjusted for Mother's Education, Family Income, and Family Structure, Age 0-3 Cont.



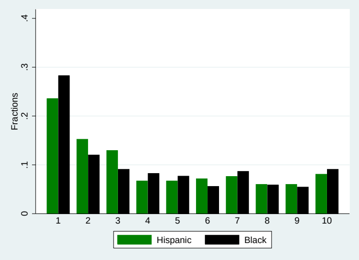
(a) Father Engagement (Females)



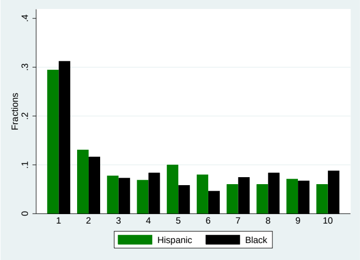
(b) Father Engagement (Males)

Source: Moon (2014).

Figure 179: Hispanic and Black Parental Investment in White Distribution: Adjusted for Mother's Education, Family Income, and Family Structure, age 4-7



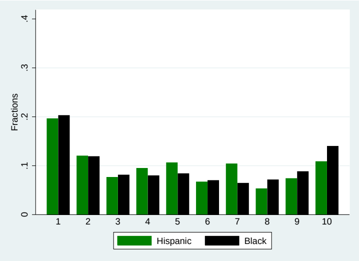
(a) Material Goods (Females)



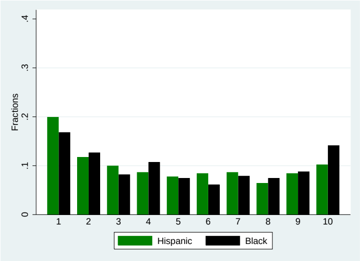
(b) Material Goods (Males)

Source: Moon (2014).

Figure 181: Hispanic and Black Parental Investment in White Distribution: Adjusted for Mother's Education, Family Income, and Family Structure, age 4-7 Cont.



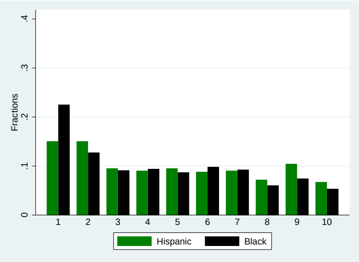
(a) Cognitive Stimulation (Females)



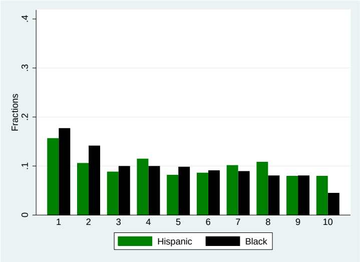
(b) Cognitive Stimulation (Males)

Source: Moon (2014).

Figure 183: Hispanic and Black Parental Investment in White Distribution: Adjusted for Mother's Education, Family Income, and Family Structure, age 4-7 Cont.



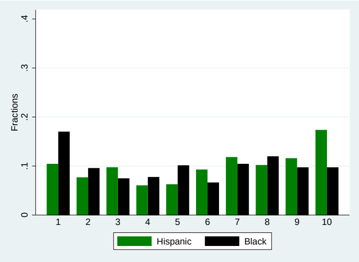
(a) Emotional Support (Females)



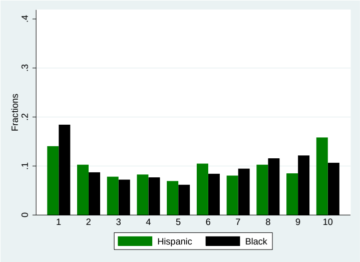
(b) Emotional Support (Males)

Source: Moon (2014).

Figure 185: Hispanic and Black Parental Investment in White Distribution: Adjusted for Mother's Education, Family Income, and Family Structure, age 4-7 Cont.



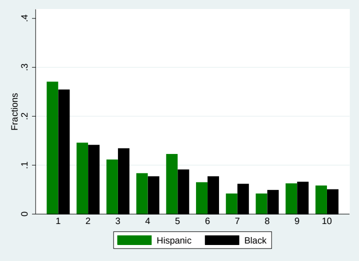
(a) Father Engagement (Females)



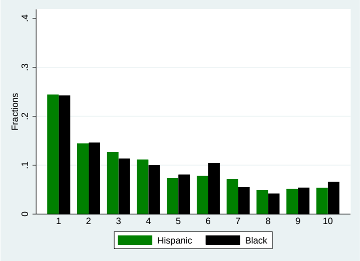
(b) Father Engagement (Males)

Source: Moon (2014).

Figure 187: Hispanic and Black Parental Investment in White Distribution: Adjusted for Mother's Education, Family Income, and Family Structure, age 8-11



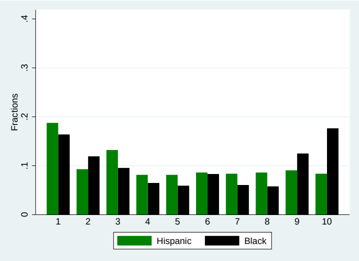
(a) Material Goods (Females)



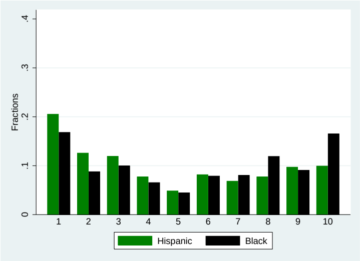
(b) Material Goods (Males)

Source: Moon (2014).

Figure 189: Hispanic and Black Parental Investment in White Distribution: Adjusted for Mother's Education, Family Income, and Family Structure, age 8-11 Cont.



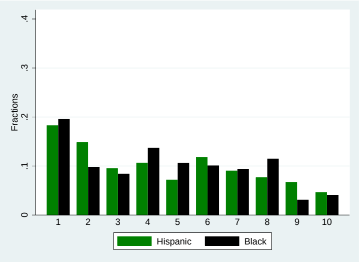
(a) Cognitive Stimulation (Females)



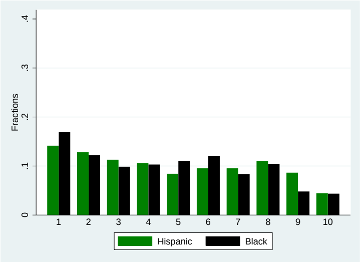
(b) Cognitive Stimulation (Males)

Source: Moon (2014).

Figure 191: Hispanic and Black Parental Investment in White Distribution: Adjusted for Mother's Education, Family Income, and Family Structure, age 8-11 Cont.



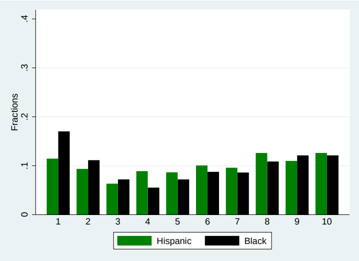
(a) Emotional Support (Females)



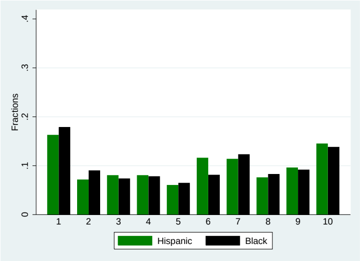
(b) Emotional Support (Males)

Source: Moon (2014).

Figure 193: Hispanic and Black Parental Investment in White Distribution: Adjusted for Mother's Education, Family Income, and Family Structure, age 8-11 Cont.



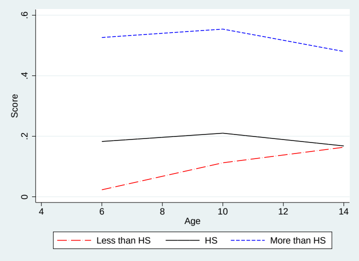
(a) Father Engagement (Females)



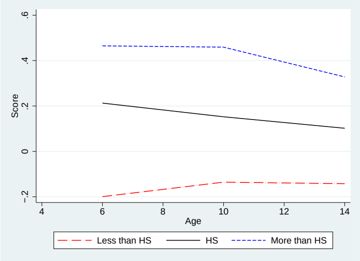
(b) Father Engagement (Males)

Source: Moon (2014).

Figure 195: Parental Investment over Childhood among Whites by Mother's Education



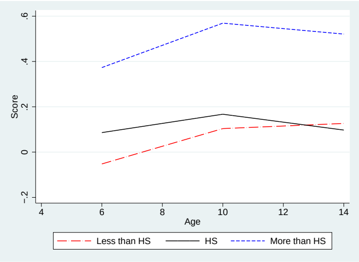
(a) Girls: Material Resource



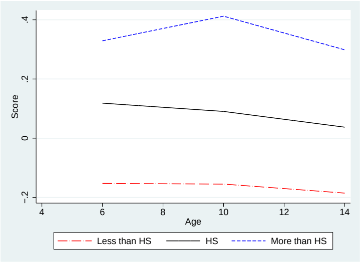
(b) Boys: Material Resource

Data: A balanced panel from Children of National Longitudinal Survey of Youth 1979.
Source: Moon (2014).

Figure 197: Parental Investment over Childhood among Whites by Mother's Education Cont.



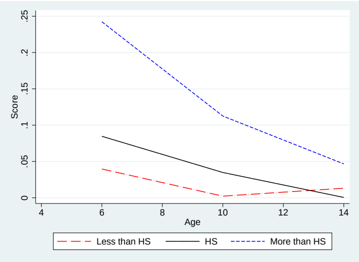
(a) Girls: Cognitive Stimulation



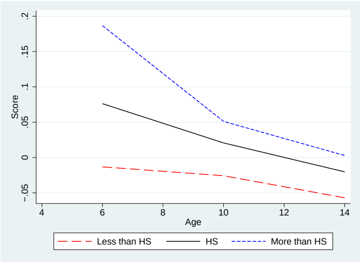
(b) Boys: Cognitive Stimulation

Data: A balanced panel from Children of National Longitudinal Survey of Youth 1979.
Source: Moon (2014).

Figure 199: Parental Investment over Childhood among Whites by Mother's Education Cont.



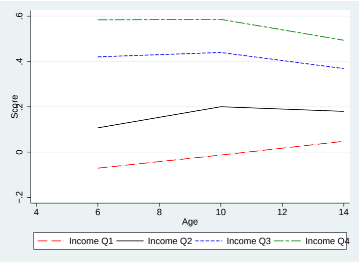
(a) Girls: Emotional Support



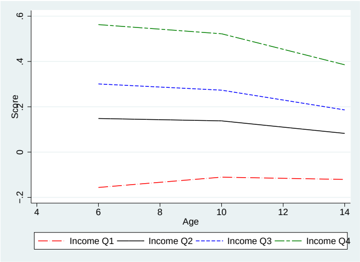
(b) Boys: Emotional Support

Data: A balanced panel from Children of National Longitudinal Survey of Youth 1979.
Source: Moon (2014).

Figure 201: Parental Investment over Childhood among Whites by Family Income Quartile



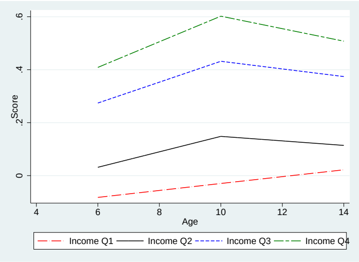
(a) Girls: Material Resource



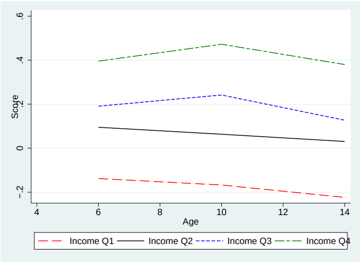
(b) Boys: Material Resource

Data: A balanced panel from Children of National Longitudinal Survey of Youth 1979.
Source: Moon (2014).

Figure 203: Parental Investment over Childhood among Whites by Family Income Quartile Cont.



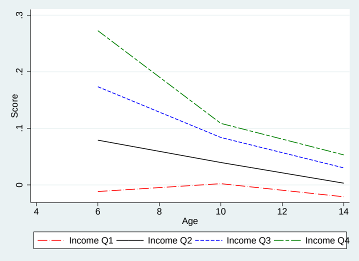
(a) Girls: Cognitive Stimulation



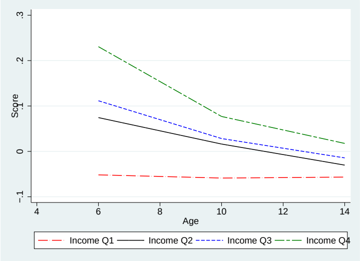
(b) Boys: Cognitive Stimulation

Data: A balanced panel from Children of National Longitudinal Survey of Youth 1979.
Source: Moon (2014).

Figure 205: Parental Investment over Childhood among Whites by Family Income Quartile Cont.



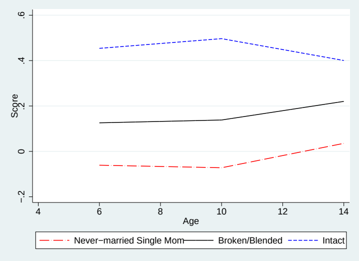
(a) Girls: Emotional Support



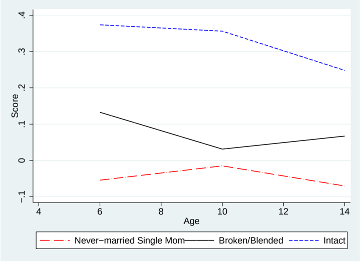
(b) Boys: Emotional Support

Data: A balanced panel from Children of National Longitudinal Survey of Youth 1979.
Source: Moon (2014).

Figure 207: Parental Investment over Childhood among Whites by Family Type



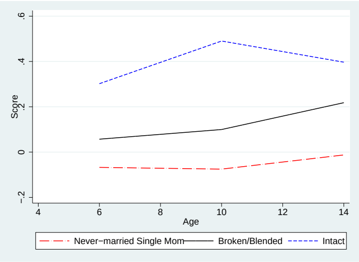
(a) Girls: Material Resource



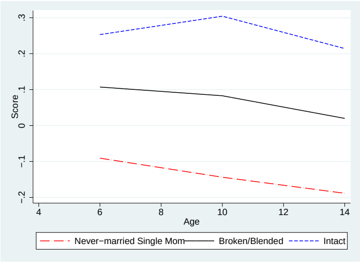
(b) Boys: Material Resource

Data: A balanced panel from Children of National Longitudinal Survey of Youth 1979.
Source: Moon (2014).

Figure 209: Parental Investment over Childhood among Whites by Family Type Cont.



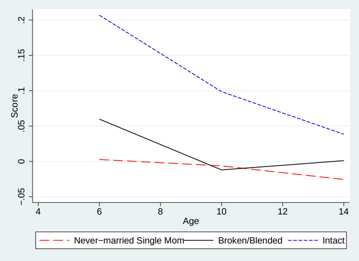
(a) Girls: Cognitive Stimulation



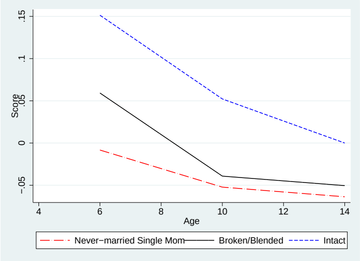
(b) Boys: Cognitive Stimulation

Data: A balanced panel from Children of National Longitudinal Survey of Youth 1979.
Source: Moon (2014).

Figure 211: Parental Investment over Childhood among Whites by Family Type Cont.



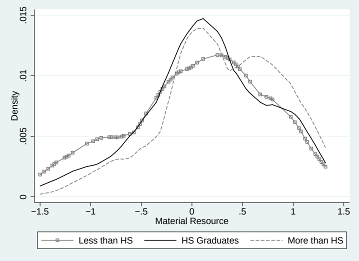
(a) Girls: Emotional Support



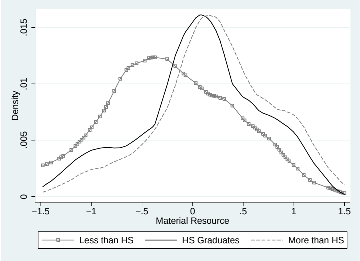
(b) Boys: Emotional Support

Data: A balanced panel from Children of National Longitudinal Survey of Youth 1979.
Source: Moon (2014).

Figure 213: Parental Investment among Whites by Mother's Education: Age 0-3



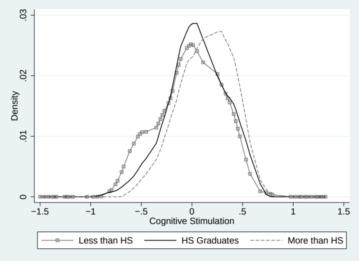
(a) Girls: Material Resource



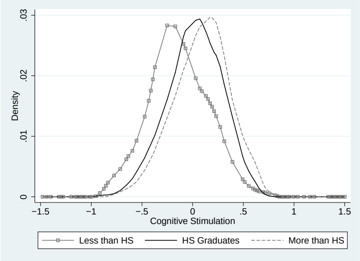
(b) Boys: Material Resource

Data: A balanced panel from Children of National Longitudinal Survey of Youth 1979.
Source: Moon (2014).

Figure 215: Parental Investment among Whites by Mother's Education: Age 0-3 Cont.



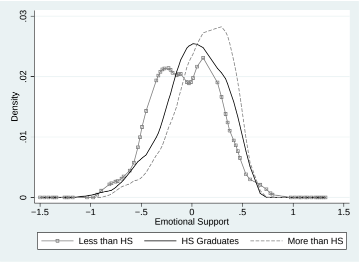
(a) Girls: Cognitive Stimulation



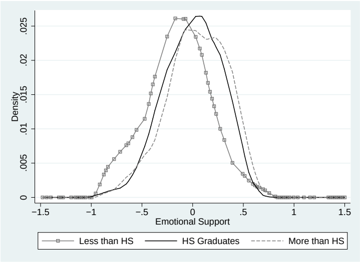
(b) Boys: Cognitive Stimulation

Data: A balanced panel from Children of National Longitudinal Survey of Youth 1979.
Source: Moon (2014).

Figure 217: Parental Investment among Whites by Mother's Education: Age 0-3 Cont.



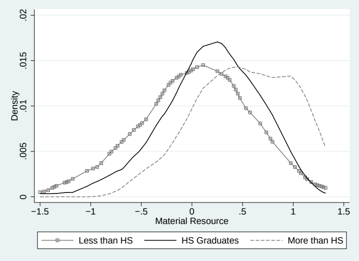
(a) Girls: Emotional Support



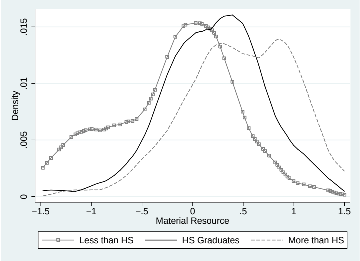
(b) Boys: Emotional Support

Data: A balanced panel from Children of National Longitudinal Survey of Youth 1979.
Source: Moon (2014).

Figure 219: Parental Investment among Whites by Mother's Education: Age 4-7



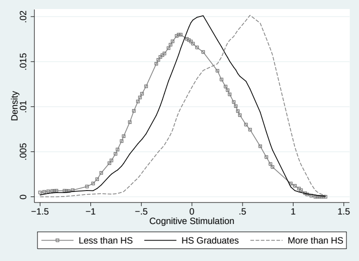
(a) Girls: Material Resource



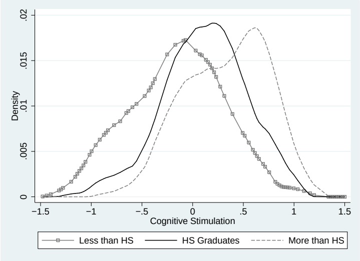
(b) Boys: Material Resource

Data: A balanced panel from Children of National Longitudinal Survey of Youth 1979.
Source: Moon (2014).

Figure 221: Parental Investment among Whites by Mother's Education: Age 4-7 Cont.



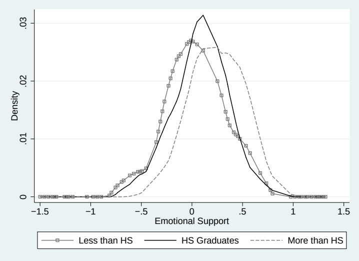
(a) Girls: Cognitive Stimulation



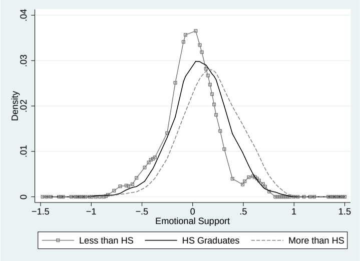
(b) Boys: Cognitive Stimulation

Data: A balanced panel from Children of National Longitudinal Survey of Youth 1979.
Source: Moon (2014).

Figure 223: Parental Investment among Whites by Mother's Education: Age 4-7 Cont.



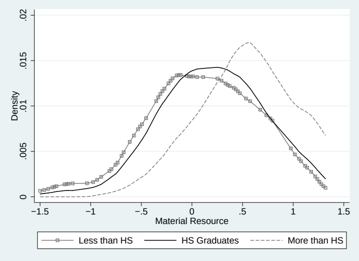
(a) Girls: Emotional Support



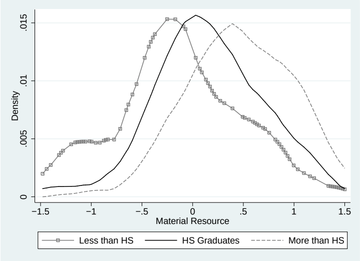
(b) Boys: Emotional Support

Data: A balanced panel from Children of National Longitudinal Survey of Youth 1979.
Source: Moon (2014).

Figure 225: Parental Investment among Whites by Mother's Education: Age 8-11



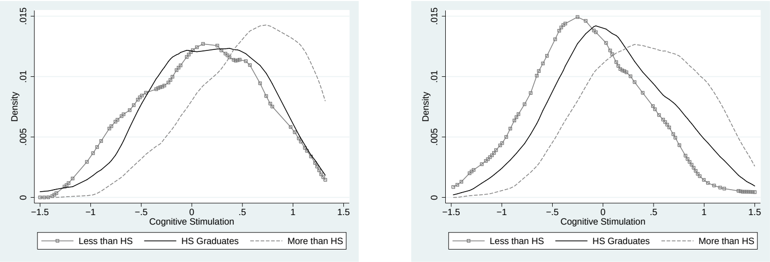
(a) Girls: Material Resource



(b) Boys: Material Resource

Data: A balanced panel from Children of National Longitudinal Survey of Youth 1979.
Source: Moon (2014).

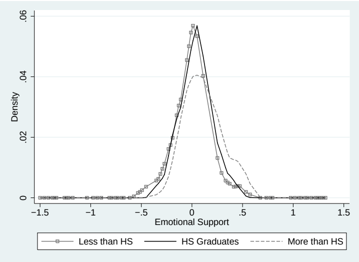
Figure 227: Parental Investment among Whites by Mother's Education: Age 8-11 Cont.



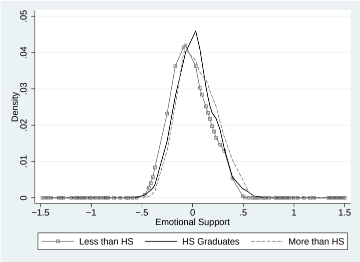
(a) Girls: Cognitive Stimulation (b) Boys: Cognitive Stimulation

Data: A balanced panel from Children of National Longitudinal Survey of Youth 1979.
Source: Moon (2014).

Figure 229: Parental Investment among Whites by Mother's Education: Age 8-11 Cont.



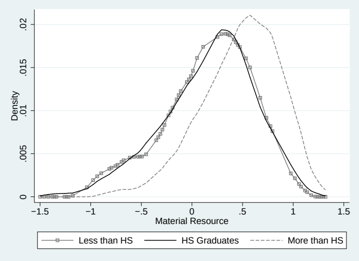
(a) Girls: Emotional Support



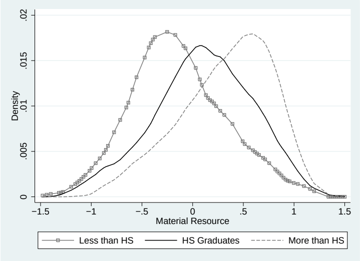
(b) Boys: Emotional Support

Data: A balanced panel from Children of National Longitudinal Survey of Youth 1979.
Source: Moon (2014).

Figure 231: Parental Investment among Whites by Mother's Education: Age 12-15



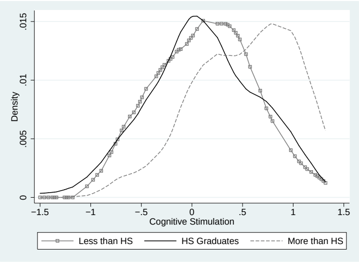
(a) Girls: Material Resource



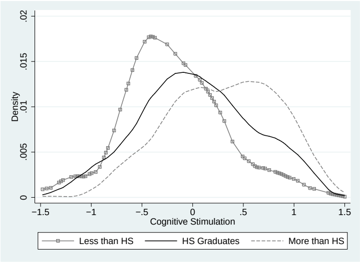
(b) Boys: Material Resource

Data: A balanced panel from Children of National Longitudinal Survey of Youth 1979.
Source: Moon (2014).

Figure 233: Parental Investment among Whites by Mother's Education: Age 12-15 Cont.



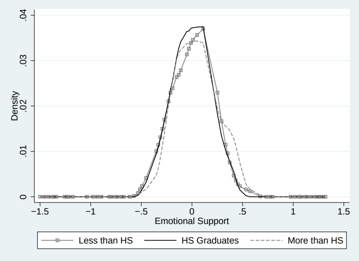
(a) Girls: Cognitive Stimulation



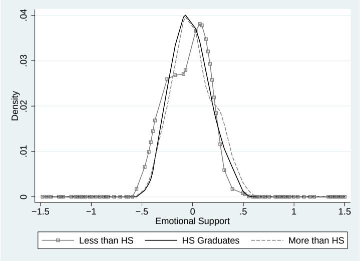
(b) Boys: Cognitive Stimulation

Data: A balanced panel from Children of National Longitudinal Survey of Youth 1979.
Source: Moon (2014).

Figure 235: Parental Investment among Whites by Mother's Education: Age 12-15 Cont.



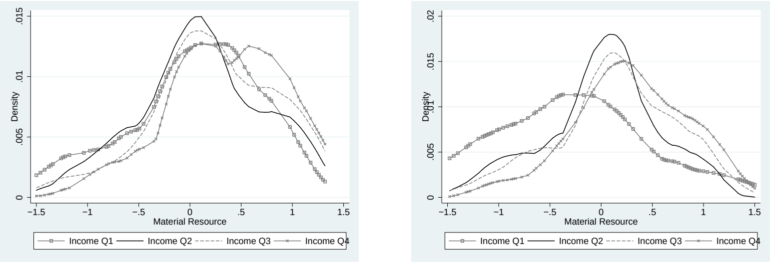
(a) Girls: Emotional Support



(b) Boys: Emotional Support

Data: A balanced panel from Children of National Longitudinal Survey of Youth 1979.
Source: Moon (2014).

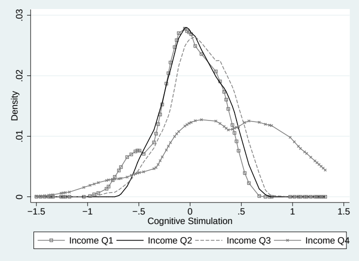
Figure 237: Parental Investment among Whites by Family Income Quartile: Age 0-3



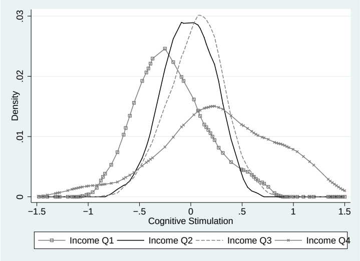
(a) Girls: Material Resource (b) Boys: Material Resource

Data: A balanced panel from Children of National Longitudinal Survey of Youth 1979.
Source: Moon (2014).

Figure 239: Parental Investment among Whites by Family Income Quartile: Age 0-3 Cont.



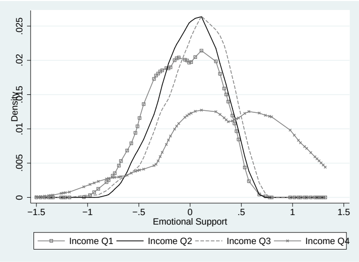
(a) Girls: Cognitive Stimulation



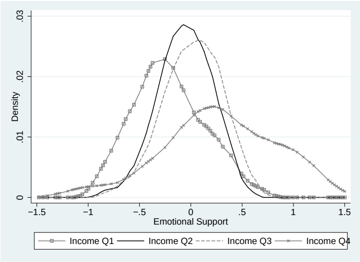
(b) Boys: Cognitive Stimulation

Data: A balanced panel from Children of National Longitudinal Survey of Youth 1979.
Source: Moon (2014).

Figure 241: Parental Investment among Whites by Family Income Quartile: Age 0-3 Cont.



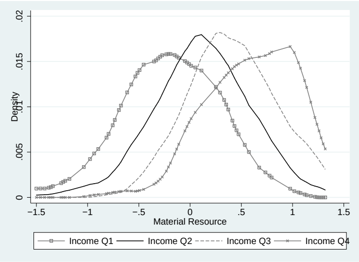
(a) Girls: Emotional Support



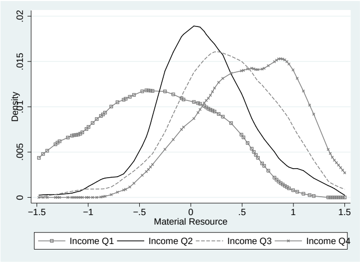
(b) Boys: Emotional Support

Data: A balanced panel from Children of National Longitudinal Survey of Youth 1979.
Source: Moon (2014).

Figure 243: Parental Investment among Whites by Family Income Quartile: Age 4-7



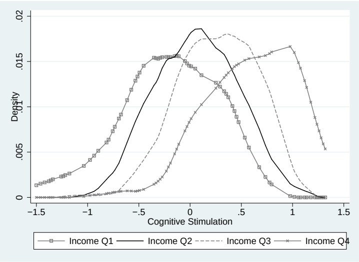
(a) Girls: Material Resource



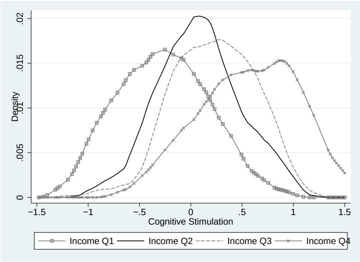
(b) Boys: Material Resource

Data: A balanced panel from Children of National Longitudinal Survey of Youth 1979.
Source: Moon (2014).

Figure 245: Parental Investment among Whites by Family Income Quartile: Age 4-7 Cont.



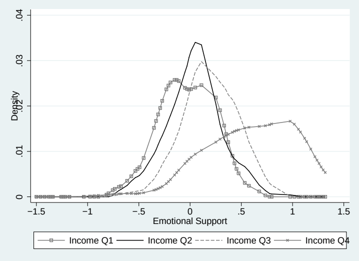
(a) Girls: Cognitive Stimulation



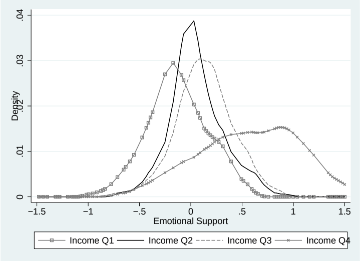
(b) Boys: Cognitive Stimulation

Data: A balanced panel from Children of National Longitudinal Survey of Youth 1979.
Source: Moon (2014).

Figure 247: Parental Investment among Whites by Family Income Quartile: Age 4-7 Cont.



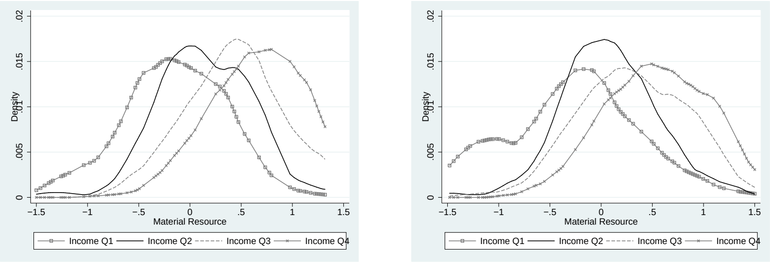
(a) Girls: Emotional Support



(b) Boys: Emotional Support

Data: A balanced panel from Children of National Longitudinal Survey of Youth 1979.
Source: Moon (2014).

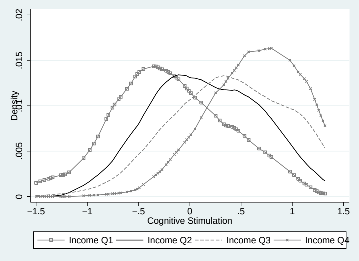
Figure 249: Parental Investment among Whites by Family Income Quartile: Age 8-11



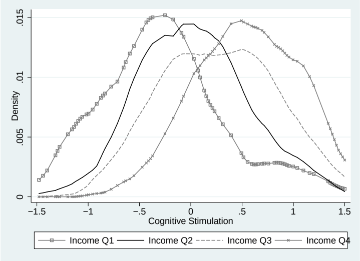
(a) Girls: Material Resource (b) Boys: Material Resource

Data: A balanced panel from Children of National Longitudinal Survey of Youth 1979.
Source: Moon (2014).

Figure 251: Parental Investment among Whites by Family Income Quartile: Age 8-11 Cont.



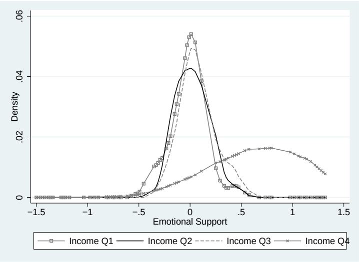
(a) Girls: Cognitive Stimulation



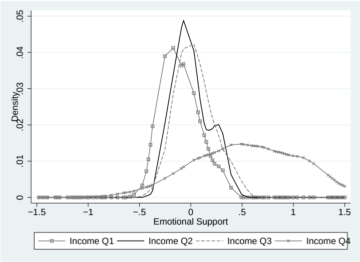
(b) Boys: Cognitive Stimulation

Data: A balanced panel from Children of National Longitudinal Survey of Youth 1979.
Source: Moon (2014).

Figure 253: Parental Investment among Whites by Family Income Quartile: Age 8-11 Cont.



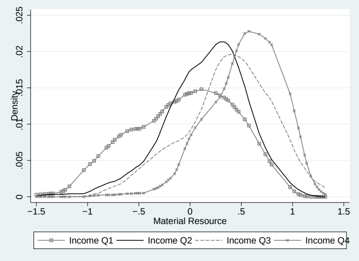
(a) Girls: Emotional Support



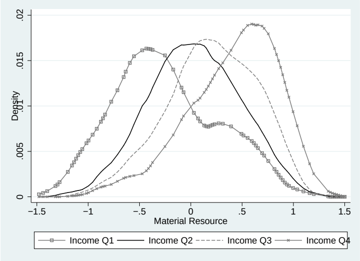
(b) Boys: Emotional Support

Data: A balanced panel from Children of National Longitudinal Survey of Youth 1979.
Source: Moon (2014).

Figure 255: Parental Investment among Whites by Family Income Quartile: Age 12-15



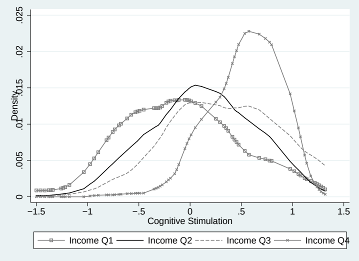
(a) Girls: Material Resource



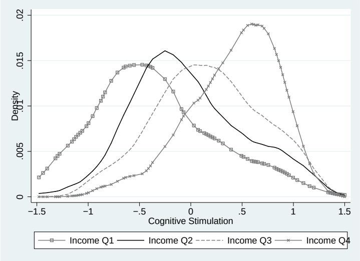
(b) Boys: Material Resource

Data: A balanced panel from Children of National Longitudinal Survey of Youth 1979.
Source: Moon (2014).

Figure 257: Parental Investment among Whites by Family Income Quartile: Age 12-15 Cont.



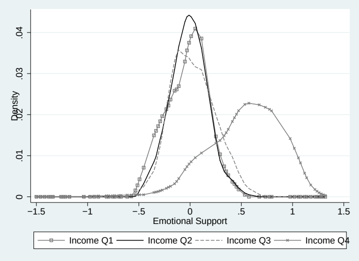
(a) Girls: Cognitive Stimulation



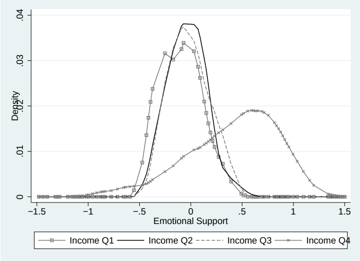
(b) Boys: Cognitive Stimulation

Data: A balanced panel from Children of National Longitudinal Survey of Youth 1979.
Source: Moon (2014).

Figure 259: Parental Investment among Whites by Family Income Quartile: Age 12-15 Cont.



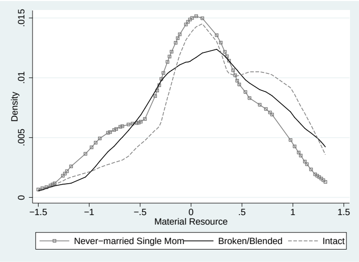
(a) Girls: Emotional Support



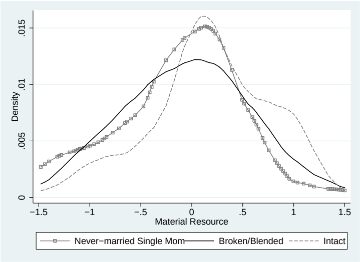
(b) Boys: Emotional Support

Data: A balanced panel from Children of National Longitudinal Survey of Youth 1979.
Source: Moon (2014).

Figure 261: Parental Investment among Whites by Family Structure: Age 0-3



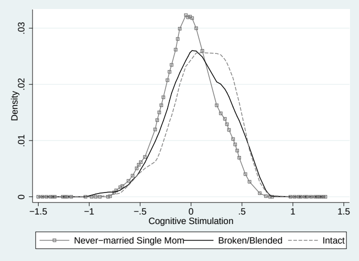
(a) Girls: Material Resource



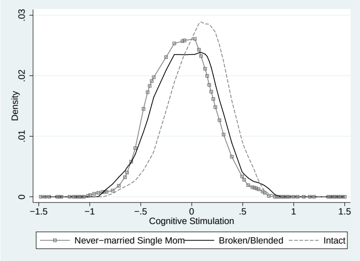
(b) Boys: Material Resource

Data: A balanced panel from Children of National Longitudinal Survey of Youth 1979.
Source: Moon (2014).

Figure 263: Parental Investment among Whites by Family Structure: Age 0-3 Cont.



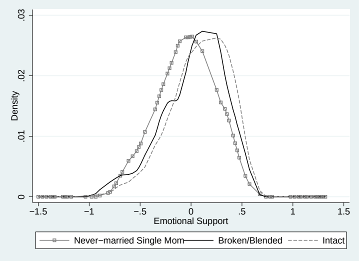
(a) Girls: Cognitive Stimulation



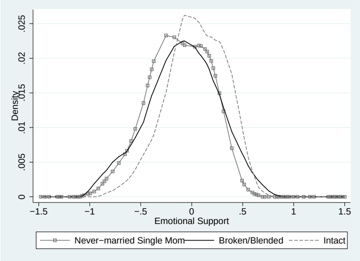
(b) Boys: Cognitive Stimulation

Data: A balanced panel from Children of National Longitudinal Survey of Youth 1979.
Source: Moon (2014).

Figure 265: Parental Investment among Whites by Family Structure: Age 0-3 Cont.



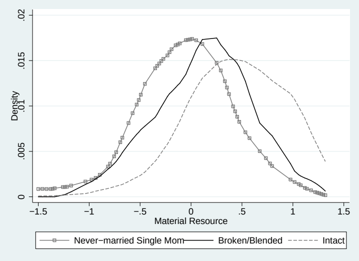
(a) Girls: Emotional Support



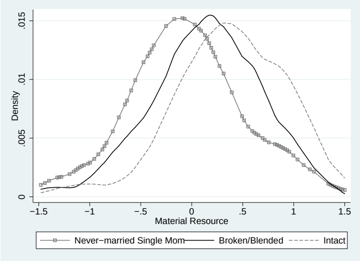
(b) Boys: Emotional Support

Data: A balanced panel from Children of National Longitudinal Survey of Youth 1979.
Source: Moon (2014).

Figure 267: Parental Investment among Whites by Family Structure: Age 4-7



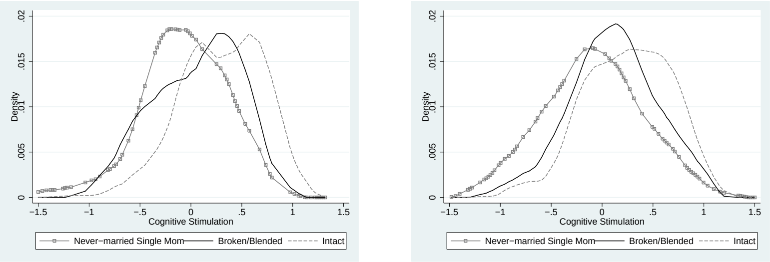
(a) Girls: Material Resource



(b) Boys: Material Resource

Data: A balanced panel from Children of National Longitudinal Survey of Youth 1979.
Source: Moon (2014).

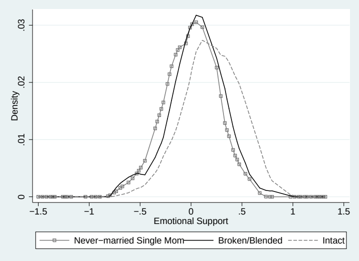
Figure 269: Parental Investment among Whites by Family Structure: Age 4-7 Cont.



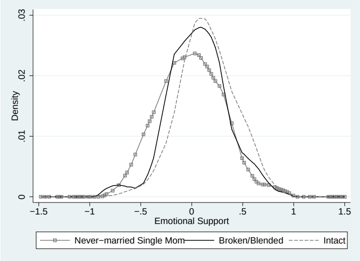
(a) Girls: Cognitive Stimulation (b) Boys: Cognitive Stimulation

Data: A balanced panel from Children of National Longitudinal Survey of Youth 1979.
Source: Moon (2014).

Figure 271: Parental Investment among Whites by Family Structure: Age 4-7 Cont.



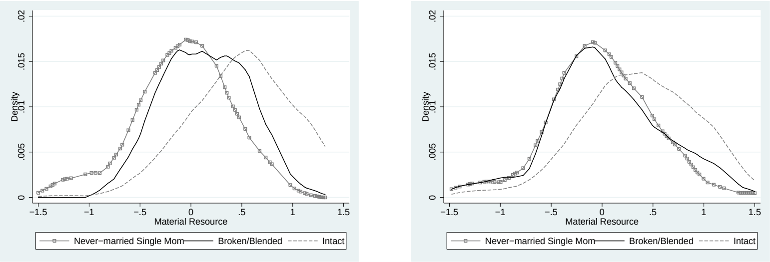
(a) Girls: Emotional Support



(b) Boys: Emotional Support

Data: A balanced panel from Children of National Longitudinal Survey of Youth 1979.
Source: Moon (2014).

Figure 273: Parental Investment among Whites by Family Structure: Age 8-11

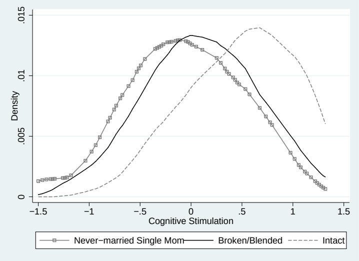


(a) Girls: Material Resource

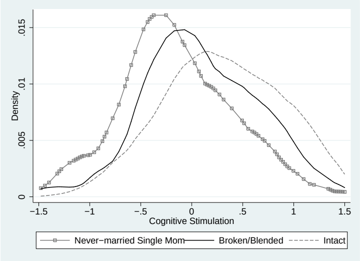
(b) Boys: Material Resource

Data: A balanced panel from Children of National Longitudinal Survey of Youth 1979.
Source: Moon (2014).

Figure 275: Parental Investment among Whites by Family Structure: Age 8-11 Cont.



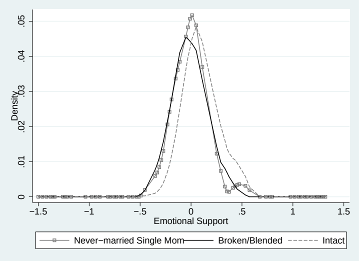
(a) Girls: Cognitive Stimulation



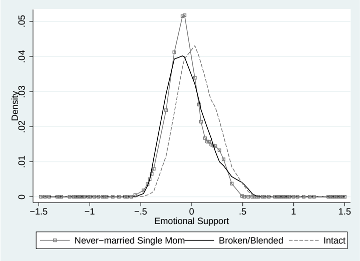
(b) Boys: Cognitive Stimulation

Data: A balanced panel from Children of National Longitudinal Survey of Youth 1979. Source: Moon (2014).

Figure 277: Parental Investment among Whites by Family Structure: Age 8-11 Cont.



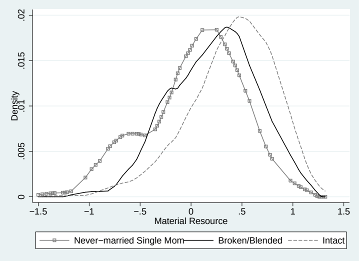
(a) Girls: Emotional Support



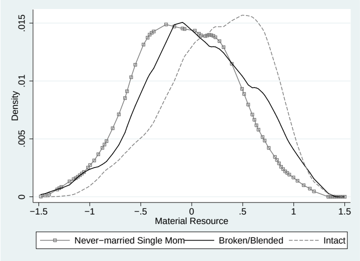
(b) Boys: Emotional Support

Data: A balanced panel from Children of National Longitudinal Survey of Youth 1979.
Source: Moon (2014).

Figure 279: Parental Investment among Whites by Family Structure: Age 12-15



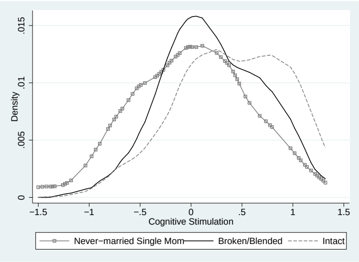
(a) Girls: Material Resource



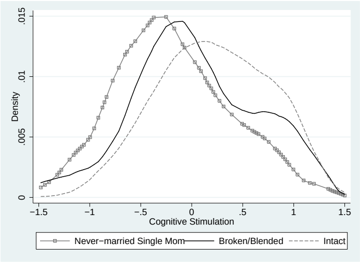
(b) Boys: Material Resource

Data: A balanced panel from Children of National Longitudinal Survey of Youth 1979.
Source: Moon (2014).

Figure 281: Parental Investment among Whites by Family Structure: Age 12-15 Cont.



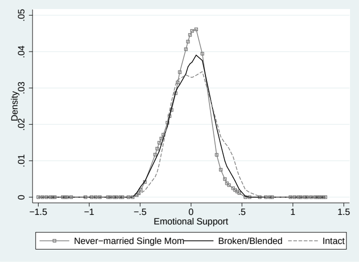
(a) Girls: Cognitive Stimulation



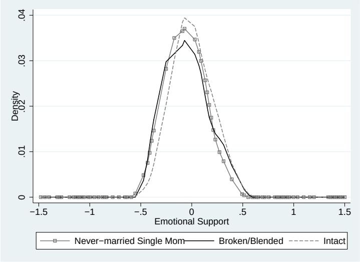
(b) Boys: Cognitive Stimulation

Data: A balanced panel from Children of National Longitudinal Survey of Youth 1979.
Source: Moon (2014).

Figure 283: Parental Investment among Whites by Family Structure: Age 12-15 Cont.



(a) Girls: Emotional Support



(b) Boys: Emotional Support

Data: A balanced panel from Children of National Longitudinal Survey of Youth 1979.
Source: Moon (2014).

Analyses of Lareau

- Table 48–51 (Lareau and Weininger (2008)) present evidence on the heterogeneity in parental behavior with their children according to family characteristics and maternal education.

Table 48: Average Number of Organized Leisure Activities Child Participates in by Social Class: Lareau Data on 88 Children*

	Poor	Working Class	Middle Class
All Children			
Organized Activities	1.5	2.5	4.9
Items with Missing Data**	2.0	3.0	2.5
Count	26	26	36
Gender			
Organized Activities: Boys	1.5	2.6	5.1
Items with Missing Data: Boys**	2.1	3.8	3.4
Count	11	14	18
Organized Activities: Girls	1.5	2.5	4.7
Items with Missing Data: Girls**	1.9	2.1	1.5
Count	15	12	18
Race			
Organized Activities: Whites	1.4	2.3	4.6
Items with Missing Data: Whites**	0.9	2.3	2.9
Count	12	14	18
Organized Activities: Blacks	1.6	2.8	5.2
Items with Missing Data: Whites**	2.9	3.8	2.0
Count	14	12	18

Source: Lareau and Weininger (2008, Table 10.2).

Table 49: Children's Participation in Organized Leisure (yes/no) by Mother's Education, Gender, and Race: National Data

	Mother's Education				
	LT HS	HS Degree	Some College	Bachelor's or Higher	Total
All Children					
% who Participate	57.1	69.1	82.1	93.6	77.6
Count	253	630	460	290	1,633
Gender					
% Boys who Participate	62.5	69.1	75.8	93.6	75.8
Count	132	313	224	139	808
% Girls who Participate	50.4	69.0	88.3	93.6	79.4
Count	121	317	236	151	825
Race*					
% Whites who Participate	59.9	75.1	87.9	94.0	83.4
Count	66	294	240	243	843
% Blacks who Participate	54.2	51.8	59.0	88.3	57.0
Count	187	336	220	47	790

Taken from Lareau and Weininger (2008).

Table 50: Children's Average Weekly Hours in Organized Leisure by Mother's Education, Gender, and Race: National Data

	Mother's Education				
	LT HS	HS Degree	Some College	Bachelor's or Higher	Total
All Children					
Mean Weekly Hours	2.02	2.91	3.38	4.82	3.45
Count	179	509	387	250	1,325
Gender					
Mean Weekly Hours: Boys	1.59	2.84	3.72	5.53	3.59
Count	91	258	187	121	657
Mean Weekly Hours: Girls	2.56	2.99	3.04	4.21	3.31
Count	88	251	200	129	668
Race*					
Mean Weekly Hours: Whites	0.90	3.25	3.52	5.03	3.73
Count	44	249	212	212	717
Mean Weekly Hours: Blacks	3.02	1.84	2.81	2.02	2.40
Count	135	260	175	38	608

Taken from Lareau and Weininger (2008).

Table 51: Children's Average Weekly Hours in Organized Leisure by Mother's Education and Employment Status: National Data

	Mother's Education				
	LT HS	HS Degree	Some College	Bachelor's or Higher	Total
Mother's Employment Status					
Not Employed	2.80	4.35	3.79	5.96	4.28
Count	79	104	55	42	280
Employed less than 35 hrs/wk	2.58	3.74	3.30	5.31	4.03
Count	35	120	108	89	352
Employed 35 hrs/wk or more	0.95	2.01	3.29	3.92	2.76
Count	65	285	224	119	693

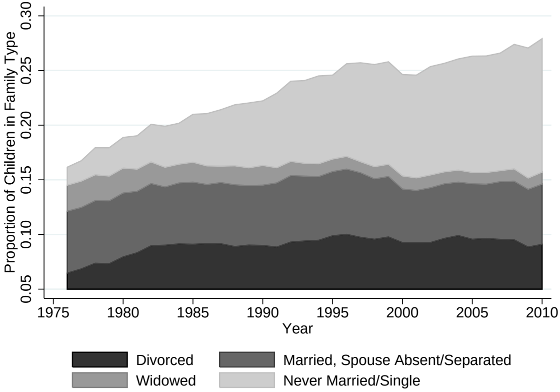
Taken from Lareau and Weininger (2008).

Return to Slide 20

Appendix C: Time Trends on Children in Single Parent Households

Time Trends on Children in Single Parent Households

Figure 285: Children in Single Parent Households by Marital Status—All Education Levels, All Races

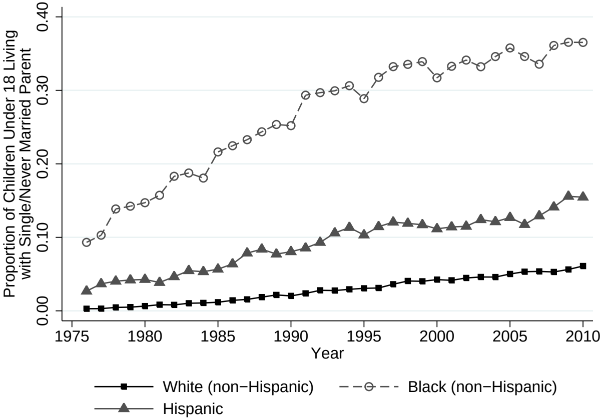


Source: Heckman (2011, Web Appendix).

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.

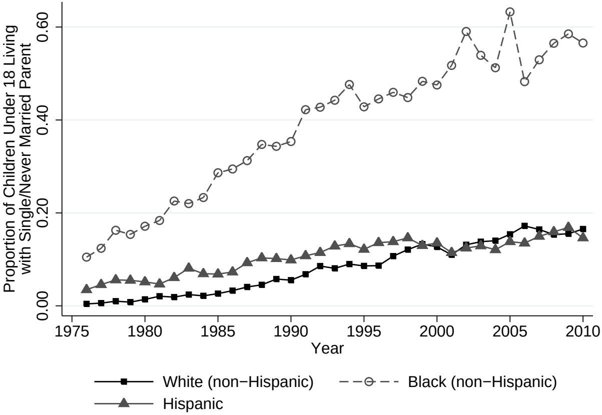
Trends for Children in Single/Never Married Households by Race

Figure 286: Children in Households with Single, Never Married Parents by Race



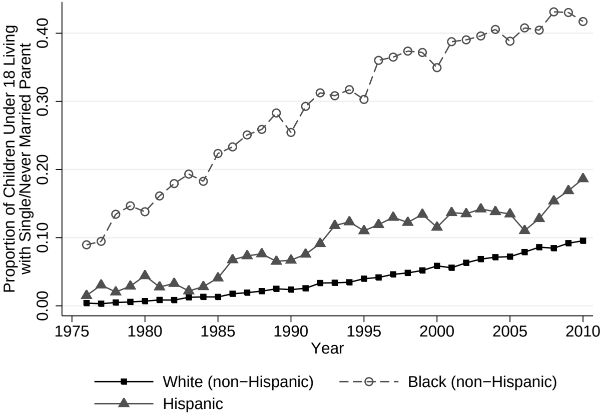
Source: Heckman (2011, Web Appendix).
Note: Parents are defined as the head of the household. Children are defined as individuals under 18, living in the household, and the child of the head of the household. Children who have been married or are not living with their parents are excluded from the calculation.

Figure 287: Children in Households with Single, Never Married Parents by Race - Dropouts



Source: Heckman (2011, Web Appendix).
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 the household. Children who have been married or are not living with their parents are excluded from the calculation. The "Dropout" category includes individuals who have finished 11 years of school or less.

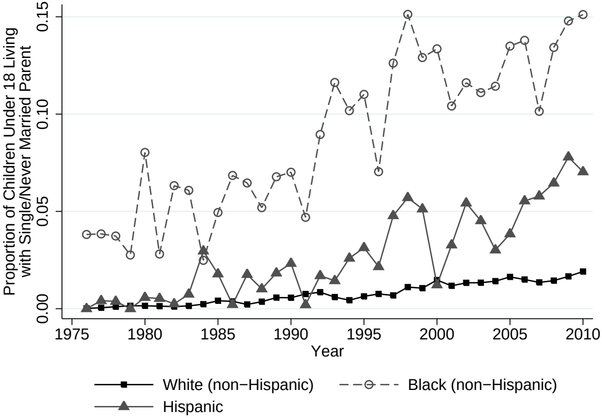
Figure 288: Children in Households with Single, Never Married Parents by Race - High School Graduates



Source: Heckman (2011, Web Appendix).

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 the household. Children who have been married or are not living with their parents are excluded from the calculation. For consistency across CPS waves, the "HS graduate" category is defined as any individual who completes 12 years of schooling, as specific degree status, whether having a high school diploma or an equivalency, is

Figure 289: Children in Households with Single, Never Married Parents by Race - College Graduates or More



Source: Heckman (2011, Web Appendix).
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 the household. Children who have been married or are not living with their parents are excluded from the calculation. The "College degree or more" category is defined as individuals who have completed a Bachelor's or higher degree.

Trends in Children in Single/Never Married Households by Education

Figure 290: Children in Households with Single, Never Married Parents by Education - All Races

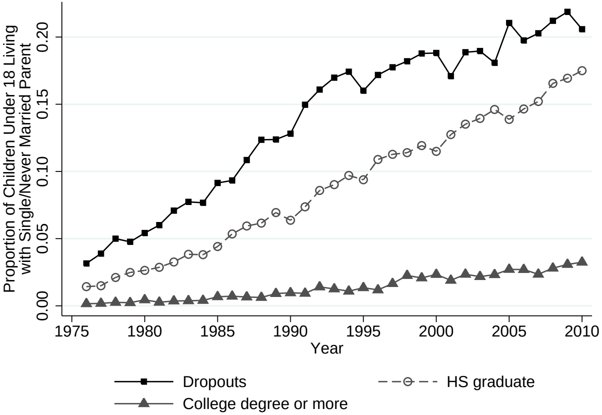


Figure 291: Children in Households with Single, Never Married Parents by Education - Non-Hispanic Whites

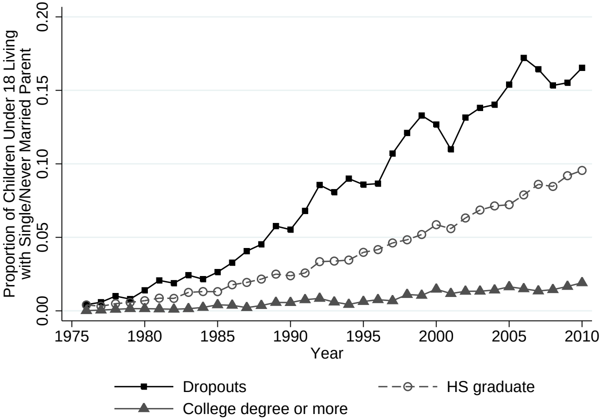


Figure 292: Children in Households with Single, Never Married Parents by Education - Non-Hispanic Blacks

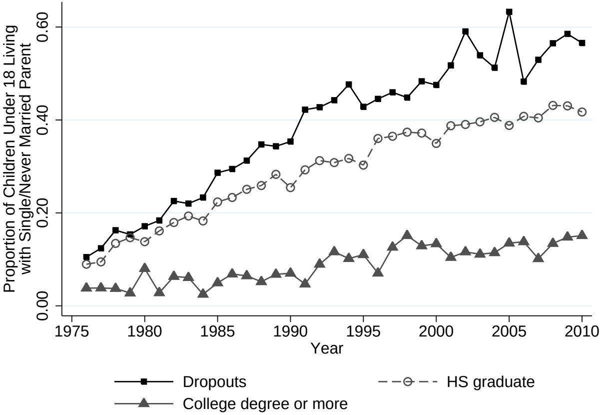
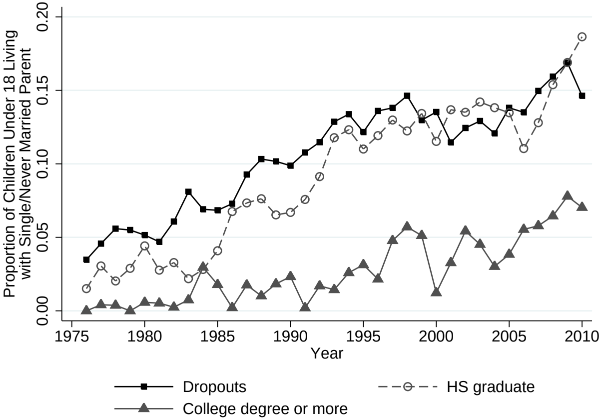


Figure 293: Children in Households with Single, Never Married Parents by Education - Hispanics



Return to Slide 21

Appendix I: Summary of Empirical Evidence on the Efficacy of Interventions

- This section summarizes the empirical evidence from a variety of interventions ranging from targeting prenatal infants to targeting young adults.
- In Heckman and Kautz (2014), we discuss these programs in great detail.
- They focus on programs that have been well studied, have long-term follow-ups, have been widely adopted, or offer unique insights.

- For three reasons, evaluating and comparing the evidence from intervention programs is challenging.
- First, many interventions are only evaluated with short-term follow-ups, which could lead to upward-biased estimates of returns if the benefits eventually dissipate or to downward-biased estimates of the returns if the effects of the programs appear later in life.
- Second, not all studies measure the same outcomes.

- Ideally, all studies would report outcomes in terms of the rate of return of the program.
- Reported outcomes often differ across studies. Many studies only consider the effect of an intervention on a few outcomes.
- Without knowing the range of outcomes affected, it is difficult to calculate a rate of return.
- Third, many programs target specific demographic groups.
- Applying the findings from one group to another might be problematic if groups differentially benefit from programs.

- Table 52f (taken from Heckman and Kautz, 2014)) summarizes the effects of each intervention discussed in this section.
- The table displays information about the nature of the intervention, the quality of the evaluation, the effects on later life outcomes, and estimates of the rate of return and cost-benefit ratio when available.

- The squares in the "Components" columns indicate the extent to which the program and the evaluation of it have the features defined in the table.
- The dots in the "Effects on Outcomes" columns indicate the extent to which the program influenced skills and outcomes.
- (The notes at the bottom of the table define the symbols and abbreviations used.)

- Three striking patterns emerge about the nature of the programs and the quality of the available evaluations of them. First, as a group, early childhood and elementary school programs have longer follow-ups.
- All of the early childhood or elementary school programs in Table 52f have evaluations that follow participants for at least 10 years and many follow them more than 20 years, whereas only two evaluations of adolescent programs follow participants for at least 10 years (the longest is 12).

- Second, early childhood programs tend to measure cognitive and character skills in addition to a variety of later-life outcomes, whereas many of the adolescent evaluations focus solely on labor market outcomes.
- Because of these features of data availability, we can better understand the sources of the effects on adult outcomes of early childhood programs by considering how these interventions produce skills.

- Due to the absence of measures of skills for many adolescent interventions, understanding these programs requires examining the curricula of the programs themselves, for example, whether the program seeks to foster cognitive or character skills.

- Third, selection into programs differs by the age of intervention.
- In most early childhood evaluations, the programs first contact parents to participate and then parents opt into the program.
- In contrast, in most adolescent evaluations, participants themselves chose to enter the program.

- Table 52f also suggests certain features of effective programs.
- Only very early interventions (before age 3) improve IQ in a lasting way, consistent with the evidence that early childhood is a critical period for cognitive development (see Knudsen et al., 2006).
- The most successful interventions target preschoolers and primary school children.
- They improve later-life outcomes by developing character skills.

- Programs that target adolescents have not been established to be as effective as programs that target earlier ages, in part because there have been fewer long-term evaluations of them.
- Several of the successful adolescent mentoring or residential programs improve labor market and social outcomes, but have relatively short follow-ups.
- The two programs with the longest follow-ups improve outcomes in the short run, but the benefits fade after a few years.
- These programs alter participants' environments and incentives during the intervention, which could influence their behavior in the short term without having a lasting effect.

- The most promising adolescent programs integrate aspects of work into traditional education.
- Such programs break down the rigid separation between school and work that characterizes the American high school.

- High schools create an adolescent society with values distinct from those of the larger society and removed from the workplace.
- See Coleman (1961).
- Even in affluent communities, the adolescent society has an anti-academic, anti-achievement bias.
- It was not until 1940 that more than half of each birth cohort graduated from high school.
- See Goldin and Katz (2008).

- In earlier times, adolescents took apprenticeships and jobs where they were supervised and mentored by adults.
- Mentoring involved teaching valuable character skills—showing up for work, cooperating with others, and persevering on tasks.
- These skills could be fostered in high schools, but with the relaxation of discipline in the schools, it is more difficult to do so.
- See Arum (2005).

- The apparent success of apprenticeship programs might arise in part from their cultivation of character skills.
- The attachment of a supervisor to an apprentice helps create character in a version of the attachment bond between parent and child.
- See Bowlby (1951); Sroufe (1997); Sroufe et al. (2005).

Table 52a: Summary of Effects for Main Interventions

	Participant/Evaluation Characteristics						
Program	Age	Duration	Target	Selection	Follow-Up	Sample	RCT Eval
Elementary							
LA's Best	5–6	6Y	SES	Schl	12Y	19,320	No
CSP	5–13	5Y	Behav	Refer	35Y	510	Yes
SSDP	6–7	6Y	Crime	Prgrm	21Y	610	Yes
Adolescence							
BBBS	10-16	1Y	SES	Self	1Y	960	Yes
IHAD	11–12	7Y	SES	Prgrm	8Y	180	Yes
EPIS	13–15	3Y	Schl	Schl	2Y	45,070	No
xl club	14	2Y	Schl	Schl	2Y	261,420	No
SAS	14–15	5Y	Schl, SES	Schl	6Y	430	No
STEP	14–15	2Y	Schl, SES	Self	4Y	4,800	Yes
QOP	14–15	5Y	Schl	Prgrm	10Y	1,070	Yes
Academies	13–16	4Y	Schl, SES	Self	12Y	1,460	Yes
ChalleNGe	16–18	1Y	Dropout	Self	3Y	1,200	Yes
Job Corps	16–24	1Y	SES	Self	9Y	15,300	Yes
Year-Up	18–24	1Y	SES	Self	2Y	200	Yes

Table 52b: Summary of Effects for Main Interventions

Program	Home	Health	Parental	On Site	Group
Elementary					
LA's Best	☐	☒	☒	☒	☒
CSP	☒	☒	☒	☒	☒
SSDP	☐	☒	☒	☒	☒
Adolescence					
BBBS	☐	☐	☐	☐	☐
IHAD	☐	☒	☒	☒	☒
EPIS	☐	☐	☐	☒	☒
xl club	☐	☐	☐	☒	☒
SAS	☐	☐	☐	☐	☐
STEP	☐	☒	☐	☒	☒
QOP	☐	☒	☐	☒	☒
Academies	☐	☐	☐	☒	☒
ChalleNGe	☐	☒	☐	☒	☒
Job Corps	☐	☒	☐	☒	☒
Year-Up	☐	☐	☐	☒	☒

(Column group header: **Components**)

Table 52c: Summary of Effects for Main Interventions

Program	IQ	School	Character	Education	Health	Crime	Earnings	Return	Benefit/Cost
	Effects on Outcomes							**Return/Benefits**	
Elementary									
LA's Best	.	◍	.	●	.	○	.		0.9
CSP	.	.	○	.	⊗	○	.		
SSDP	.	●	●	●	●	◍	○		3.1
Adolescence									
BBBS	.	◐	○	.	◐	○	.		1.0
IHAD	.	.	.	●	.	.	.		
EPIS	.	●	.	.	.	.	.		0.9–3.0
xl club	.	○	.	.	.	.	.		
SAS	.	◍	○	●	.	.	.		
STEP	.	○	.	○	.	.	○		
QOP	.	○	.	◍	○	⊗	○		0.42
Academies	.	◍	○	○	○	◍	◐		
ChalleNGe	.	.	◍	●	◐	◍	●	6.4	2.66
Job Corps	.	.	.	○	◍	◍	◍		0.22
Year-Up	.	.	.	.	.	.	●		

Table 52d: Summary of Effects for Main Interventions

Program	Participant/Evaluation Characteristics						
	Age	Duration	Target	Selection	Follow-Up	Sample	RCT Eval
Early							
NFP	< 0	2Y	SES	Prgrm	19Y	640	Yes
ABC	0	5Y	SES	Refer	30Y	90	Yes
IHDP	0	3Y	Health	Prgrm	18Y	640	Yes
FDRP	0	5Y	SES	Prgrm	15Y	110	No
PCDC	1	2Y	SES	Prgrm	15Y	170	Yes
JSS	1–2	2Y	Health	Prgrm	22Y	160	Yes
Perry	3	2Y	SES, IQ	Prgrm	37Y	120	Yes
Head Start	3	2Y	SES	Prnt	23Y	4,170	Yes
CPC	3–4	2Y	SES	Prnt	25Y	1,290	No
TEEP	3,5	2Y	SES	Prgrm	22Y	260	Yes
STAR	5–6	4Y	SES	Prgrm	22Y	11,000	Yes

Table 52e: Summary of Effects for Main Interventions

Program	Home	Health	Parental	On Site	Group
	Components				
Early					
NFP	☒	☒	☒	☐	☐
ABC	☐	☒	☒	☒	☒
IHDP	☒	☐	☒	☒	☒
FDRP	☒	☒	☒	☒	☒
PCDC	☒	☐	☒	☒	☒
JSS	☒	☒	☒	☐	☐
Perry	☒	☐	☒	☒	☒
Head Start	☒	☒	☒	☒	☒
CPC	☐	☒	☒	☒	☒
TEEP	☒	☒	☒	☒	☐
STAR	☐	☐	☐	☒	☒

Table 52f: Summary of Effects for Main Interventions

Program	Effects on Outcomes							Return/Benefits	
	IQ	School	Character	Education	Health	Crime	Earnings	Return	Benefit/Cost
Early									
NFP	●	◐	●	○	◍	◐	.		2.9
ABC	●	●	◐	◐	◍	◐	◐		3.8
IHDP	◐	◐	◐	○	○	○	.		
FDRP	○	◐	◍	.	.	●	.		
PCDC	◍	◍	●	.	.	.	.		
JSS	●	●	●	◍	●	.	●		
Perry	◍	●	●	◐	○	●	◐	7–10	7.1–12.2
Head Start	◍	◍	○	●	●	◐	●		
CPC	.	●	●	●	●	●	●	18	10.8
TEEP	◍	●	●	●	.	.	.		
STAR	.	◍	●	●	.	.	●	6.2	

Notes: ☐ – Does not include intervention component. ☒ – Includes intervention component. ○ – No effects. ● – Positive effects. ◯ – Weakly positive effects. ◐ – Mixed effects (either different studies find different results or only particular sub-populations benefited). ⊗ – Negative effects. "." – Not measured. "Age" – The age at which participants entered the program. For programs that targeted grades, rather than ages, it was assumed that children entered kindergarten at ages 5–6 and the age range advanced one year for each subsequent grade. "Duration" – Length of the treatment. In cases where the treatment length varied for participants, the longest duration was presented. "Target" – Population that was targeted by the program. SES – socioeconomic status or disadvantage. Behav – Behavior. Schl – School Performance. Crime – local crime rates. IQ – low IQ. "Selection" – The party that acted first in joining the sample. Prgrm – Evaluation program contacted participants. Refer – Other party referred participants to program. Prnt – Parent applied to program. Self – Participant applied to program. Schl – School selected participants. "Follow-Up" – Duration of longest follow-up evaluation in years. "Sample" – Largest sample size from the studies examined (rounded to nearest 10). "Home" – Included home visits. "Health" – Included a nutritional component. "Parental" – Involved parents. "On Site" – Took place at an on site location. "Group" – Whether the intervention combined participants in groups. "IQ" – IQ score. "School" – school performance. "Character" – measured character skills. "Education" – educational attainment. "Health" – health (including drug use). "Crime" – crime. "Earnings" – earnings or related outcomes. "Return" – Annual rate of return. "Benefit/Cost" – Estimated benefits divided by costs.

- First note that more children are going to college at virtually all quartiles of ability and income.
- Increases in college going are strongest for the lowest ability group, especially less able children with richer parents.
- However, this provides no firm evidence for or against credit constraints.
- Also note that the absolute income gap is widening across income quartiles over time.
- The trend could simply be a consequence of wealth elasticity of child education by parents.
- Rich families can afford to spend their money on dumb kids' education.

- Education is an income elastic merit good.
- This is consistent with work on targeted family transfers Keane and Wolpin (2001), Johnson (2013).
- Targeted (tied) transfers promote college going and explain much of their estimated effect of parental income on college going.
- More educated parents have a greater marginal propensity to transfer income (in a tied fashion to children).
- We don't know (but would like to) how this marginal propensity is affected by information and parenting supplements.

- But drawing on Carneiro et al. (2011) there is no efficiency argument for investing in less able adolescents.
- Carneiro et al. (2011) show that the returns to college are negative for low ability students.
- Interpretations in this literature confuse its finding that income is "more relevant" today than in the past with the claim that it has somehow become dominant—which it has not.
- Recent "evidence" claiming to show that early life income matters more in fact shows what Carneiro and Heckman show.

Return to Slide 187

Appendix I.1 Some Evidence on Early Life Interventions

- We focus on the evidence regarding interventions which have a long-term follow-up, which have been extensively studied or widely adopted, or that offer unique insights.
- We draw on the analysis of Heckman and Kautz (2014) where a more comprehensive discussion of each program is presented.

Nurse Family Partnership

- The Nurse-Family Partnership (NFP) is a program targeted at low-income, unmarried, and/or adolescent mothers.
- It consists of nurse visits to young mothers from the first or second trimester of the mother's first pregnancy until the second birthday of her first child.
- The program encourages mothers to reduce smoking, teaches them how to take care of their children and helps them to pursue education and find jobs.

- Evaluated exploiting the random assignment, the program benefits children.
- The treated group exhibits persistent higher IQ scores through age 6 (Olds et al., 2007), lower rate of substance abuse and lower levels of internalizing behavior (e.g. anxiety, depression and, withdrawal) by age 12 (Kitzman et al., 2010) and lower propensity to engage in crime by age 19 (Eckenrode et al., 2010).

- The program also benefits mothers by reducing their dependence on welfare.
- The effects are at best weak on grades and achievement scores, suggesting that the program was most effective in promoting non-cognitive, character skills in the child and improving maternal income and employment prospects.

Perry Preschool Program

- The Perry Preschool program targeted 3- and 4-years old low income black children with initial IQ below 85 at age 3.
- Selection into the program was based on random assignment.
- Children attended 2.5 hours of center-based preschool five days a week for two years.
- Teachers were also involved in home visits during which they interacted, played and talked with the child.

- The program focused on building organizational and social skills and was designed to cultivate independence and a sense of responsibility in the children (Schweinhart et al., 1993).
- The daily routing was understood as a key component of teaching children temporal relations (Weikart et al., 1971).

- Children where first planning an activity to execute and then would go to the art, large motor, doll or quiet center to complete their planned activity.
- The program ended after two years of enrollment and then children from both treatment and control group attended the same school.

- While it appears that the program did not have a lasting effect on IQ scores (Figure 294 and Figure 295), it improved adult outcomes including academic achivement, employment, earnings, marriage, health and crime (Table H.9), resulting in a statistically significant rate of return of around 6-10% per annum (Conti et al., 2014; Heckman et al., 2010a,b).
- These returns are above the post- World War II, pre-2008 meltdown, stock market returns to equity in U.S. labor market that are estimated to be 5.8% per annum.[1]

- The Perry Preschool Program worked primarily through improving character traits which, in turn, improved labor market outcomes, health behavior and reduced crime.
- Figure 296 shows that the treatment groups of both genders improved their teacher-reported externalizing behavior, a trait related to Agreeableness and Conscientiousness.

- For girls, the program improved Openness to Experience (proxied by academic motivation).
- Heckman et al. (2013a) decompose the treatment effects on adult outcomes and shows that most of the Perry treatment effects arise from lasting changes in character traits not from changes in IQ.
- (Tables 56 and 57).

Figure 294: Perry Preschool Program: IQ, by age and treatment group

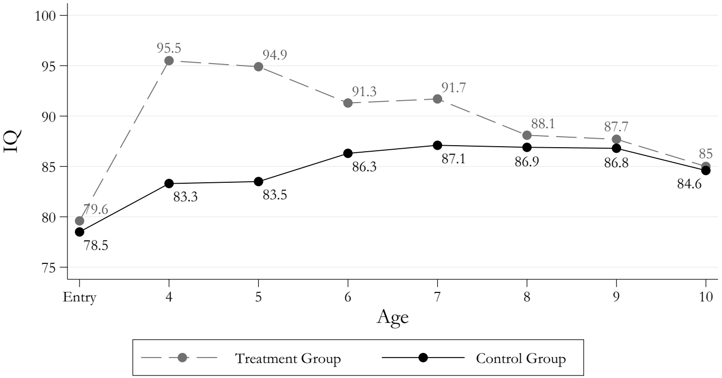


Figure 295: Perry Preschool Program: Stanford-Binet IQ Test Scores by Gender and Treatment Status

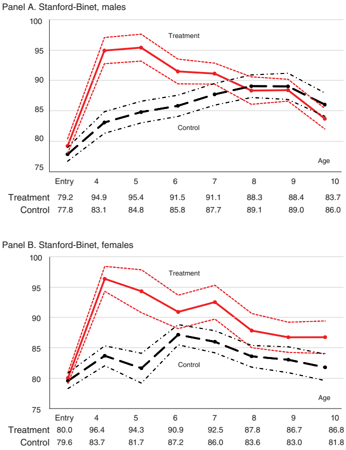
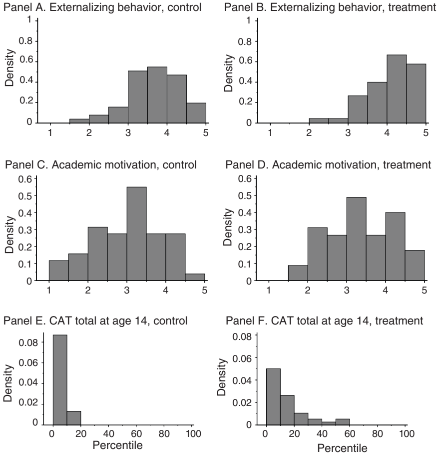


Figure 1. Stanford-Binet IQ Test Scores by Gender and Treatment Status

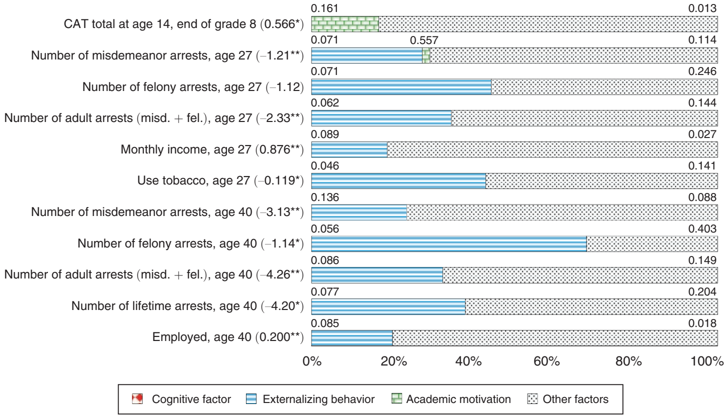
Source: Heckman et al. (2013a).

Figure 296: Perry Preschool Program: Histograms of Indices of Personality Skills and CAT Scores



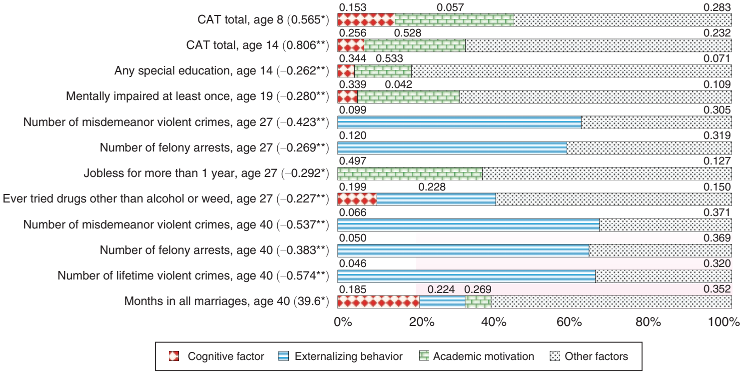
Source: Heckman et al. (2013a).

Figure 297: Perry Preschool Program: Decompositions of Treatment Effects on Outcomes, Males



Source: Heckman et al. (2013a).

Figure 298: Perry Preschool Program: Decompositions of Treatment Effects on Outcomes, Females



Source: Heckman et al. (2013a).

Table 53: Perry Preschool Program: Program Treatment Effects

Variable	Treatment effect: Effect	Effect size	p-value	Control group: Mean	Standard error	Treatment group: Mean	Standard error
Panel A. Males							
CAT total at age 14, end of grade 8	0.566*	0.652	(0.060)	0.000	(0.164)	0.566	(0.204)
Number of misdemeanor arrests, age 27	−1.21**	−0.363	(0.036)	3.03	(0.533)	1.82	(0.445)
Number of felony arrests, age 27	−1.12	−0.324	(0.101)	2.33	(0.554)	1.21	(0.342)
Number of adult arrests (misd.+fel.), age 27	−2.33**	−0.402	(0.024)	5.36	(0.927)	3.03	(0.734)
Monthly income, age 27	0.876**	0.607	(0.018)	1.43	(0.231)	2.31	(0.352)
Use tobacco, age 27	−0.119*	−0.236	(0.093)	0.538	(0.081)	0.419	(0.090)
Number of misdemeanor arrests, age 40	−3.13**	−0.372	(0.039)	8.46	(1.348)	5.33	(1.042)
Number of felony arrests, age 40	−1.14*	−0.266	(0.092)	3.26	(0.684)	2.12	(0.598)
Number of adult arrests (misd.+fel.), age 40	−4.26**	−0.373	(0.041)	11.7	(1.831)	7.46	(1.515)
Number of lifetime arrests, age 40	−4.20*	−0.346	(0.053)	12.4	(1.945)	8.21	(1.778)
Employed, age 40	0.200**	0.394	(0.024)	0.500	(0.085)	0.700	(0.085)
Sample size	72			39		33	
Panel B. Females							
CAT total, age 8	0.565*	0.614	(0.062)	0.000	(0.196)	0.565	(0.223)
CAT total, age 14	0.806**	0.909	(0.014)	0.000	(0.209)	0.806	(0.204)
Any special education, age 14	−0.262**	−0.514	(0.025)	0.462	(0.100)	0.200	(0.082)
Mentally impaired at least once, age 19	−0.280**	−0.569	(0.017)	0.364	(0.105)	0.083	(0.058)
Number of misdemeanor violent crimes, age 27	−0.423**	−0.292	(0.032)	0.423	(0.284)	0.000	(0.000)
Number of felony arrests, age 27	−0.269**	−0.325	(0.021)	0.269	(0.162)	0.000	(0.000)
Jobless for more than 1 year, age 27	−0.292*	−0.573	(0.071)	0.542	(0.104)	0.250	(0.090)
Ever tried drugs other than alcohol or weed, age 27	−0.227**	−0.530	(0.045)	0.227	(0.091)	0.000	(0.000)
Number of misdemeanor violent crimes, age 40	−0.537**	−0.364	(0.016)	0.577	(0.289)	0.040	(0.040)
Number of felony arrests, age 40	−0.383**	−0.425	(0.028)	0.423	(0.177)	0.040	(0.040)
Number of lifetime violent crimes, age 40	−0.574**	−0.384	(0.019)	0.654	(0.293)	0.080	(0.055)
Months in all marriages, age 40	39.6*	0.539	(0.076)	47.8	(15.015)	87.5	(18.853)
Sample size	51			26		25	

Source: Heckman et al. (2013a).
Notes: Statistics are shown for the outcomes analyzed in this paper. There are differences in treatment effects by gender although strong effects are found for both. "CAT total" denotes the California Achievement Test total score normalized to control mean zero and variance of one. Test statistics are corrected for the effect of multiple hypothesis testing and threats to validity (see Heckman et al., 2010a, Conti et al., 2014). The reported effect is the difference in means between treatment and control groups. The effect size is the ratio of the effect to the standard deviation of the control group. Stars denote statistical significance: *** - 1 percent level, ** - 5 percent level, * - 10 percent level. Monthly income is adjusted to thousands of year-2006 dollars using annual national CPI.

*** Significant at the 1 percent level.

** Significant at the 5 percent level.

* Significant at the 10 percent level.

Abecedarian Program

- Similarly to Perry, the Abecedarian program was also designed to promote self-reinforcement among the children and reduce dependence on adult feedback (Ramey et al., 1982).
- It was more intense than Perry combining a preschool component starting as early as at 6 weeks old and a school-age treatment through grade three.
- The curriculum focused on "educational games" to build cognitive abilities (language, math, reading, writing), behavioral skills (attending behavior, task orientation, listening, task completion), and creativity and motor skills (through action songs, rhymes, story telling, fingerplays).

- It also had a medical and nutritional component.
- The program produced lasting improvements in IQ (mostly for girls) because the interventions started very early in life (Campbell et al., 2001).
- Evidence suggests that IQ is more malleable in the very early childhood (Shonkoff and Phillips, 2000).
- Girls also showed a greater educational attainment, reduced participation in crime, decrease in substance abuse, and improved internalizing and externalizing behavior.
- Boys showed better health conditions and improvements in non-cognitive skills (Conti et al., 2014).

Jamaican Study

- The Jamaican Supplementation study is an example of a childhood program offered in a less developed country with a long-term follow-up.
- It consists of two years of nutritional supplementation (milk formula) or stimulation (encouraged the mother to play with children in an effective manner) or both.
- The stimulation intervention appeared more effective.

- Both interventions stimulated short-term cognitive development, but only stimulation improved cognitive and character skills (in particular internalizing behavior) in the long run.
- Stimulation also improved earnings and educational attainment (Gertler et al., 2013; Grantham-McGregor et al., 1991).

Return to Slide 26

Appendix I.2 Large Scale Programs

- The success of early interventions such as Perry and Abecedarian incentivized policymakers to propose similar programs on larger scale. Head Start is one of them with children eligible for enrollment from age three to five.
- It combines center-based preschool interventions with medical services and parental assistance.
- The program largely vary by site making an overall evaluation difficult (Deming, 2009).
- The empirical evidence on its effectiveness is mixed.

- IQ and achievement test scores are improved only in the short run, but some studies find that educational attainment are improved and criminality is reduced in particular for blacks (Deming, 2009; Garces et al., 2002).
- These effects are likely underestimated as many members of the control group joined the program in a different site than where they originally applied or enrolled in other more intensive early childhood programs.
- The Chicago Child-Parent Center program is targeted at 3- and 4- years old disadvantaged children.

- It offers half- or full-day of preschool intervention, but parents are encouraged to be involved, visit the center, receive advice on good parenting behavior and are assisted in pursuing further education and seeking jobs.
- The program appears to have improved education, criminal behavior, reduced substance abuse and also increased annual earnings at age 28 (Niles et al., 2006; Reynolds, 1995; Reynolds et al., 2011, 2001).

Return to Slide 184

Appendix I.3: Interventions in Kindergarten and Elementary School

- Many programs have been proposed to promote moral an character education in school.
- The subject, however, raises controversies as scholars disagree about the origins of character and morality (see Lapsley and Yeager, 2012).
- The Seattle Social Development Project focused on classroom management, interactive teaching, and cooperative learning and aimed at fostering the attachment between children and their parents and teachers.

- It does not have strong effects when evaluated in terms of achievement tests, but it appears successful when life outcomes such as earnings, participation in crime or health status are considered (Hawkins et al., 1999, 2005, 2008).
- The Cambridge-Somerville Program, targeted at five to thirteen years old boys with behavioral problems, is an example of an harmful program as the treated group performed worse than the control in terms of drinking habits, health and participation in crime.

- A possible explanation can be attributed to the creation of dependence on outside assistance (McCord, 1978).
- In project Star children and teachers were randomly assigned to kindergarten classrooms of different class sizes.
- The effects on achievement scores fade over time, but children placed in better classes shown better fourth- and eight-grade behavior according to teacher based ratings and higher earnings in early adulthood (Chetty et al., 2011).
- This evidence shows, as in the case of the Perry program, the importance of long-term follow-ups to properly assess the outcomes of an early intervention.

Return to Slide 187

Appendix L: Dynamic Complementarity for the Vector Case

- Consider the following specification for a vector-valued technology mapping a $L \times 1$ vector of parental investments $\boldsymbol{I_t}$, and a $J \times 1$ vector of skills $\boldsymbol{\theta_t}$, into a $J \times 1$ vector of next period capabilities $\boldsymbol{\theta_{t+1}}$:

$$\boldsymbol{\theta_{t+1}} = \boldsymbol{f^t}(\boldsymbol{\theta_t}, \boldsymbol{I_t}). \tag{35}$$

- The matrix of second-order partial derivatives of the skill vector $\boldsymbol{\theta}_{t+s+1}$ with respect to the investment vectors $\boldsymbol{I}_{t+s}$ and $\boldsymbol{I}_t$ is given by the $J \times L^2$ matrix:

$$\frac{\partial^2 \boldsymbol{\theta}_{t+s+1}}{\partial \boldsymbol{I}_t \partial \boldsymbol{I}_{t+s}} = \begin{bmatrix} \frac{\partial^2 f^{1,t}(\cdot)}{\partial i_{1,t+s} \partial i_{1,t}} & \cdots & \frac{\partial^2 f^{1,t}(\cdot)}{\partial i_{L,t+s} \partial i_{1,t}} & \frac{\partial^2 f^{1,t}(\cdot)}{\partial i_{1,t+s} \partial i_{2,t}} & \cdots & \cdots & \cdots & \frac{\partial^2 f^{1,t}(\cdot)}{\partial i_{L,t+s} \partial i_{L,t}} \\ \vdots & \ddots & \vdots & \vdots & \ddots & & \ddots & \vdots \\ \frac{\partial^2 f^{J,t}(\cdot)}{\partial i_{1,t+s} \partial i_{1,t}} & \cdots & \frac{\partial^2 f^{J,t}(\cdot)}{\partial i_{L,t+s} \partial i_{1,t}} & \frac{\partial^2 f^{J,t}(\cdot)}{\partial i_{1,t+s} \partial i_{2,t}} & \cdots & \cdots & \cdots & \frac{\partial^2 f^{J,t}(\cdot)}{\partial i_{L,t+s} \partial i_{L,t}} \end{bmatrix} \tag{36}$$

$$\frac{\partial^2 f^{j,t}(\cdot)}{\partial i_{l,t+s}\partial i_{l',t}} \quad \text{for} \quad j = 1, \ldots J \quad \text{and} \quad l, l' = 1, \ldots, L \qquad (37)$$

- Is the cross-partial derivative of the entry j of vector $\boldsymbol{\theta_{t+s+1}}$ with respect to $i_{l,t+s}$
- l^{th} entry of the vector of investments $\boldsymbol{I_{t+s}}$, and $i_{l',t}$
- l' entry of the vector $\boldsymbol{I_t}$.

- The sign of each entry is determined by the sign of:

$$\frac{\partial^2 f^{j,t}(\boldsymbol{\theta_t}, \boldsymbol{I_t})}{\partial i_{l,t+s} \partial \boldsymbol{\theta_{t+s}}} \frac{\partial \boldsymbol{\theta_{t+s}}}{\partial i_{l',t}} \quad \text{for} \quad j = 1, \dots J \quad \text{and} \quad l, l' = 1, \dots, L. \tag{38}$$

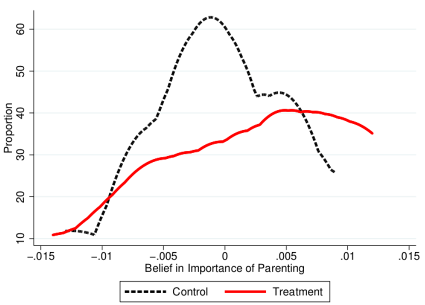
- A sufficient condition for the above to be positive is that each cross partial derivative $\frac{\partial^2 f^{j,t}(\boldsymbol{\theta_t}, \boldsymbol{I_t})}{\partial i_{l,t+s} \partial \theta_{j',t+s}}$ is positive for each $j, j' = 1, \dots J$ and $l = 1 \dots L$
- Each entry in the skill vector is increasing in each type of investment.

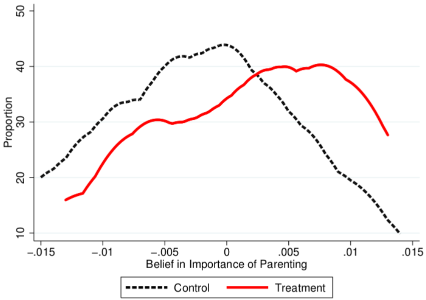
Return to Slide 48

Appendix J: Parental Responses to Intervention Programs

- This appendix presents evidence on parental responses from the NFP, Perry preschool and ABC intervention programs surveyed in Slide 581.
- The NFP program provided home visits to first time teenage mothers, advising them on proper nutrition and care of young children, including the importance of cognitive stimulation.
- The Perry program had home visits on average once a week.
- The ABC program did not have home visits, but interacted with parents at the ABC center.
- The evidence generally supports positive (complementary) responses of parents to interventions.

Figure 299: Parental Response to Perry Preschool Program After 1-year experience of treatment

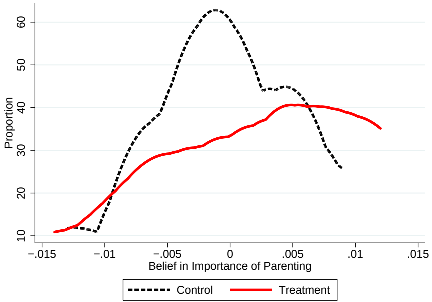




Source: Moon (2013).

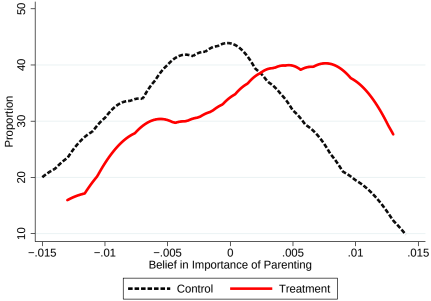
Notes:
(a) Parental response is measured by a factor score obtained from 10 items of Parental Attitude Research Instrument (PARI) administered at child's age 4 or 5 after 1-year experience of Perry Preschool intervention. (b) The factor model was estimated by a maximum likelihood factor estimation with categorical indicators. A higher value indicates that a mother has a stronger belief in importance of warm parenting. (c) 10 items used in this estimation are a mother's 4-point scale response to the following questions : "One of the worst things about taking care of a home is a woman feels that she can't get out"; "Children would be happier and better behaved if parents would show an interest in their affairs"; "A mother should do her best to avoid any disappointment for her child"; "Mothers very often feel that they can't stand their children a moment longer"; "Having to be with the children all the time gives a woman the feeling that her wings have been clipped"; "Parents must earn the respect of their children by the way they act." "Parents who are interested in hearing about their children's parties, dates, and fun help them grow up right"; "A childs' ideas should be seriously considered in making family decisions"; "Parents should know better than to allow their children to be exposed to difficult situations"; and "When a child is in trouble, he ought to know he won't be punished for talking about it with his parents."
Source: Moon (2013).

Figure 300: Parental response to Perry Preschool Program after 1 year experience of treatment: Girls



Source: Moon (2013).

Figure 301: Parental response to Perry Preschool Program after 1 year experience of treatment: Boys



Source: Moon (2013).

Table 54: NFP Memphis, Parental Responses (Females)

Outcome	**Age** (years)	Sample Size # C	# T	Conditional Effect Size	Asymptotic p-values	Permutation Single p-val	Freedman-Lane Stepdown
Home Observation Measurement of the Environment (HOME)	1	220	104	0.354	**0.003**	**0.004**	**0.007**
Non-Abusive Parenting Attitudes (Bavolek)	1	227	105	0.288	**0.012**	**0.005**	**0.005**
Home Observation Measurement of the Environment (HOME)	2	222	101	0.301	**0.010**	**0.003**	**0.006**
Non-Abusive Parenting Attitudes (Bavolek)	2	222	102	0.370	**0.003**	**0.006**	**0.006**

Source: Moon (2013).

Table 55: NFP Memphis, Parental Responses (Males)

Outcome	**Age** (years)	Sample Size # C	# T	Conditional Effect Size	Asymptotic *p*-values	Permutation Single *p*-val	Freedman-Lane Stepdown
Home Observation Measurement of the Environment (HOME)	1	221	95	0.208	**0.051**	**0.041**	**0.041**
Non-Abusive Parenting Attitudes (Bavolek)	1	225	100	0.273	**0.015**	**0.003**	**0.006**
Home Observation Measurement of the Environment (HOME)	2	224	98	0.169	**0.092**	**0.075**	**0.075**
Non-Abusive Parenting Attitudes (Bavolek)	2	228	99	0.316	**0.006**	**0.003**	**0.006**

Source: Moon (2013).

Table 56: Abecedarian Intervention, Attachment (Videotapes)

Variable	Age (In Months)	Ctr. Mean	Diff. Means	Blk. *p*-val	IPW P. Co.Co.	Ctr. Mean	Diff. Means	Blk. *p*-val	IPW P. Co.Co.	Gen. Diff.
		Males				*Females*				
Mutual reading	6	35.322	30.678	**0.066**	**0.017**	30.079	34.281	**0.002**	**0.005**	0.917
Mutual reading, 20m	20	50.327	44.157	**0.024**	**0.033**	20.089	34.663	**0.019**	**0.092**	0.754
Mutual reading	36	37.762	148.430	**0.003**	**0.000**	46.308	20.484	0.141	0.497	**0.010**
Mutual reading	60	97.200	55.300	**0.070**	**0.002**	44.174	-3.947	0.602	**0.014**	0.219
Mutual playing with toy	6	382.409	2.022	0.353	0.889	308.236	134.748	**0.040**	0.134	**0.055**
Mutual playing with toy	20	397.764	-51.479	0.894	0.872	302.274	178.659	**0.008**	**0.003**	**0.001**
Mutual playing with toy	36	381.429	112.456	**0.063**	**0.019**	297.808	188.192	**0.014**	**0.002**	0.471
Mutual playing with toy	60	618.350	-79.619	0.598	0.119	341.957	212.589	**0.030**	**0.000**	**0.014**
Child plays alone	6	-411.678	-19.906	0.511	0.871	-565.800	132.776	0.140	**0.092**	**0.056**
Child plays alone	20	-595.291	-45.509	0.868	0.910	-723.348	149.177	**0.044**	**0.017**	**0.006**
Child plays alone	36	-815.286	115.978	**0.068**	**0.014**	-899.962	204.837	**0.007**	**0.001**	0.401
Child plays alone	60	-552.350	-94.150	0.615	0.185	-853.130	216.721	**0.029**	**0.000**	**0.011**

Notes:
(a) Ctr. Mean denotes mean value for control group
(b) Diff. Means denotes the difference in the mean values between treatment and control groups
(c) Blk. *p*-value denotes the block *p*-value for the the male block
(d) IPW P. Co. Co. denotes the inverse probability weighting correlation coefficient
(e) Gen. Diff. denotes the *p*-value for the mean values of the two genders being equal
Source: Moon (2013).

Table 57: Abecedarian Intervention, Parental Investment (HOME)

Variable	Age (In Months)	Ctr. Mean	Diff. Means	Blk. *p*-val	IPW P. Co.Co.	Ctr. Mean	Diff. Means	Blk. *p*-val	IPW P. Co.Co.	Gen. Diff.
		Males				*Females*				
Maternal warmth	6	7.043	-0.599	0.805	0.957	6.700	0.420	**0.070**	**0.044**	**0.068**
Maternal warmth	18	7.619	0.122	0.209	**0.058**	6.714	1.112	**0.040**	**0.001**	**0.091**
Maternal warmth	30	7.286	-0.206	0.635	**0.001**	7.111	0.472	**0.057**	**0.006**	0.309
Organization of environment	6	4.652	0.422	**0.076**	**0.001**	4.633	0.007	0.641	0.439	0.145
Organization of environment	18	5.238	0.021	0.361	**0.069**	4.964	0.340	0.311	**0.017**	0.394
Organization of environment	30	5.238	0.070	0.676	**0.088**	5.148	0.102	0.286	**0.065**	0.934
Avoidance of restrict./punish.	42	5.619	-0.219	0.708	0.553	5.808	0.109	0.185	**0.045**	0.575
Avoidance of restrict./punish.	54	5.571	0.081	0.241	**0.045**	5.917	0.447	**0.044**	**0.000**	0.400
Stimulation of mature behavior	42	8.286	0.114	0.654	0.333	8.385	0.574	0.660	0.227	0.548
Stimulation of mature behavior	54	8.857	0.882	**0.051**	**0.001**	9.000	1.000	**0.045**	**0.000**	0.885

Notes:
(a) Ctr. Mean denotes mean value for control group
(b) Diff. Means denotes the difference in the mean values between treatment and control groups
(c) Blk. *p*-value denotes the block *p*-value for the the male block
(d) IPW P. Co. Co. denotes the inverse probability weighting correlation coefficient
(e) Gen. Diff. denotes the *p*-value for the mean values of the two genders being equal
Source: Moon (2013).

Return to Slide 52

Appendix D.4: The Problem of the Parent

The Problem of the Parent

- The parent is assumed to be the decision-maker in the household.
- The child passively accepts investment.
- The consumption of the child is not modeled.
- The problem solved by the parent depends on the age of the child.
- When the child is between ages 1 and $T-1$, he only receives investments and cannot work.

- When the child reaches age T, the parent may invest a minimum level or something beyond that minimum.
- If the parent invests the minimum amount, the child does not attend college but becomes a high school graduate and works full time.
- If the parent invests any amount beyond the minimum, the child attends school (college) full-time.
- At the end of the period, he becomes a college graduate.

The Problem When the Child Is between 1 and $T-1$ Years Old

- Parental labor supply is assumed to be perfectly inelastic.
- At each age t of the child, the parent is subject to productivity innovations ε_t, corresponding to labor market uncertainty.
- The shocks ε_t are independently and identically distributed across parents.

- The shocks follow a first-order Markov process:

$$\ln \varepsilon_{t+1} = \rho_\varepsilon \ln \varepsilon_t + \sigma_\eta \eta_t^\varepsilon. \tag{39}$$

- Parents are assumed to have positive earnings.
- Productivity innovations are restricted so that there exists $\varepsilon_{\min}$ with the property that $\varepsilon_t \geq \varepsilon_{\min} > 0$ for any $t = T+1, \ldots, 2T$.
- The labor income of the parent is $wh\varepsilon_t$, where w is the efficiency wage and r is the risk-free discount rate.
- Innovations in wages and labor market uncertainty are missing in BTS.

- The level of capability of the parent, h, is the outcome of investment decisions made by the grandparent.
- In similar fashion, the level of skill of the child when an adult, h', will also be the consequence of investments made by the parent, and satisfies $h' = \theta_{T+1}$.
- Defining s_t as the stock of savings of the parent at age t, the individual state variables for the parents of children who are between 1 and $T-1$ years old is $(h, \theta_t, s_t, \varepsilon_t, t)$.

- Given the state variables, the parent chooses household consumption c_t, savings s_{t+1}, and investments I_t in the cognitive skill of the child.
- The savings of the parents are in a risk-free asset which pays a rate of interest r.
- p denotes the price of the investment goods in cognitive skill.
- Following Laitner (1992), the parents cannot leave debts to their children and have negative net worth, so savings are subject to the lower bound equal to $\frac{-wh\varepsilon_{\min}}{(1+r)}$ (the "natural" borrowing limit).

- $V(t, h, \theta_t, s_t, \varepsilon_t)$ is the value function of the parent of a child at age t, $1 \leq t \leq T-1$. The problem of the parent is:

$$V(t, h, \theta_t, s_t, \varepsilon_t)$$
$$= \max_{c_t, l_t, s_{t+1}} \{u(c_t) + \beta \mathbb{E}[V(t+1, h, \theta_{t+1}, s_{t+1}, \varepsilon_{t+1}) | \varepsilon_t]\}$$

- Subject to:

$$c_t + pI_t + s_{t+1} = wh\varepsilon_t + (1+r)\, s_t \tag{40}$$

$$s_{t+1} \geq -\left(wh\varepsilon_{\min}\right), \;\; I_t, c_t \geq 0 \tag{41}$$

- And the technology for capability formation.

- Associating multiplier μ_t to the borrowing constraint in stage t, the optimal conditions for consumption and investments are given by:

$$u_c(c_t) = \beta(1+r)\mathbb{E}\left[V_s\left(t+1, h, \theta_{t+1}, s_{t+1}, \varepsilon_{t+1}\right)|\varepsilon_t\right] + \mu_t \tag{42}$$

$$\beta\mathbb{E}\left[\frac{\partial\theta_{t+1}}{\partial I_t} V_\theta\left(t+1, h, \theta_{t+1}, s_{t+1}, \varepsilon_{t+1}\right)|\varepsilon_t\right] = \beta(1+r)p\mathbb{E}\left[V_s\left(t+1, h, \theta_{t+1}, s_{t+1}, \varepsilon_{t+1}\right)|\varepsilon_t\right] + \mu_t \tag{43}$$

- This implies that the marginal utility of investments is equated to the marginal utility of consumption and to the marginal utility of future wealth.
- Whenever the constraint binds ($\mu_t \geq 0$), consumption and investment will be reduced as the agent would like to borrow more than ($wh\varepsilon_{min}$), but she is constrained.

- Suppose now that the agent is not constrained in period t.
- Using the envelope condition for assets we can rewrite the optimal condition for investment and consumption making clear the dependence on expected future constraints:

$$\beta \mathbb{E}_t \left[\frac{\partial \theta_{t+1}}{\partial I_t} V_\theta \left(t+1, h, \theta_{t+1}, s_{t+1}, \varepsilon_{t+1} \right) | \varepsilon_t \right] = p u_c(c_t) \tag{44}$$

$$= \beta(1+r) p \mathbb{E}_t \left[V_s \left(t+1, h, \theta_{t+1}, s_{t+1}, \varepsilon_{t+1} \right) | \varepsilon_t \right]$$

$$= \left[\beta(1+r) \right]^2 p \mathbb{E}_t \left[\mathbb{E}_{t+1} \left[V_s \left(t+2, h, \theta_{t+2}, s_{t+2}, \varepsilon_{t+2} \right) | \varepsilon_{t+1} \right] + \mu_{t+1} | \varepsilon_t \right] \tag{45}$$

$$= \left[\beta(1+r) \right]^2 p \left[\mathbb{E}_t \left[V_s \left(t+2, h, \theta_{t+2}, s_{t+2}, \varepsilon_{t+2} \right) | \varepsilon_{t+1} \right] + \mathbb{E}_t [\mu_{t+1} \mid s_{t+1} = -wh\varepsilon_{min}] \right] P(s^*_{t+1} < -wh\varepsilon_{min}) \tag{46}$$

- Where s^*_{t+1} represents the optimal unconstrained amount of savings from stage $t+1$ to stage $t+2$ and

$$P(s^*_{t+1} < -wh\varepsilon_{min}) = P\left(\varepsilon_{t+1}wh - c^*_{t+1}(\varepsilon_{t+1}wh) - pI^*_{t+1}(\varepsilon_{t+1}wh) < -wh\varepsilon_{min} - (1+r)s_t\right) \tag{47}$$

- c_{t+1}^* and I_{t+1}^* represent the optimal unconstrained levels of consumption and investments in period $t+1$ which depend on the realization of income.
- Even when the parent is not constrained in period t, the expectation of future constraints reduces current consumption and investments levels.
- The fear of hitting the constraint in the future induces a precautionary motive for savings which reduces current investments and consumption.

The Problem When the Child Is T Years Old: Go to College or Not?

- Consider the decision to go to college (made by the parent).
- When the child reaches age T, the parent decides to invest the minimum amount, $\underline{I}$, or something beyond that amount.
- The parent uses the relevant information to make that decision, which is contained in the vector of state variables $(h, \theta_t, s_t, \varepsilon_t, n_t)$.

- Let κ be tuition cost. The parent's problem can be stated as:

$$\begin{aligned} & V\left(T, h, \theta_T, s_T, \varepsilon_T\right) \\ & = \max_{c_T, I_T, s_1'} \left\{u\left(c_T\right) + \beta \mathbb{E}\left[V\left(1, h', \theta_1', s_1', \varepsilon_1'\right)\right]\right\} \end{aligned}$$

- Subject to:

$$c_T + s_1' + p\underline{I} = wh\varepsilon_T + w\theta_T + (1+r)\,s_T \text{ if } I_T = \underline{I} \tag{48}$$

$$c_T + s_1' + (pI_T + \kappa) = wh\varepsilon_T + (1+r)\,s_T \text{ if } I_T > \underline{I} \tag{49}$$

$$s_T \geq 0 \tag{50}$$

- And the technology for the production of skills.

- The budget constraint (48) states that a child who receives the minimum amount of investments $\underline{I}$ works full time.
- Refer to this child as a high school graduate.
- Note that the high-school-graduate child's earnings are pooled with the rest of the parental resources.
- Abstract from productivity shocks for the child before he reaches adulthood.
- If the parent decides to invest any amount above the minimum, so that $I_T > \underline{I}$, then the parent must pay the variable cost of the investment, which is p by unit, plus a fixed cost, φ—college tuition.

- A child who receives more than the minimum amount of investment does not work.
- This is described by the budget constraint (49).
- Note that equation (50) embodies the notion that the parent faces lifetime liquidity constraints.
- The parent dies and cannot leave debts to the child.

- Following Cunha (2007), one can establish a steady state general equilibrium.
- Firms producing final output under constant returns to scale.
- Also a child investment good is produced.
- Cunha (2007) establishes a stochastic general equilibrium for the steady state, extending Laitner to include human capital.

Appendix D.5: Firms

Firms

- Both education goods and final outputs are produced.
- The final output sector uses physical capital and labor, measured in efficiency units, to produce the consumption good.
- The education goods sector uses only labor, also measured in efficiency units, to produce the investment good for cognitive skills.

The Consumption Good Sector

- The production function in the consumption good sector is assumed to exhibit constant returns to scale.
- Only stationary equilibrium is established.
- It is not necessary to use time subscripts.

- Let $\boldsymbol{K}, \boldsymbol{L}$ denote the aggregate quantities of physical capital and labor, respectively.
- Let $\boldsymbol{Y}$ denote aggregate output. The production technology is represented by the production function $F : \boldsymbol{Y} = F(\boldsymbol{K}, \boldsymbol{L})$.
- Satisfies the Inada Conditions.
- It is twice-continuously differentiable.

- The problem of the firm in the goods production sector is:

$$\pi_Y = \max \left\{ F\left(\boldsymbol{K}, \boldsymbol{L}\right) - w\boldsymbol{L} - \left(r + \delta\right)\boldsymbol{K} \right\}$$

- With first-order conditions:

$$w = \frac{\partial F(\boldsymbol{K}, \boldsymbol{L})}{\partial \boldsymbol{L}}$$

$$(r + \delta) = \frac{\partial F(\boldsymbol{K}, \boldsymbol{L})}{\partial \boldsymbol{K}}$$

The Education Good Sector

- Let E denote the total supply of educational goods.
- This sector does not use physical capital as input, only labor U.
- The production technology is

$$E = U.$$

- The problem of the firm in this sector is to maximize π_E:

$$\pi_E = \max\left\{p\boldsymbol{E} - w\boldsymbol{U}\right\}.$$

- Problem has a solution with limited, positive production if, and only if

$$p = w.$$

Market-Clearing Conditions

- Let $\zeta_t = (h, \theta_t, s_t, n_t, \varepsilon_t)$.
- This is the vector of state variables facing the parents.
- Define $\zeta = (\zeta_1, \ldots, \zeta_T)$.
- Let $g(\zeta)$ denote the joint probability density function of the state variables.

- Let $c_t(\zeta_t), s_t(\zeta_t)$ denote the consumption and savings functions when the child is t years old.
- Let $\boldsymbol{C}_t$, $\boldsymbol{S}_t$ denote the aggregate consumption and savings of households that have a child who is t years old, where $t = 1, 2, \ldots, T$.

- By definition,

$$\boldsymbol{C}_t = \int c_t(\zeta_t)\, g(\zeta)\, d\zeta,$$
$$\boldsymbol{S}_t = \int s_t(\zeta_t)\, g(\zeta)\, d\zeta.$$

- Denote the economy-wide investment in physical capital (conducted by the firm in the consumption good sector) by Q.
- The market clearing in the consumption good sector is given by the condition

$$\sum_{t=1}^{T} C_t + Q = Y.$$

- Analogously, equilibrium in the physical capital sector the equilibrium condition is given by

$$\sum_{t=1}^{T} S_t = K.$$

- Let $I_t(\zeta_t)$ denote the investments in cognitive skill when the child is t years old.
- Use $\boldsymbol{I}_t$ to denote the aggregate investment by households with a t-year-old child, $t = 1, 2, \ldots, T$.
- When the child is t years old, $t = 1, 2, \ldots, T - 1$, aggregate investment is $\boldsymbol{I}_t = \int I_t(\zeta_t)\, g(\zeta)\, d\zeta$.

- When the child is T years old, one must keep track of the fact that some children receive investments beyond the minimum amount and the others do not.
- The share of the children who receive investments is the share of children who become college graduates.
- Consequently, aggregate investment by households with a T-years-old child is:

$$\boldsymbol{I}_T = \int_{\{\zeta_T / I_T(\zeta_T) = \underline{I}\}} \underline{I}\, g(\zeta)\, d\zeta + \int_{\{\zeta_T / I_T(\zeta_T) > \underline{I}\}} I_T(\zeta_T)\, g(\zeta)\, d\zeta.$$

- The market clearing condition for this sector is

$$\sum_{t=1}^{T} I_t = E.$$

- To compute the aggregate stock of efficiency units, let $g_h(h)$ denote the probability density function of adult efficiency units.
- In households where children are t years old, $t = 1, 2, \ldots, T-1$, they supply an amount of efficiency units that given by

$$\boldsymbol{H}_t = \int h g_h(h)\, dh.$$

THE UNIVERSITY OF CHICAGO

- In households where children are T years old, we may have two different types of persons supplying efficiency units: the parent and the child who is only receiving the minimum amount of investments, $\underline{I}$.
- Let $g_{\theta}, I_T\left(\theta_T, I_T(\varepsilon_T)\right)$ denote the joint probability density function of efficiency units (determined by cognitive skills) for the children who are T years old and $I_T(\varepsilon_T)$.

$$\boldsymbol{H}_T = \int hg_h(h)\,dh + \int_{\{\zeta_T / I_T(\zeta_T) = \underline{I}\}} \theta_T g_\theta, (\theta_T, I_T(\zeta_T))\, d\theta_T d(\varepsilon_T).$$

- The total supply of efficiency units in every calendar year in this economy is given by $\boldsymbol{H}$ is defined as

$$\boldsymbol{H} = \sum_{t=1}^{T} \boldsymbol{H}_t.$$

- $\boldsymbol{L}, \boldsymbol{U}$ denote the aggregate amount of efficiency units allocated to the consumption and education good sector, respectively.
- Feasibility of the efficiency units allocation implies

$$\boldsymbol{L} + \boldsymbol{U} = \boldsymbol{H}.$$

- Cunha (2007) establishes the existence of stationary equilibrium for this model.

Definition of Stationary Equilibrium

A Stationary Recursive Competitive Equilibrium is a set of functions $\{V(\zeta_t)\}_{t=1}^{T}$, $\{c_t(\zeta_t), I_t(\zeta_t), s_t(\zeta_t)\}_{t=1}^{T}$, $\boldsymbol{K}$, $\boldsymbol{L}$, $\boldsymbol{Y}$, $\boldsymbol{U}$, *wage rate* w, *interest rate* r, *prices of investment goods* p, *distributions of parents across states,* $g(\zeta)$ *such that:*

(a) *Given prices* w *and* r, *the functions* $\{V(\zeta_t)\}_{t=1}^{T}$, $\{c_t(\zeta_t), I_t(\zeta_t), s_t(\zeta_t)\}_{t=1}^{T}$ *solve the parent's maximization problem.*

(b) *Given prices* w *and* r, $\boldsymbol{K}$ *and* $\boldsymbol{L}$ *maximizes consumption-good firm's profits and* $\boldsymbol{U}$ *maximizes the education-good sector firm's profit.*

(c) *Markets for consumption, investments in education, physical capital and efficiency units clear.*

(d) *The distributions of households across states* $\{\mu_t(\theta_t, h, s_t, \varepsilon_t)\}_{t=1}^{T}$ *are calendar-year invariant and are determined as a fixed point of an operator that maps current-calendar-year distributions into next-calendar-year distributions taking into account parent's optimal decisions and the evolution of exogenous states.*

Return to Slide 95

Appendix D.7: Targeting Relatively More Investment Toward Disadvantaged Children Can Be Socially Efficient

Introduction

- Analyze the problem of investing in children with different initial endowments assuming that children are weighted equally ($\omega_k = 1$ for all k). Parents only care about total output.
- No social justice concerns.
- Families are assumed to only care about productivity.
- Consider the following two-stage model of childhood investment:

$$\theta_3 = f^{(2)}(\theta_2, I_2) \tag{51}$$

$$\theta_2 = f^{(1)}(\theta_1, I_1) \tag{52}$$

- θ_3 represents the level of skill at the beginning of adulthood.

- The functions are assumed to be strictly concave in I_2 and I_1, respectively, and twice differentiable.
- Concavity in θ_2 or θ_1 is not required for an optimum, although it plays a role in signing terms in the comparative statics exercise below.
- The assumptions made below imply that all inputs are normal.
- Total resources are E.
- The price of input i is p_i.
- There are two children: A and B.
- Their initial endowments are θ_1^A and θ_1^B, respectively.

- $\theta_1^A = \gamma\theta_1^B$ and consider how, from a position of initial equality ($\theta_1^A = \theta_1^B$ or $\gamma = 1$), raising the initial endowment of A affects Benthamite allocations of investment goods between A and B.
- Denote investment in the first period for child A by I_1^A and in the second period by I_2^A. I_1^B and I_2^B are defined analogously for child B.

One Period of Childhood: Version of the Problem as in Becker and Tomes (1986)

- Parents (or social planners) seek to maximize the aggregate of adult skills (θ_2):

$$\theta_2^A + \theta_2^B$$

$$\text{subject to} \quad E = p_1(I_1^A + I_1^B),$$

- First order condition is:

$$\text{F.O.C.: } f_2^{(1)}\left(\gamma\theta_1^B, I_1^A\right) = f_2^{(1)}\left(\theta_1^B, I_1^B\right).$$

$$\text{sign}\left(\frac{\partial I_1^A}{\partial \gamma}\right) = \text{sign}\left(f_{12}^{(1)}(\cdot)\right)_{\gamma=1}$$

- $f_{12}^{(1)}(\cdot)$ is the value of $f^{(12)}$ in the neighborhood of $(\cdot)$.
- Parents (social planners) invest more in the disadvantaged if inputs are substitutes with initial endowments and they invest less if they are complements.
- These are **direct** complements and substitutes.

Multiperiod Setting

- In the multiperiod setting it is still optimal to invest more in the child with the lower initial endowment if $f_{12}^{(1)}(\cdot) < 0$ even though $f_{12}^{(2)}(\cdot) > 0$.
- Pattern consistent with the evidence on the evolution of complementarity at later stages in the life cycle: $f_{12}^{(1)}(\cdot) < f_{12}^{(2)}(\cdot)$.
- However, targeting relatively more investment to the initially more disadvantaged child can still be efficient if $0 \leq f_{12}^{(1)}(\cdot) \leq f_{12}^{(2)}(\cdot)$.

- To establish this suppose that parents (or social planners) seek to maximize

$$\theta_3^A + \theta_3^B$$

- Subject to

$$E = p_1(I_1^A + I_1^B) + p_2(I_2^A + I_2^B).$$

First Order Conditions:

$$f_1^{(2)}\left(f^{(1)}\left(\theta_1^A, I_1^A\right), I_1^A\right) f_2^{(1)}\left(\theta_1^A, I_1^A\right) = \lambda p_1$$

$$f_2^{(2)}\left(f^{(1)}\left(\theta_1^A, I_1^A\right), I_2^A\right) = \lambda p_2$$

$$f_1^{(2)}\left(f^1\left(\theta_1^B, I_1^B\right), I_2^B\right) f_2^{(1)}\left(\theta_1^B, I_1^B\right) = \lambda p_1$$

$$f_2^{(2)}\left(f^1\left(\theta_1^B, I_1^B\right), I_2^B\right) = \lambda p_2$$

$$p_1\left(I_1^A + I_1^B\right) + p_2\left(I_2^A + I_2^B\right) = E.$$

- Consider an enhancement of the endowment of A in the neighborhood of initial equality ($\theta_1^A = \theta_1^B$).
- As before, let $\theta_1^A = \gamma\theta_1^B$.
- Perturb γ from position $\gamma = 1$.
- Take total differentials of the system of first order conditions:

$$
\left.
\begin{aligned}
&\left\{ f_{11}^{(2)}(\cdot) \left[f_2^{(1)}(\cdot) \right]^2 + f_1^{(2)}(\cdot) f_{22}^{(1)}(\cdot) \right\} dI_1^A + \left[f_{12}^{(2)}(\cdot) f_2^1(\cdot) \right] dI_2^A + \theta_1^B \underbrace{\left[f_{11}^{(2)} f_1^{(1)}(\cdot) f_2^{(1)}(\cdot) + f_1^{(2)}(\cdot) f_{21}^{(1)}(\cdot) \right]}_{\text{“Term 1”}} d\gamma \\
&\qquad = (d\lambda) p_1 + \lambda dp_1 \\
&\left\{ f_{21}^{(2)}(\cdot) f_2^{(1)}(\cdot) \right\} dI_1^A + \left\{ f_{22}^{(2)}(\cdot) \right\} dI_2^A + \theta_1^B \underbrace{\left\{ f_{21}^{(2)}(\cdot) f_1^{(1)}(\cdot) \right\}}_{\text{“Term 2”}} d\gamma = (d\lambda) p_2 + \lambda dp_2 \\
&\left\{ f_{11}^{(2)}(\cdot) \left[f_2^{(1)}(\cdot) \right]^2 + f_1^{(2)}(\cdot) f_{21}^{(1)}(\cdot) \theta_1^B \right\} dI_1^B + \left[f_{12}^2(\cdot) f_2^1(\cdot) \right] dI_2^B = (d\lambda) p_1 + \lambda dp_1 \\
&\left\{ f_{21}^{(2)}(\cdot) f_2^{(1)}(\cdot) \right\} dI_1^B + \left\{ f_{22}^{(2)}(\cdot) \right\} dI_2^B = (d\lambda) p_2 + p_2 d\lambda \\
&-dE + p_1 dI_1^A + p_2 dI_2^A + p_1 dI_1^B + p_2 dI_2^B + I_1^A dp_2 + I_2^A dp_2 + I_1^B dp_1 + I_2^B dp_2 = 0.
\end{aligned}
\right\} \quad (53)
$$

A Three-Stage Analysis

- Fruitful to analyze the problem in three stages.
- In the first stage, we consider, for a single agent, how as $\gamma \uparrow$, the allocation of a fixed bundle of resources between investment in the first period and investment in the second period is affected.
- Then in the second stage consider how, as $\gamma \uparrow$, the productivity of expenditure changes and how resources are allocated across A and B.
- Clearly, resources shift to where they become more productive.

- In the third stage, consider how an increase in resources is allocated between the first and the second periods.
- Sometimes convenient to use fictitious child A specific prices (p_1^A and p_2^A) and child B specific prices p_1^B and p_2^B.

- Expenditures on child A and child B:

$$E_A = p_1 I_1^A + p_2 I_2^A$$
$$E_B = p_1 I_1^B + p_2 I_2^B.$$

- Maximize each of θ_3^A and θ_3^B separately subject to E_A and E_B
- Then allocate E_A and E_B to equalize marginal productivity of expenditure across A and B.

- Assume concavity of the production functions in terms of θ_1 or θ_2.
- This allows us to use standard results from consumer theory.
- The "$d\gamma$" terms act like income-compensated price changes.
- They do not affect total resources E. Assuming interior solutions, $\gamma \uparrow$ is like an income-compensated change in the (child-specific) input prices p_1 and p_2.

The effect of $\gamma \uparrow$ on the allocation of investments across periods holding E_A fixed

- Consider the effect of an increase in γ on the allocation of period one and period two investment of child A while E_A is fixed.
- We consider the allocation of E_A and E_B across A and B later).
- The displacement system derived from the first order conditions:

$$\underbrace{\begin{bmatrix} c & d & -p_1 \\ d & e & -p_2 \\ -p_1 & -p_2 & 0 \end{bmatrix}}_{\substack{|M| \\ (+)}} \begin{bmatrix} dI_1^A \\ dI_2^A \\ d\lambda \end{bmatrix} = \begin{bmatrix} \lambda dp_1 - \theta_1^B(\text{Term} \quad 1)d\gamma \\ \lambda dp_2 - \theta_1^B(\text{Term} \quad 2)d\gamma \\ 0 \end{bmatrix}. \tag{53}$$

- The income compensated own price changes are negative.
- Cross effects can be shown to be positive under the conditions specified below.
- $|M| > 0$ from the assumption of a regular optimum.
- To simplify the notation, suppress the "$\cdot$" notation. We can sign

$$c = \left[f_{11}^{(2)} [f_2^{(1)}]^2 + f_1^{(2)} f_{22}^{(1)} \right] \leq 0$$

- if period 2 production is concave in θ_2 and period 1 production is concave in I_1.

THE UNIVERSITY OF CHICAGO

- We assume that all marginal products are strictly positive unless otherwise noted.
- But c might still be negative if period 2 production is convex in θ_2 ($f_{11}^{(2)} > 0$) provided $f_1^{(2)} f_{22}^{(1)}$ is sufficiently negative.

$$d = f_{12}^{(2)} f_2^{(1)} > 0 \quad \text{if there is second period complementarity}$$

and

$$e = f_{22}^{(2)} < 0 \quad \text{from concavity in } I_2.$$

- In displacement system (53)

$$\text{Term 1} \equiv \left[f_{11}^{(2)} f_{1}^{(1)} f_{2}^{(1)} + f_{1}^{(2)} f_{21}^{(1)} \right]$$

- may be of either sign.

- The second grouping of terms in Term 1 is positive under first period complementarity.
- It is negative under substitutability.
- The first grouping is negative under concavity of $f^{(2)}$ in θ_2.
- Under second period complementarity ($f_{21}^{(2)} > 0$) and

$$\text{Term 2} = \left[f_{21}^{(2)} f_1^{(1)} \right] \geq 0.$$

- The change associated with Term 1 alone is opposite in sign to the change in the income-constant price of I_1^A which is negative.
- Similarly, a change associated with Term 2 alone is opposite in sign from a change in the price of I_2^A.

- Using Cramer's Rule,

$$\frac{\partial I_1^A}{\partial \gamma} = \frac{\begin{vmatrix} -\theta_1^B(\text{Term } 1) & d & -p_1 \\ -\theta_1^B(\text{Term } 2) & e & -p_2 \\ 0 & -p_2 & 0 \end{vmatrix}}{|M|}$$

$$= \left(\frac{(\text{Term } 1)p_2^2 - (\text{Term } 2)p_1 p_2}{|M|} \right) \theta_1^B .$$

- Focus on the numerator since the denominator is positive.
- Substitute out for p_1 and p_2 using the first order conditions (53).
- The numerator can be written as

$$\underbrace{\theta_1^B \left[\frac{1}{\lambda^2}\right]}_{+} \left\{ \left[f_{11}^{(2)} f_1^{(1)} f_2^{(1)} + f_1^{(2)} f_{21}^{(1)} \right] \left[f_2^{(2)} \right]^2 - \left[f_{21}^{(2)} f_1^{(1)} f_1^{(2)} f_2^{(1)} f_2^{(2)} \right] \right\}$$

- Focusing further on the term in braces (which is multiplied by a positive term), we obtain

$$\left\{ \left[f_{11}^{(2)} f_{1}^{(1)} f_{2}^{(1)} \left[f_{2}^{(2)} \right]^2 + f_{1}^{(2)} f_{21}^{(1)} \left(f_{2}^{(2)} \right)^2 - f_{21}^{(2)} \left(f_{1}^{(2)} \right)^2 f_{2}^{(2)} f_{1}^{(1)} f_{2}^{(1)} \right] \right\}$$

$$=f_2^{(1)}\left(f_2^{(2)}\right)^2 f_1^{(2)}\left[\frac{f_{11}^{(2)}}{f_1^{(2)}}\left(f_1^{(1)}\right)+\frac{f_{21}^{(1)}}{f_2^{(1)}}-\frac{f_{21}^{(2)}}{f_2^{(2)}}f_1^{(2)}\right]$$

$$=f_2^{(1)}\left(f_2^{(2)}\right)^2 f_1^{(2)}\left[f_1^{(1)}\underbrace{\underset{(-)}{\left[\frac{\partial \ln f_1^{(2)}}{\partial \theta_2^A}\right]}}_{\substack{\text{Diminishing marginal}\\ \text{productivity of } \theta_2}}+\underbrace{\left(\frac{\partial \ln f_2^{(1)}}{\partial \theta_1^A}\right)}_{\substack{\text{Effect of } \theta_1^A\\ \text{on marginal}\\ \text{productivity of } I_1^A\\ (+)\\ \text{(under}\\ \text{complementarity)}}}-\underbrace{\left(\frac{\partial \ln f_2^{(2)}}{\partial \theta_2^A}\right)}_{\substack{\text{Effect of } \theta_2^A\\ \text{on marginal}\\ \text{productivity of } I_2^A\\ (+)\\ \text{(under}\\ \text{complementarity)}}}f_1^{(1)}\right]$$

- Note that $f_1^{(1)}=\frac{\partial\theta_2^A}{\partial\theta_1^A}$.
- This is the marginal self productivity of θ_1.

- Thus the term in brackets is:

$$\left[\underbrace{\frac{\partial \mathit{Inf}_1^{(2)}}{\partial\theta_1^A}}_{\substack{\text{The effect of } \theta_1^A \\ \text{on the marginal} \\ \text{productivity of } \theta_2^A}} + \underbrace{\frac{\partial \mathit{Inf}_2^{(1)}}{\partial\theta_1^A}}_{\substack{\text{The effect of } \theta_1^A \\ \text{on the marginal} \\ \text{productivity of } I_1^A}} - \underbrace{\frac{\partial \mathit{Inf}_2^{(2)}}{\partial\theta_1^A}}_{\substack{\text{The effect of } \theta_1^A \\ \text{on the marginal} \\ \text{productivity of } I_2^A}}\right]$$

$$= \frac{\partial}{\partial\theta_1^A}\left[\mathit{Inf}_1^{(2)} + \mathit{Inf}_2^{(1)} - \mathit{Inf}_2^{(2)}\right] \tag{54}$$

- Consider the three effects inside the bracket going from left to right.
- The first term is the effect of θ_1^A on the marginal product of θ_2^A in period 2 production.
- From concavity (in terms of θ_2^A), this term is negative.
- Diminishing returns is a force toward investing less in the first period.
- This term reflects how first period stocks of skills augment second period stocks of skills.

- If, example, $f_1^{(1)} = 0$ (so $\frac{\partial \theta_2^A}{\partial \theta_1^A} = 0$), this term is zero.
- This could occur if there is 100% depreciation of skills or if there is a threshold value of θ_1 beyond which increases in θ_1 do not affect θ_2 and the agent is at or beyond the threshold.
- If θ_2^A has a low or zero productivity in second period production, this term is small or zero.

- The second term is the effect of increasing θ_1^A on augmenting the productivity of first period investment in producing θ_2^A.
- This is the term that drives the analysis in a one period model of childhood.

- The third term is the effect of increasing θ_1^A on augmenting the productivity of second period investment.
- Again, if there is no self-productivity ($\frac{\partial \theta_2^A}{\partial \theta_1^A} = 0$), this term is zero.
- Greater complementarity with later stages in the life cycle is a force toward investing less in the first period.

- Thus, in the absence of self-productivity ($f_1^1 = \frac{\partial \theta_2^A}{\partial \theta_1^A} = 0$), the effect is driven solely by the second term.
- Under complementarity, the sign of the effect is positive.

- Thus,

$$\frac{\partial I_1^A}{\partial \gamma} < 0$$

- if (a) $f^{(2)}$ concave in θ_2^A, $f_{21}^{(1)} < 0$, $f_{21}^{(2)} > 0$
- and/or (b) $f^{(2)}$ is concave in θ_2 and $\frac{\partial ln f_2^{(1)}}{\partial \theta_1} < f_1^{(1)} \frac{\partial ln f_2^{(2)}}{\partial \theta_2}$, or
- if there are other configurations so that the term in brackets in (54) is positive.

- Because of the budget constraint it follows that

$$\frac{\partial I_2^A}{\partial \gamma} > 0 \quad \text{if} \quad \frac{\partial I_1^A}{\partial \gamma} < 0$$

- The effects are offsetting.
- This is an analysis for allocation of investment *within* the life cycle of child A.

Stage 2
The Effects on Productivity: Allocation Between A and B

- Let λ_A be the productivity of expenditure on A.
- λ_B is defined analogously for B.
- If, as $\gamma \uparrow$, $\lambda_A \uparrow$, it is optimal to allocate to $A (E_A \uparrow)$.
- If $\lambda_A \downarrow$ it is optimal to allocate less to A ($E_A \downarrow$).
- The sign of this relationship hinges on the sign of Term 1 as we now show.

$$\frac{\partial \lambda_A}{\partial \gamma} = \frac{\begin{vmatrix} c & d & (-\text{Term} \;\; 1) \\ d & e & (-\text{Term} \;\; 2) \\ -p_1 & -p_2 & 0 \end{vmatrix}}{|M|} \theta_1^B$$

THE UNIVERSITY OF CHICAGO

- Collecting terms and using the first order conditions (53), using

$$p_1 = \frac{1}{\lambda} f_1^{(2)} f_2^{(1)} \quad \text{and} \quad p_2 = \frac{1}{\lambda} f_2^{(2)}$$

$$\frac{\partial \lambda_A}{\partial \gamma} = \underbrace{\frac{\theta_1^B}{\lambda} \frac{1}{|M|}}_{(+)} \left[\underbrace{(\text{Term } 1)}_{(?)} \underbrace{[f_2^{(2)} d - f_1^{(2)} f_2^{(1)} e]}_{\substack{Q_1 \\ (+)}} - \underbrace{\underbrace{(\text{Term } 2)}_{(+)} \underbrace{[f_2^{(2)} c - d f_1^{(2)} f_2^{(1)}]}_{\substack{Q_2 \\ (-)}}}_{+} \right],$$

- Remember: $d > 0$; $e < 0$; $c < 0$

$$Q_1 = f_2^{(1)} \left[f_2^{(2)} f_{12}^{(2)} - f_1^{(2)} f_{22}^{(2)} \right] > 0$$

- and

$$Q_2 = f_2^{(2)} f_{11}^{(2)} [f_2^{(1)}]^2 + f_2^{(2)} f_1^{(2)} f_{22}^{(1)} - f_{12}^{(2)} f_2^{(1)} f_1^{(2)} f_2^{(1)} < 0.$$

- Thus

$$\frac{\partial \lambda}{\partial \gamma} = \frac{\theta_1^B}{\lambda} \frac{1}{|M|} \left[\underset{?}{(\text{Term}} \; 1)\underset{(+)}{(Q_1)} + \underset{(+)}{(\text{Term}} \; 2)\underset{(+)}{Q_2} \right].$$

- So if Term 1 $(+)$, then $\frac{\partial \lambda_A}{\partial \gamma} > 0$.
- This is a sufficient condition.
- In this case, as $\gamma \uparrow$ it is efficient to allocate *more* to $A (E_A \uparrow)$.

- If Term 1 is sufficiently negative, it is optimal to allocate *less* to $A(E_A) \downarrow$.
- Recall that a sufficient condition for Term 1 to be negative is that $f_{21}^{(1)} < 0$.
- But even if $f_{21}^{(1)} > 0$, if there is sufficiently strong diminishing returns in $\theta_1 (f_{11}^2 < 0)$, the optimal response of an increase in γ is to reduce I_1^A (i.e. to favor the disadvantaged child).

Stage 3:
Allocation of Changes in Endowments over Periods

- From standard results in consumer theory,

$$\frac{\partial I_1^A}{\partial E_A} = \frac{(-1)}{|M|} \begin{vmatrix} d & -p_1 \\ e & -p_2 \end{vmatrix} = \frac{dp_2 - p_1 e}{|M|} = \frac{(f_2^{(1)})}{\lambda |M|} \left[f_{12}^{(2)} f_2^{(2)} - f_1^{(2)} f_{22}^{(2)} \right] \geq 0$$

- $d > 0$, $e < 0$
- Recall we assume $f_{12}^{(2)} > 0$
- From concavity it follows that $f_{22}^{(2)} < 0$.
- Thus $\frac{\partial I_1^A}{\partial E_A} > 0$.

$$\frac{\partial I_2^A}{\partial E_A} = \frac{\begin{vmatrix} c & -p_1 \\ d & -p_2 \end{vmatrix}}{|M|} = \underbrace{\frac{1}{\lambda|M|}}_{(+)} \left\{ \left(f_2^{(1)}\right)^{(2)} f_1^{(2)} f_{12}^{(2)} - (f_2^{(2)})[f_{11}^{(2)}\left(f_2^{(1)}\right)^{(2)} + f_1^{(2)} f_{22}^{(1)}] \right\}$$

- This expression is also positive.
- Thus inputs are normal under our assumptions.
- For the case $p_1 = p_2 = 1$ (which we can assume with no loss of generality)

$$\frac{\partial I_1^A}{\partial E_A} = \frac{f_{12}^{(2)} f_2^{(1)} - f_{22}^{(2)}}{|M|}$$

$$\frac{\partial I_2^A}{\partial E_A} = \frac{f_{11}^{(2)} \left(f_2^{(1)}\right)^2 - f_1^{(2)} f_{22}^{(1)} + f_{12}^{(2)} f_2^{(1)}}{|M|}.$$

- Observe that $\frac{\partial I_1^A}{\partial E_A}$ is larger
  (a) the greater the second period complementarity $(f_{12}^{(2)})$ (so that I_1^A has greater productivity in producing final output θ_3^A),
  (b) the larger $f_2^{(1)}(= \frac{\partial \theta_2^A}{\partial I_1^A})$ (so that I_1^A is more productive in producing the intermediate product θ_2^A);
  (c) the more rapidly the decline in the productivity of I_2^A.
- Intuitively, relatively more is allocated to first period investment the more productive is the first period investment.

Putting it All Together

- The second step is the key one.
- It determines the allocation of expenditure across children in response to an increase in endowment ($\gamma \uparrow$).
- The greater the decline in self productivity with increases in θ_1 (the more negative $f_{11}^{(2)}$), the more likely it is that more resources are devoted to the less advantaged child.
- This negative effect is amplified by greater productivity of θ_1 in period 1 ($f_1^{(1)}$) and greater productivity of I_1 in period 1.

- These effects are reinforced if there is substitutability between θ_1 and $I_1 (f_{21}^{(1)} < 0)$.
- If $f_{21}^{(1)}$ is positive, the redistributive effect is attenuated.
- This offsetting effect is weaker the smaller the productivity of θ_2 in period 2 production.

- The first step explores substitution effects arising from the change in γ.
- The third step explores income effects across periods arising from transfers across children.
- The other steps determine the allocation of investment across periods for each child.
- The analysis of the third step for each child informs us that resources are differentially allocated to the more productive period.
- The analysis of the first step makes a similar claim but investigates how changes in γ affect the relative productivity of investment in each period.

- In Section 746 below, we establish that if first period investment (I_1) and initial endowment (θ_1) are substitutes, ($f_{12}^{(1)} < 0$), but θ_2 is complementary with second period investments ($f_{12}^{(2)} > 0$), first period investments are greater for the more disadvantaged child.

- But even if $(f^{(1)}_{12} > 0)$, greater first period investment in the initially disadvantaged child may be optimal.
- This is more likely (ceteris paribus)

(a) the more steeply diminishing is the productivity of second period skills ($f_{22}^{(2)}$);
(b) the greater the self productivity of the stock of skills in the first period ($f_1^{(1)} = \frac{\partial \theta^2}{\partial \theta_1}$);
(c) the smaller first period complementarity ($f_{21}^{(1)}$) relative to second period complementarity and absolutely
(d) the more rapidly diminishing the marginal productivity of $\theta_1 (f_{11}^{(1)})$;
(e) the greater the second period complementarity ($f_{12}^{(2)}$);
(f) the greater the first period productivity of investment ($f_2^{(1)}$) and
(g) the more rapidly diminishing the productivity of second period investment ($f_{22}^{(2)}$).

- 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.

Appendix

- Direct proofs of some additional propositions

Proof that $f_{12}^{(1)} < 0$ is sufficient for $\frac{\partial I_A^1}{\partial \gamma} < 0$.

- Consider the bordered Hessian displacement system associated for the problem for both children treated together:

$$\begin{bmatrix} c & d & 0 & 0 & -p_1 \\ d & e & 0 & 0 & -p_2 \\ 0 & 0 & c & d & -p_1 \\ 0 & 0 & d & e & -p_2 \\ -p_1 & -p_2 & -p_1 & -p_2 & 0 \end{bmatrix} \begin{bmatrix} dI_1^A \\ dI_2^A \\ dI_1^B \\ dI_2^B \\ d\lambda \end{bmatrix} = \begin{bmatrix} \lambda dp_1 - \theta_A^1(\text{Term } 1)d\gamma \\ \lambda dp_2 - \theta_1^B(\text{Term } 2)d\gamma \\ \lambda dp_1 \\ \lambda dp_2 \\ -dE + \sum\limits_{\substack{j\in\{A,B\} \\ l\in\{1,2\}}} I_l^j dp_l \end{bmatrix} \tag{55}$$

- where as before

$$c = \left[f_{11}^{(2)} [f_2^{(1)}]^2 + f_1^{(2)} f_{22}^{(1)} \right] \leq 0$$

- if period 2 production is concave in θ_2 and period 1 production is concave in I_1.
- But it might also arise if period 1 production is convex in θ_2.

$$d = f_{12}^{(2)} f_2^{(1)} > 0 \quad \text{if there is second period complementarity}$$

$$e = f_{22}^{(2)} < 0 \quad \text{from concavity in } I_2.$$

- Recall that

$$T_1 \equiv \text{Term 1} \equiv \left[f_{11}^{(2)} f_1^{(1)} f_2^{(1)} + f_1^{(2)} f_{21}^{(1)} \right]$$

- may be of either sign.

- The second grouping of terms in Term 1 is positive under complementarity in the first period; negative under substitutability.
- The first grouping is negative under concavity of $f^{(2)}$ in θ_2 (but it might be positive if there are increasing returns).
- Under second period complementarity ($f_{21}^{(2)} > 0$)

$$T_2 \equiv \text{Term } 2 = \left[f_{21}^{(2)} f_1^{(1)} \right] \geq 0.$$

- Let H be the bordered Hessian associated with displacement system (55) and let $|H|$ be the determinant of the Hessian.
- $|H| > 0$ under the assumption of a regular optimum.

- Then the income-compensated effect of a change in p_2^A on I_1^A is

$$\frac{\partial I_1^A}{\partial p_2^A} = \lambda \begin{vmatrix} d & 0 & 0 & -p_1 \\ 0 & c & d & -p_1 \\ 0 & d & e & -p_2 \\ 0 & -p_1 & -p_2 & 0 \end{vmatrix} / |H|$$

$$= \lambda d \underbrace{\begin{vmatrix} c & d & -p_1 \\ d & e & -p_2 \\ -p_1 & -p_2 & 0 \end{vmatrix}}_{<0} / |H|. \tag{56}$$

THE UNIVERSITY OF CHICAGO

- The numerator of (56) is negative from the sufficiency conditions for an optimum for the two stage budgeting problem for A and from second period dynamic complementarity $(d > 0)$.

- Hence both inputs are Hicks-compensated cross substitutes:

$$\frac{\partial I_1^A}{\partial p_2^A} \quad < 0.$$

- and from symmetry

$$\frac{\partial I_1^A}{\partial p_2^A} = \frac{\partial I_2^A}{\partial p_1^A} \quad < 0.$$

- Collecting results,

$$\text{let} \quad S_{ij} = \frac{\partial I_i^A}{\partial p_j^A} \qquad i,j \in \{1,2\}$$

$$\frac{\partial I_1^A}{\partial \gamma} = -\left\{ \underset{(-)}{[S_{11}]}\underset{(?)}{[\text{Term 1}]} + \underset{(-)}{[S_{12}]}\underset{(+)}{[\text{Term 2}]} \right\} d\gamma \tag{57}$$

$$\frac{\partial I_2^A}{\partial \gamma} = -\left\{ \underset{(-)}{[S_{12}]}\underset{(?)}{[\text{Term 1}]} + \underset{(-)}{[S_{22}]}\underset{(+)}{[\text{Term 2}]} \right\} d\gamma. \tag{58}$$

- If Term 1 is sufficiently negative, which could happen even if $f_{21}^{(1)}(\cdot) > 0$, then

$$\frac{\partial I_1^A}{\partial \gamma} < 0.$$

- (Term 1 would be negative if $f_{21}^{(1)} < 0$) and possibly even

$$\frac{\partial I_2^A}{\partial \gamma} < 0.$$

- Term 1 positive $\Rightarrow \frac{\partial I_1^A}{\partial \gamma} > 0$ and $\frac{\partial I_1^B}{\partial \gamma} < 0$.
- Thus it may be efficient to allocate more to the less endowed, even in both periods.

- We can say something stronger.
- If $f_{12}^{(1)} < 0$, but $f_{12}^{(2)} > 0$, then as $\gamma \uparrow$, $I_A \downarrow$ and the term in braces in (57) is positive.
- To prove this define $T_1 = \text{Term 1}$ and $T_2 = \text{Term 2}$ and notice that

$$\frac{\partial I_1^A}{\partial \gamma} = \frac{\begin{vmatrix} -T_1\theta_1^B & d & 0 & 0 & -p_1 \\ -T_2\theta_1^B & e & 0 & 0 & -p_2 \\ 0 & 0 & c & d & -p_1 \\ 0 & 0 & d & e & -p_2 \\ 0 & -p_2 & -p_1 & -p_2 & 0 \end{vmatrix}}{} = \frac{|N|}{|H|}\theta_1^B,$$

$$\underbrace{|H|}_{(+)}$$

where

$$|N| = \left\{ -T_1 e \underbrace{\begin{vmatrix} c & d & -p_1 \\ d & e & -p_2 \\ -p_2 & -p_2 & 0 \end{vmatrix}}_{|M|>0} - T_1 p_2 \begin{vmatrix} 0 & 0 & -p_2 \\ c & d & -p_1 \\ d & e & -p_2 \end{vmatrix} \right.$$

$$\left. + \; T_2 d \underbrace{\begin{vmatrix} c & d & -p_1 \\ d & e & -p_2 \\ -p_1 & -p_2 & 0 \end{vmatrix}}_{|M|>0} + T_2 p_2 \begin{vmatrix} 0 & 0 & -p_1 \\ c & d & -p_1 \\ d & e & -p_2 \end{vmatrix} \right\} \theta_1^B$$

$$|N| = \left[(-T_1 e + T_2 d)|m| - \underbrace{\underset{(?)}{(T_1)}\,\underset{(+)}{p_2}\,\underset{(-)}{(-p_2)}\underset{(+)}{\begin{vmatrix} c & d \\ d & e \end{vmatrix}}}_{-\text{if } (T_1)<0} + \underbrace{\underset{(+)}{T_2}\,\underset{(+)}{p_2}\,\underset{(-)}{(-p_1)}\underset{(+)}{\begin{vmatrix} c & d \\ d & e \end{vmatrix}}}_{(-)} \right] \theta_1^B$$

- Thus it follows as a sufficient condition that

$$|N| < 0 \text{ if } \left[(-T_1 e + T_2 d) < 0 \right].$$

- Writing out $(-T_1 e + T_2 d)$,

$$(-T_1 e + T_2 d) = -f_{11}^{(2)} f_1^{(1)} f_2^{(1)} f_{22}^{(2)} - f_1^{(2)} f_{21}^{(1)} f_{22}^{(2)} + f_{21}^{(2)} f_1^{(1)} f_{12}^{(2)} f_2^{(1)},$$

- and collecting the first and the last terms:

$$\underbrace{-\underbrace{f_1^{(1)} f_2^{(1)}}_{(+)} \underbrace{\left[f_{11}^{(2)} f_{22}^{(2)} - [f_{12}^{(2)}] \right]}_{(+) \text{ by concavity}}}_{(-)} - \underbrace{\underset{(+)}{f_1^{(2)}} \underset{(?)}{f_{21}^{(1)}} \underset{(-)}{f_{22}^{(2)}}}_{(-) \text{ if } f_{21}^{(1)} < 0} \tag{59}$$

- so

$$(-T_1 e + T_2 d) < 0 \quad \text{if} \quad f_{21}^{(1)} < 0,$$

- and hence

$$|N| < 0 \quad \text{if} \quad f_{21}^{(1)} < 0,$$

- so

$$\frac{\partial I_1^A}{\partial \gamma} < 0 \quad \text{if} \quad f_{21}^{(1)} < 0.$$

- Notice, however, that even if $f_{21}^{(1)}(\cdot) > 0$, it is possible that

$$\frac{\partial I_1^A}{\partial \gamma} < 0.$$

- (See the second term in equation (59).)
- Notice that the more negative $f_{22}^{(2)}$ (i.e., the more sharply are the diminishing returns to I_2^A in period 2), the more negative is $\frac{\partial I_1^A}{\partial \gamma}$.

- The intuition for this offsetting effect is that as second period investments become less effective, then it is more productive to invest relatively more in the first period.
- Concavity in terms of θ_2 is not strictly required.

- Next consider

$$\frac{\partial I_2^A}{\partial \gamma} =$$

$$\frac{\begin{vmatrix} c & -T_1\theta_1^B & 0 & 0 & -p_1 \\ d & -T_2\theta_1^B & 0 & 0 & -p_2 \\ 0 & 0 & c & d & -p_1 \\ 0 & 0 & d & e & -p_2 \\ -p_1 & 0 & -p_1 & -p_2 & 0 \end{vmatrix}}{|H|}$$

$$= \frac{\tilde{N}}{|H|}\theta_1^B$$

$$\tilde{N} = T_1 \begin{vmatrix} d & 0 & 0 & -p_2 \\ 0 & c & d & -p_1 \\ 0 & d & e & -p_2 \\ -p_1 & -p_1 & -p_2 & 0 \end{vmatrix}$$

$$- T_2 \begin{vmatrix} c & 0 & 0 & -p_1 \\ 0 & c & d & -p_1 \\ 0 & d & e & -p_2 \\ -p_1 & -p_1 & -p_2 & 0 \end{vmatrix}$$

$$= T_1 \left[d \begin{vmatrix} c & d & -p_1 \\ d & e & -p_2 \\ -p_1 & -p_2 & 0 \end{vmatrix} + p_1 \begin{vmatrix} 0 & 0 & -p_2 \\ c & d & -p_1 \\ d & e & -p_2 \end{vmatrix} \right]$$

$$-T_2 \left[c \begin{vmatrix} c & d & -p_1 \\ d & e & -p_2 \\ -p_1 & -p_2 & 0 \end{vmatrix} + p_1 \begin{vmatrix} 0 & 0 & -p_1 \\ c & d & -p_1 \\ d & e & -p_2 \end{vmatrix} \right]$$

$$
= (T_1 d - T_2 c) \underset{(+)}{\begin{vmatrix} c & d & -p_1 \\ d & e & -p_2 \\ -p_1 & -p_2 & 0 \end{vmatrix}}
$$

$$
- \underbrace{T_1 p_1 p_2}_{(-)\text{ if } T_1 < 0} \underset{(+)}{\begin{vmatrix} c & d \\ d & e \end{vmatrix}} + T_2 \underset{(+)}{(p_1)^2} \underset{(+)}{\begin{vmatrix} c & d \\ d & e \end{vmatrix}}
$$

- Focus on the term $(T_1 d - T_2 c)$

$$= (\underset{(-)}{T_1}\underset{(+)}{d} - \underset{(+)}{T_2}\underset{(-)}{c})\underset{(+)}{\begin{vmatrix} c & d & -p_1 \\ d & e & -p_2 \\ -p_1 & -p_2 & 0 \end{vmatrix}} - (\underset{(-)}{T_1}\underset{(+)}{p_1 p_2} - \underset{+}{T_2}\underset{+}{p_1^2})\underset{(+)}{\begin{vmatrix} c & d \\ d & e \end{vmatrix}}$$

- Observe that

$$
\begin{aligned}
(T_1 d - T_2 c) = & \left[f_{11}^{(2)} f_1^{(1)} f_2^{(1)} + f_{12}^{(1)} f_1^2 \right] f_{12}^{(2)} f_2^{(1)} \\
& - f_{21}^{(2)} f_1^{(1)} \left[f_{11}^{(2)} \left(f_2^{(1)} \right)^2 + f_1^{(2)} f_{22}^{(1)} \right]
\end{aligned}
$$

$$
\begin{aligned}
&= \cancel{f_{11}^{(2)} f_1^{(1)} f_2^{(1)} f_{12}^{(2)} f_2^{(1)}} \\
&\quad + f_{12}^{(1)} f_1^{(2)} f_{12}^{(2)} f_2^{(1)} \\
&\quad \cancel{- f_{21}^{(2)} f_1^{(1)} f_{11}^{(2)} \left(f_2^{(1)} \right)^2} \\
&\quad - f_{21}^{(2)} f_1^{(1)} f_1^{(2)} f_{12}^{(1)} \\
&= f_{12}^{(2)} \underset{(+)}{f_1^{(2)}} \underbrace{\left[f_{12}^{(1)} f_2^{(1)} - f_1^{(1)} f_{22}^{(1)} \right]}_{T_3}
\end{aligned}
$$

- and the last term is positive ($T_3 > 0$), if in the period 1 production function $f_{12}^{(1)} > 0$ (first period complementarity).

- This is a sufficient condition for

$$\frac{\partial I_2^A}{\partial \gamma} > 0.$$

- Notice that when Term 1 (T_1) is negative, then T_3 can be negative.[2]
- Thus, it is possible that the efficient policy redistributes to the less endowed in period 1 but to the more endowed in period 2.

- It is also possible that as $\gamma \uparrow$, it is socially efficient to invest in the disadvantaged child in both periods, although this seems unlikely.
- In general, it is not efficient to make the initially disadvantaged child whole by the start of the second period, and second period complementarity reinforces starting of second period discrepancies.

Return to Slide 146

Appendix D.8: Some Evidence from Simulations on Why Dynamic Complementarity is a Force Toward Targeting Disadvantaged Children in the Early Years

- Dynamic complementarity is a force toward equalization of early stage investments even in the absence of family inequality aversion.
- To illustrate the mechanism underlying this claim, suppose that, for each child k, the outcome of interest for parents are children's earnings E_k and that they are a function of children's adult human capital determined by "genes" $(\theta_{1,k})$ and early $(I_{1,k})$ and late $(I_{2,k})$ parental investments.

$$E_k = wf^2(\theta_{2,k}, I_{2,k}) = \ f^2 \left(\gamma_2 \theta_{2,k}^{\phi_2} + (1 - \gamma_2) I_{2,k}^{\phi_2} \right)^{\frac{\rho_2}{\phi_2}} \qquad (60)$$

with

$$\theta_{2,k} = f^1(\theta_{1,k}, I_{1,k}) = \ f^1 \left(\gamma_1 \theta_{1,k}^{\phi_1} + (1 - \gamma_1) I_{1,k}^{\phi_1} \right)^{\frac{\rho_1}{\phi_1}} \qquad (61)$$

- Where w is the payment to skill corresponding to one unit of human capital which is determined by equilibrium in the factor markets.
- Since w is common across families and siblings we assume that the measurement of human capital is chosen so that $w = 1$.

- The budget constraint faced by the parents with total resources R^e is:

$$p_1 \sum_{k=1}^{n} I_1 + p_2 \sum_{k=1}^{n} I_2 = R^e. \tag{62}$$

- Consider the case of a parent with two children i and j.
- We show that even in the absence of inequality aversion, the shape of the technology, and in particular the presence of decreasing returns in at least one of the two periods, might induce parents to follow a compensating strategy devoting more resources to the less endowed child, say j $(\theta_{1,i} > \theta_{1,j})$.

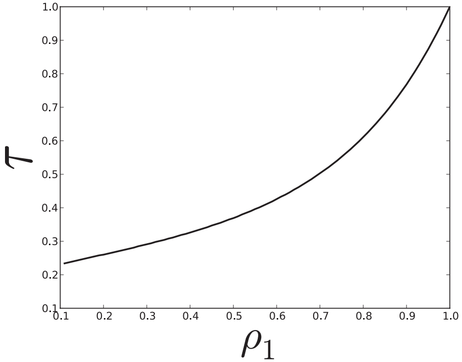
THE UNIVERSITY OF CHICAGO

- As a measure of parental compensation with respect to initial inequality we define the parameter τ as:

$$\tau \equiv \left(\frac{E_i}{E_j}\right) \Big/ \left(\frac{\theta_i}{\theta_j}\right), \tag{63}$$

- Which captures how much earnings differences are inflated compared to initial endowment differences.
- If $\tau = 1$, the parents perfectly translate "genetic" differences into earnings.
- In results from a simulation exercise, Figure 302 shows that earnings differences are dampened compared to differences in initial endowments whenever $\rho_1 < 1$.

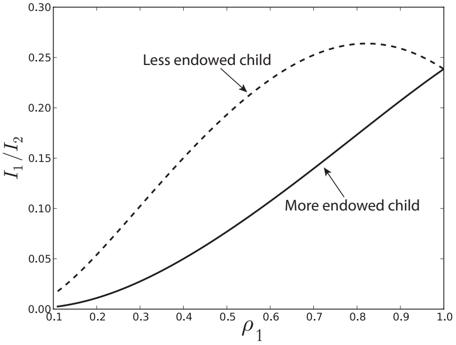
Figure 302: Earnings Equalization



Notes: The parental preference parameters used in the simulation are $\sigma = 1$ and $\omega_i = \omega_j = 0.5$. Total resources are $R^e = 4$. The technology of skill formation parameters, capturing increasing complementarity between skills and investments over time, are: $\gamma_1 = \gamma_2 = 0.5$, $\phi_1 = 0.6$, $\phi_2 = -0.5$, $\rho_2 = 1$. The parameter ρ_1 defines the degree of homogeneity of the first period technology. We vary the value of ρ_1 over the range $[0.1, 1]$. Child i has a skill endowment of 5 while child j of 1.

- We also consider the how changes in ρ_1 affect parental behavior in Figures 303, 304, and 305.
- Figure 303 shows the ratio of early (I_1) to late (I_2) investments.

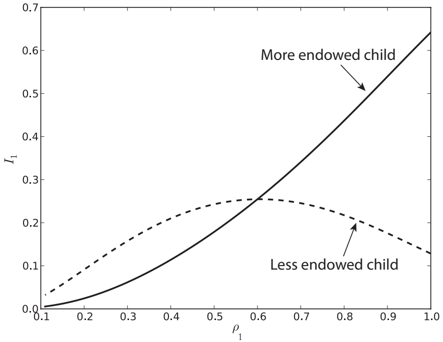
Figure 303: Ratio Early to Late Investments



Notes: The solid line refers to the most endowed child, the dashed line to the least endowed chid. The parameters used are as in Figure 302.

- This ratio is always higher for the less endowed child j whenever ρ_1 is smaller than one.
- Figure 304 shows that the *less* endowed child receives a *higher* amount of early investment whenever the period 1 technology exhibits substitutability between skills (initial endowments) and investments (i.e. when $\rho_1 < \phi_1$).

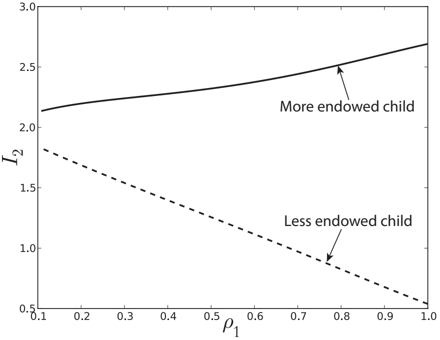
Figure 304: Levels of Early Investments



Notes: The solid line refers to the most endowed child, the dashed line to the least endowed chid. The parameters used are as in Figure 302.

- Figure 305 shows that the most endowed child always receives a higher level of late investment.

Figure 305: Levels of Late Investments



Notes: The solid line refers to the most endowed child, the dashed line to the least endowed chid. The parameters used are as in Figure 302.

- Late investments are an increasing function of ρ_1 for the more endowed child while they are decreasing in ρ_1 for the less endowed child.
- As ρ_1 decreases the less endowed child receives a higher level of early investments and a level of late investments which is increasingly closer to the one of his more endowed brother.
- This explains why earnings tend to be equalized as ρ_1 decreases.

- We conclude that if the technology of skill formation is defined over more than one period, parents might exhibit compensating behavior in investments in children's human capital even in absence of inequality aversion.
- In particular, less endowed children receive a higher level of early investment than their more endowed siblings if the technology of skill formation exhibits substitutability between initial (genetic) endowments and the level of early investments.

Return to Slide 152

Appendix K.1: Overview of Structural Models of Parental Investments

Table 58: Structural Models of Parental Investments ("✓" means present; "X" means absent)

	OLG Model	Dynastic Links	Explicit Models of Parental Preferences, Altruism (A) or Paternalism (P)	Model Estimated
Cunha and Heckman (2007)	✓	A,B,C,	✓^{i}(A)	X
Cunha (2007)	✓	A,B,C	✓^{i}(A)	✓
Caucutt and Lochner (2012)	✓	B,C	✓$^{\mathrm{i}}$ (A)	✓
Del Boca et al. (2013)	X	X	✓$^{\mathrm{j}}$(P)	✓
Gayle et al. (2013)	✓	A,C	✓$^{\mathrm{j}}$(P)	✓
Cunha et al. (2013)	X	X	✓$^{\mathrm{j}}$(P)	✓
Bernal (2008)	X	X	✓$^{\mathrm{j}}$(P)	✓

[A]Through parental skills, [B]Through asset transfers, [C]Only through genes (initial conditions), [D]Natural borrowing limit, [E]Limits can be more stringent than natural limit.

Table 58: Structural Models of Parental Investments ("✓" means present; "X" means absent)

	Parental Goods Investment	Parental Time Investment	Technology Depends on Parental Skill	Self-productivity
Cunha and Heckman (2007)	✓	X	✓	✓
Cunha (2007)	✓	X	✓	✓
Caucutt and Lochner (2012)	✓	X	X	✓
Del Boca et al. (2013)	✓	✓	X	✓
Gayle et al. (2013)	✓	✓	✓	X
Cunha et al. (2013)	✓	X	✓	✓
Bernal (2008)	✓	✓	✓	✓

[A] Through parental skills, [B] Through asset transfers, [C] Only through genes (initial conditions), [D] Natural borrowing limit, [E] Limits can be more stringent than natural limit.

Table 58: Structural Models of Parental Investments ("✓" means present; "X" means absent)

	Parental Learning About Technology	Bequests	Intragenerational Borrowing	Multiple Skills of Children
Cunha and Heckman (2007)	X	✓	✓[E]	X
Cunha (2007)	X	✓	✓[D]	X
Caucutt and Lochner (2012)	X	X	✓[E]	X
Del Boca et al. (2013)	X	X	X	X
Gayle et al. (2013)	X	X	X	X
Cunha et al. (2013)	✓	X	X	X
Bernal (2008)	X	X	X	X

[A]Through parental skills, [B]Through asset transfers, [C]Only through genes (initial conditions), [D]Natural borrowing limit, [E]Limits can be more stringent than natural limit.

Table 58: Structural Models of Parental Investment
("✓" means present; "X" means absent)

	Multichild Families (Preferences for Equity vs. Efficiency)	**Endogenous Fertility Decisions**	**Multiple Parents**	**Endogenous Mating Decisions**
Cunha and Heckman (2007)	X	X	X	X
Cunha (2007)	X	X	X	X
Caucutt and Lochner (2012)	X	X	X	X
Del Boca et al. (2013)	✓	X	✓	X
Gayle et al. (2013)	✓	✓	✓	✓
Cunha et al. (2013)	X	X	X	X
Bernal (2008)	X	X	X	X

[A]Through parental skills, [B]Through asset transfers, [C]Only through genes (initial conditions), [D]Natural borrowing limit, [E]Limits can be more stringent than natural limit.

Return to Slide 99

Return to Slide 131

Credit Constraints, Uncertainty & Misperceptions Causes of Intergenerational Mobility:

Caucutt & Lochner (2012) on Credit Constraints

Motivation

- In a credit market that is perfect across generations, so that the child's adult earnings can be borrowed against, family earnings have no effect on child's adult earnings.
- But there is some evidence that an exogenous shift in parental earnings affects child development.
- The evidence is quite weak; see the survey by Heckman and Mosso (2014).
- Using a somewhat general household model, Caucutt & Lochner derive the implied relationships between parental earnings and child outcomes in human capital and earnings.

- An especially interesting feature of the model is that credit constraints binding in early childhood affect child outcomes differently than credit constraints binding in later childhood.
- This presentation explains their model and analysis, making a few simplifications along the way because our focus is on child development rather than adulthood.

General Model and Notation

- Three time periods: early childhood ($t = 1$), late childhood ($t = 2$), adulthood ($t = 3$).
- The paper allows multiple adulthood periods; adds little.
- Human capital h determined endogenously as:
- $h_3 = f(i_1, i_2)$.
- i_t denotes child investment decision.

- Earnings y determined as:
- Earlier childhood income: y_1 (exogenous, due to parents).
- Later childhood income: y_2 (exogenous, due to parents).
- Adulthood income: $y_3 = Ra_3 + h_3$ (endogenous).

- Savings/borrowing a satisfies:
- Early childhood borrowing: $a_2 \geq -L_1$.
- Late childhood borrowing: $a_3 \geq -L_2$.
- Given: gross interest rate R, borrowing constraints L_t.
- Agent's life-cycle problem: Subject to constraints above,

$$\max_{a_2,a_3,i_1,i_2,c_1,c_2} u(c_1) + \beta u(c_2) + \beta^2 u(y_3) : \quad \begin{array}{c} y_1 = a_2 + i_1 + c_1 \\ y_2 + Ra_2 = a_3 + i_2 + c_2 \end{array},$$

Optimality Conditions in General Model

- The FOC's for investment are,

$$[i_1]\ u'(c_1) = \beta^2 u'(y_3) f_1(i_1, i_2)$$
$$[i_2]\ u'(c_2) = \beta u'(y_3) f_2(i_1, i_2)$$

- Marginal consumption utility equals marginal investment utility in present value.
- The FOC's for assets are,

$$[a_2]\ u'(c_1) \geq \beta R u'(c_2)$$
$$[a_3]\ u'(c_2) \geq \beta R u'(y_3)$$

- Marginal consumption utility is at least as great as the payoff to savings in present value (equal if constraint does not bind).
- Euler equation ("MRS equals TRS"):

$$R \leq \frac{u'(c_1)}{\beta u'(c_2)} = \frac{f_1(i_1, i_2)}{f_2(i_1, i_2)}$$

Case: No Constraints Bind, No Role for Family Income

- This is a key result from Becker & Tomes (1986).
- The four FOC's reduce to two equations in two unknowns,

$$R^2 = \beta f_1(i_1, i_2)$$
$$R = \beta f_2(i_1, i_2)$$

- so optimal investment is not a function of parental income (absence of y_1 and y_2 in these equations).

- Intuition:
- Each child borrows until the marginal return to investment equals the marginal cost of investment.
- The marginal cost is independent of parental income (it's R^2 in $t = 1$ and R in $t = 2$), so the marginal benefit must also be independent of parental income.
- Since marginal benefit depends only on the technology f (and discount β), and f does not vary with parental income, optimal investment cannot vary with parental income.
- However, borrowing amount depends on parental income.

Case: Child Investment and Intergenerational Mobility when Only the Early Childhood Constraint Binds

- Suppose that parents cannot borrow optimally in early childhood.
- Then, $a_2 = -L_1$ and the agent's problem simplifies to,

$$\max_{i_1, i_2, a_3} u\left(y_1 + L_1 - i_1\right) + \beta u\left(y_2 - RL_1 - i_2 - a_3\right) + \beta^2 u\left(Ra_3 + f\left(i_1, i_2\right)\right)$$

THE UNIVERSITY OF CHICAGO

- where $c_1 = y_1 + L_1 - i_1$ and $c_2 = y_2 - RL_1 - i_2 - a_3$.
- Optimality conditions:

$$\frac{u'(c_1)}{u'(c_2)} = \beta \frac{f_1(i_1, i_2)}{f_2(i_1, i_2)}$$

$$\frac{u'(c_1)}{u'(c_2)} = \frac{\beta}{R} f_1(i_1, i_2)$$

$$u'(c_2) = \beta R u'(y_3)$$

Properties when Early Childhood Borrowing Binds

- Suppose $f_{12} > 0$ (investments are complementary over time), as found empirically; Cunha, Heckman, & Schennach (2010).
- Proposition 2 from Caucutt & Lochner (proofs are difficult):
  1. $\frac{\partial i_1}{\partial y_1} > 0$ and $\frac{\partial i_1}{\partial y_2} < 0$.
  2. $\frac{\partial i_2}{\partial y_1} > 0$ and $\frac{\partial i_2}{\partial y_2} < 0$.
  3. $\frac{\partial h_3}{\partial y_1} > 0$ and $\frac{\partial h_3}{\partial y_2} < 0$ (similarly for $y_3 = h_3$).

- It is unsurprising that investment rises in both periods when family income rises in the constrained period.
- However, it is shocking (only to me?) that if an early childhood constrained family becomes richer in later childhood, this harms the child!
- E.g., if poor families need to borrow more only in early childhood, the child experiences lower investment both early and late, and lower human capital and earnings in adulthood, if the family becomes richer when the child is older.

Case: Child Investment and Intergenerational Mobility when Constraints Bind in Both Early and Late Childhood

- The paper shows that the effect of y_1 on i_t equals R times the effect of y_2 on i_t if only the later constraint binds, $t = 1, 2$.
- If both early and late bind, then $a_2 = -L_1$ and $a_3 = -L_2$, and the agent's problem simplifies to,

$$\max_{i_1, i_2} u\left(y_1 + L_1 - i_1\right) + \beta u\left(y_2 - RL_1 - i_2 + L_2\right) + \beta^2 u\left(-RL_2 + f\left(i_1, i_2\right)\right)$$

THE UNIVERSITY OF CHICAGO

- where $c_1 = y_1 + L_1 - i_1$ and $c_2 = y_2 - RL_1 - i_2 - a_3$.
- Proposition 2 continued: if f_{12} is sufficiently positive, then:
  1. $\frac{\partial i_1}{\partial y_1} > 0$ and $\frac{\partial i_2}{\partial y_2} > 0$.
  2. $\frac{\partial i_1}{\partial y_2} > 0$ and $\frac{\partial i_2}{\partial y_1} > 0$.
  3. $\frac{\partial h_3}{\partial y_1} > 0$ and $\frac{\partial h_3}{\partial y_2} > 0$.
- so investment and child outcomes benefit from each income.

THE UNIVERSITY OF CHICAGO

Why the Model is Useful

- Distinguishes early from late childhood borrowing constraints, showing that they have different policy implications (e.g., late income hurts the child in an only early-constrained family).
- Relates parent earnings *across the life-cycle* (as opposed to total lifetime earnings as in the IGE literature) to child adult earnings via investment choices and borrowing constraints.
- Can explain marginal returns to investment that are too high in early childhood to be optimal, a phenomenon supported by some empirical evidence.

- If only poor are borrowing-constrained, the model predicts:
- Investment levels are lower in poor children.
- An income shock affects investment in poor children but not others, and the effect is large (relative to the interest rate).
- If some poor families have rising income profiles and only early constraint binds, these families are expected to invest less in early childhood.

Return to Slide 129