Inequality in Health

Lecture IX: Health, Human Capital and Skill Formation

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Outline

Recap of Last Lecture

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- Health and education: strong positive correlation, robust
  - ...over time
  - ...across countries
  - ... for any health outcome (SAH, mortality, obesity, etc).
- **Endogeneity problem** due to
  1. Reverse causation: health affects education.
  2. Omitted variables: time and risk preferneces, family background, etc.
- School reforms have been used to estimate the **causal effect** of education towards health.
- Fischer et al. (2021) evaluate two educational reforms that affected the **quantity** or both **quality and quantity** of education.
- Increasing quantity improves the longevity.
- Increasing classroom heterogeneity impacts quality and is associated with **worse health**.

Skills and Personality Traits

Health as Human Capital

- Recall from Dalgaard and Strulik (2014) and Grossman (1972): health production characterised by
  - Endowments
  - Investments
  - Dynamics and persistence
- The same features characterise the **production of skills** in children.
- A large body of literature studies process of **skill formation** – for **cognitive** and **non-cognitive skills**.
- Health is a critical resource in that process – and may be seen as an interdependent outcome.
- Hence, view health as human capital.

Health and Cognitive Ability

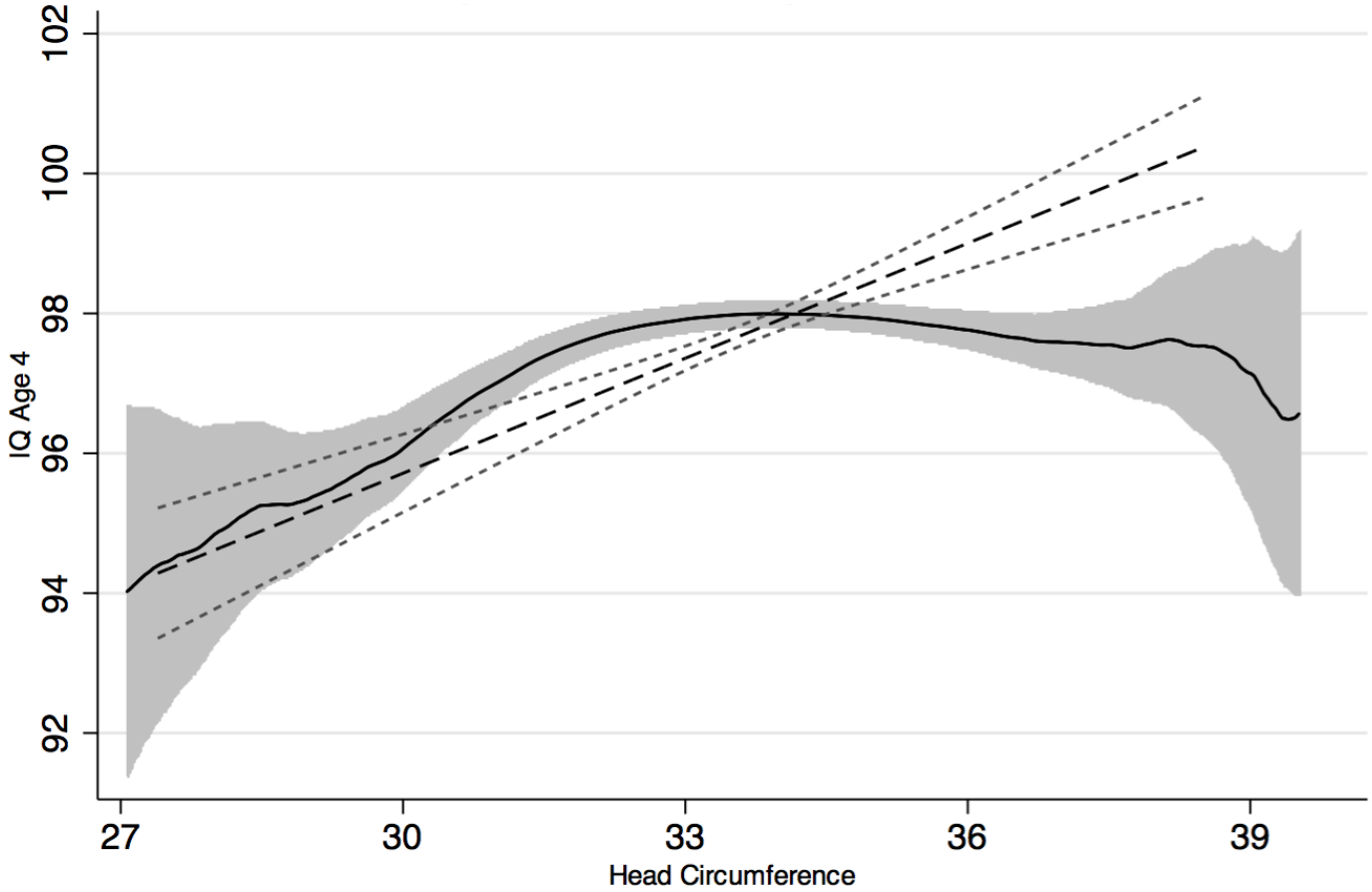

Figure 1. Head Circumference and IQ at Age 4.

Types of Skills

- Heckman, Cunha and coauthors developed a large body of literature on the **skill formation** process and the relevance of **early investments**.
- They distinguish between two types of skills, both relevant for subsequent lifetime achievement:
  - **Cognitive** abilities: measured for instance by IQ, test scores.
  - **Noncognitive**: personality and social and emotional traits, like motivation, perseverance, tenacity.
- They find that cognitive and noncognitive abilities have direct effects on **wages**, **schooling**, participation in **crime**.
- Additionally, noncognitive abilities also have a direct influence on **teenage pregnancy** and **smoking**.
- **Skills** are determined by parental environment and investments at different stages of childhood.

Non-Cognitive Skills

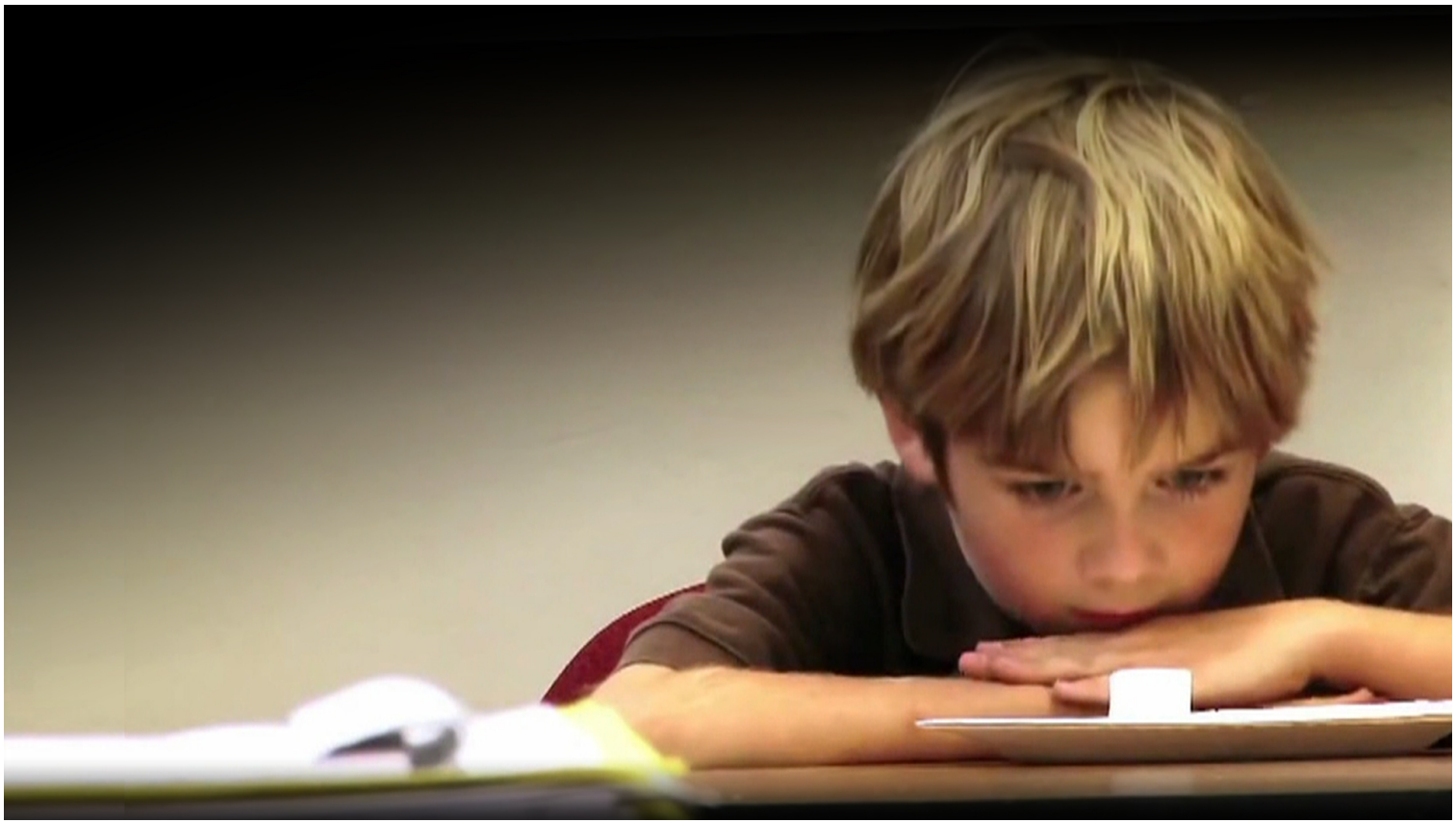

Figure 2. Self-Control.

Non-Cognitive Skills

- **Self-Efficacy**
  - Individual's belief that they have capacity to succeed at a particular task in the future.
  - Demonstrated effect on academic outcomes.
- **Engagement**
  - Participation, effort, persistence, concentration, affective reaction.
  - Related to improved school attendance.
- **Self-Control**
  - Impulsivity, temper, (lack of) persistence.
  - Linked to academic achievement and social functioning.
- **Meta-Cognitive Strategies**
  - Goal-oriented efforts to influence one's own learning behaviors and processes by focusing awareness on thinking and selecting, monitoring, and planning **strategies** that are most conducive to learning.
  - Strongly related to academic achievement.

Source: Gutman and Schoon (2016).

Big Five Personality Traits

O **Openness to Experience**.
- Appreciation for art, emotion, adventure, unusual ideas, curiosity.

C **Conscientiousness**.
- A tendency to be organized and dependable, show self-discipline, act dutifully, aim for achievement, and prefer planned behavior.

E **Extraversion**.
- Energy, positive emotions, surgency, assertiveness, sociability and the tendency to seek stimulation in the company of others.

A **Agreeableness**.
- A tendency to be compassionate and cooperative rather than suspicious and antagonistic towards others.

N **Neuroticism**.
- The tendency to experience unpleasant emotions easily, such as anger, anxiety, depression, and vulnerability.

- Big 5 clearly important determinants of choices in life and success.
- But very stable $\Rightarrow$ unsuited for interventions.

The Timing of Interventions

Why Invest in Disadvantaged Children?

- **Equity**: social justice.
- **Economic efficiency**: large returns to such investments.
- Which are the factors that influence the development of skills in young children?
- Many major economic and social problems can be traced to low levels of **skill and ability** in the population (Cunha and Heckman, 2010).
- Life cycle skill formation as a **dynamic process** in which inputs provided early in life greatly affect the productivity of later inputs.

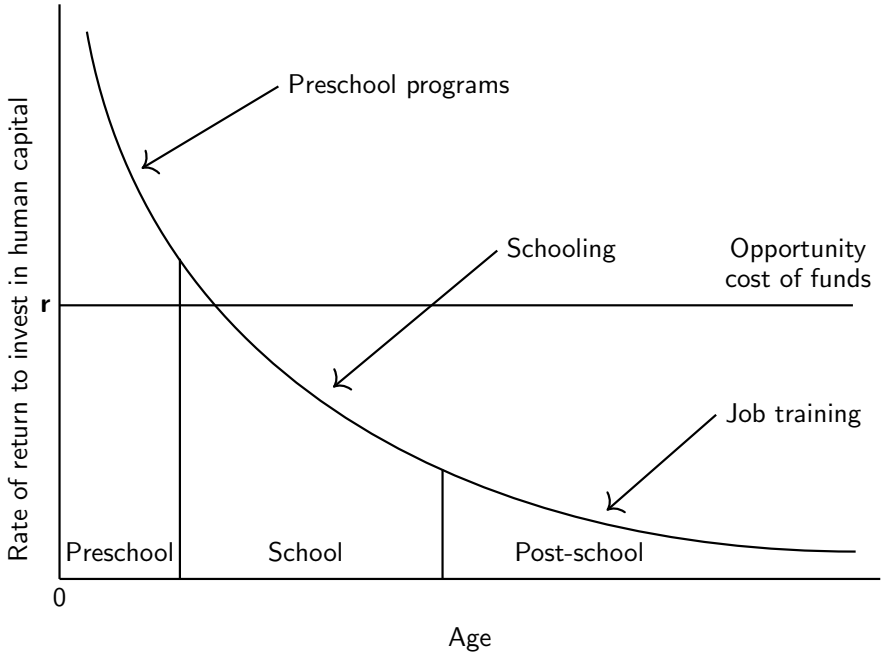

Figure 3. Rates of return to human capital investment (initial investment equal across all ages). Source: Heckman (2008).

When to Invest? The Timing of Interventions

- **Gaps** in **cognitive** ability across income groups emerge early in life; widen slightly in the early years of schooling, then they remain basically constant after the age of 8 (Cunha and Heckman, 2010).
- School environment accounts for these gaps just in a small part; moreover, schooling does not **change** such gaps to a large extent.
- Similar patterns characterize **noncognitive** skills. Gaps by family income appear early in life and persist.
- Therefore the **timing** of parental investments matters a lot.
- Remediation for disadvantaged early environments becomes progressively more **costly** the **later** it is attempted in the life cycle.

Modelling Skill Formation

Skill Formation: Key Features

1. **Self-productivity**:
   - Notion that skills/abilities acquired in one period raise the stock of skills that can be gained in the following periods (**self-reinforcement**).
   - Acquired skills are also **cross-fertilizing**, e.g. higher self-control (non-cognitive) fosters more effective learning of cognitive skills.
2. **Dynamic complementarities**:
   - Idea that skills/abilities acquired in one period influence the **productivity** of investments in subsequent periods.
   - The higher the stock of skills in the first period, the more productive future investments will be.
   - **Dynamicity**: skill begets skill, learning begets learning.
   - Also in the other direction: once a child falls behind, they are likely to remain behind: early failure begets later failure.

Source: Cunha and Heckman (2007).

The Production Model

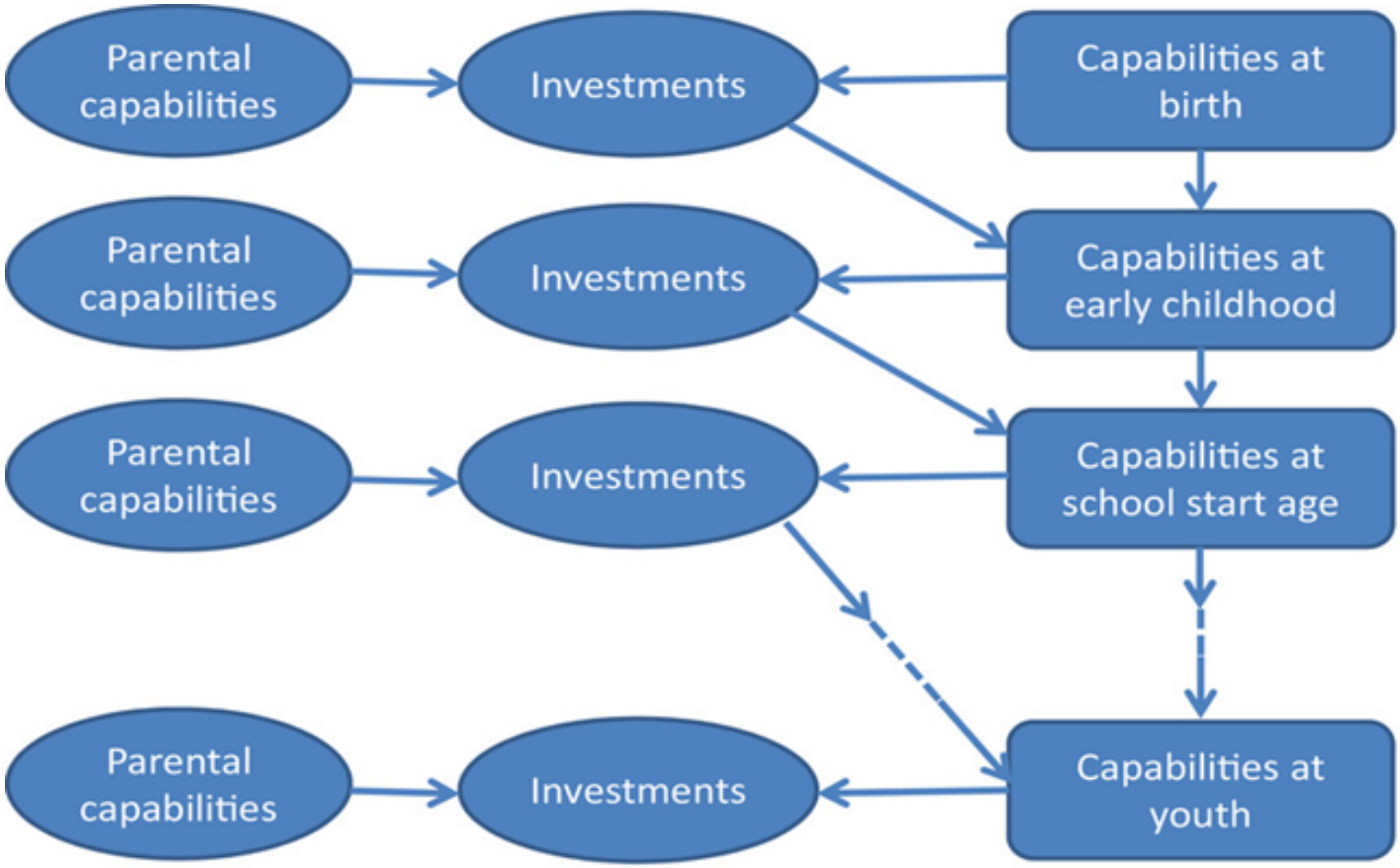

Figure 4. Skill Formation Process: A Sketch.

Source: Rosholm et al. (2021).

A Simplified Model I

- We study a simple multistage model to analyse the process of cognitive and noncognitive **skill formation** for children.
- Take-home message: substitution possibilities are greater **early** in life.
- Two children A, B.
- Two periods $t = 1, 2$ in which investments are made, where $t = 1$ is "**early**" and $t = 2$ is "**late**".
- One capability θ: θ_1^A denotes A's **initial skill endowment** and θ_P^A denotes the skill of A's parents (**parental endowment**).

A Simplified Model II

The technology production functions are defined as:

$$\begin{aligned} \theta_2 = &\quad \gamma_1\theta_1 + \gamma_2 I_1 + (1-\gamma_1-\gamma_2)\theta_P && \text{in period 1} \\ \theta_3 = &\quad \min\{\theta_2, I_2, \theta_P\} && \text{in period 2} \end{aligned}$$

where

- θ children's **capabilities** (example: given bundle of cognitive/noncognitive abilities);
- γ_t **self-productivity** at time t: $\gamma \in [0,1]$ and by definition $(1-\gamma_1-\gamma_2) = \gamma_P$;
- I_t **Investments** in the child's skill at time t. To simplify, we assume that investments in both cognitive and noncognitive skills are the same.

The Constrained Maximization Problem

How much should we **invest** in children A and B in each of the two periods $1, 2$ in order to maximize total aggregate skills, subject to a resource constraint?

$$\begin{aligned} \max \quad & \left[\begin{array}{l} \min\left\{\gamma_1\theta_1^A + \gamma_2 I_1^A + (1-\gamma_1-\gamma_2)\theta_P^A, I_2^A, \theta_P^A\right\} \\ +\min\left\{\gamma_1\theta_1^B + \gamma_2 I_1^B + (1-\gamma_1-\gamma_2)\theta_P^B, I_2^B, \theta_P^B\right\} \end{array} \right] \\ \text{s.t.} \quad & I_1^A + I_2^A + I_1^B + I_2^B \leq M \end{aligned}$$

where

M are the **total resources** available for investment.

Solution

If the resource constraint is non-binding, optimal investments are:

$$
\begin{aligned}
I_1^A &= \frac{(\gamma_1+\gamma_2)\theta_P^A - \gamma_1\theta_1^A}{\gamma_2} \\
I_1^B &= \frac{(\gamma_1+\gamma_2)\theta_P^B - \gamma_1\theta_1^B}{\gamma_2} \\
I_2^A &= \theta_P^A \\
I_2^B &= \theta_P^B
\end{aligned}
$$

A Simplified Model: Implications I

- Assume that child A is disadvantaged compared to B on both measures of disadvantage:

$$\theta_1^A < \theta_1^B \text{ and } \theta_P^A < \theta_P^B$$

- We may observe a situation in which $I_1^A > I_1^B$ **and** $I_2^A < I_2^B$, if

$$\theta_P^A - \theta_P^B > \frac{\gamma_1}{(\gamma_1 + \gamma_2)}(\theta_1^A - \theta_1^B) \tag{1}$$

holds.

- If parental endowment differences $(\theta_P^A - \theta_P^B)$ are "less negative" than child endowment differences $(\theta_1^A - \theta_1^B)$, scaled by a factor, it is optimal to **invest more** in the **early** years for the **disadvantaged** child and **less** in **later** years.

A Simplified Model: Implications II

- We can also rewrite Eq. 1 as:

$$\theta_P^A - \theta_P^B > \frac{\gamma_1}{(1-\gamma_P)}(\theta_1^A - \theta_1^B)$$

- The higher the self-productivity γ_1 and the higher the parental environment productivity γ_P, the more likely is that the inequality will be satisfied for any fixed level of disparity.
- To summarize, the simplified two-stage model by Cunha et al. (2010) indicates that it is optimal to **invest relatively more** in **disadvantaged** young children in the **early** years.

Application: Yi et al. (2015)

- Yi et al. (2015): effects of early health shocks on
  - **parental investments** in health and education
  - child outcomes.
- Sample of 1,456 Chinese twins from 2002/2003.
- Main findings: parental investments **compensate** differences due to health shocks

Data

- Dataset: Chinese Child Twins Survey
  - Conducted 2002/2003
  - All households with twins aged 6-18 in Chinese city Kunming
  - Observations: 1,456 twin pairs
- Variables:
  - Health outcomes: height, weight, BMI, general health status
  - Education outcomes: literature, mathematics, grade repetition, ...
  - Intermediate variables: health investment, educational investment
  - Covariates: age, gender, maternal characteristics, ...

Empirical Strategy: Parental Investments

Parental investments are modeled as:

$$I^k_{i,\tau} = \alpha^k_1 e^H_{i,\tau} + \alpha^k_2 e^H_{j,\tau} + \alpha^k_3 \omega_{i,\tau} + \alpha^k_4 \omega_{j,\tau} + \alpha^k_5 \xi_{i,\tau} + \alpha^k_6 \xi_{j,\tau} + \alpha^k_7 \zeta_\tau + \mu_\tau + \epsilon^k_{i,\tau}$$

where

- I^k parental investment in $k \in \{H, C\}$ with $H =$ *health* and $C =$ *education*,
- e early health shock (dummy) for individual i/sibling j,
- ω birth weight,
- ξ personal characteristics,
- ζ vector containing price for human capital investment, wage rate, non-labour income, and other parental characteristics, and
- μ parental preferences.

Empirical Strategy: Parental Investments

- **Twin design**: ζ_τ and μ_τ are identical for each twin pair.
- Within-twin fixed effects estimator given by:

$$\Delta I_\tau^k = \left(\alpha_1^k - \alpha_2^k\right) \Delta e_\tau^H + \left(\alpha_3^k - \alpha_4^k\right) \Delta \omega_\tau + \left(\alpha_5^k - \alpha_6^k\right) \Delta \xi_\tau + \Delta \epsilon_\tau^k \tag{2}$$

- Interest in coefficient $\left(\alpha_1^k - \alpha_2^k\right)$ which reflects the intra-household investment strategy.

Empirical Strategy: Child Human Capital

- Human capital production function given by:

$$\theta_{i,\tau}^k = \beta_1^k e_{i,\tau}^H + \beta_2^k \omega_{i,\tau} + \beta_3^k I_{i,\tau}^k + \beta_4^k \xi_{i,\tau} + \beta_5^k \kappa_\tau + \mu_\tau + \nu_{i,\tau}^k \quad (3)$$

where

κ observable parental characteristics.

- Taking fist differences:

$$\Delta\theta_\tau^k = \beta_1^k \Delta e_\tau^H + \beta_2^k \Delta I_\tau^k + \beta_3^k \Delta\omega_\tau + \beta_4^k \Delta\xi_\tau + \Delta\nu_\tau^k, \quad (4)$$

β_1^k captures biological effects of health shocks, and β_2 effect of family investments.

- Endogeneity of investments $\Rightarrow$ **instrument** with price of investments, wage rate, and non-labour income; all interacted with variation in child characteristics.

Results: Parental Investments

	Dependent variable:		
	Health investment in child i (*log*)	Health investment in child j (*log*)	Difference in health investment
	(1)	(2)	(3)
Early health shocks (i)	1.192***	−0.288	1.349***
	(0.325)	(0.312)	(0.243)
Early health shocks (j)	0.001	1.194***	
	(0.322)	(0.309)	

	Dependent variables:		
	Education investment in child i (*log*)	Education investment in child j (*log*)	Difference in education investment
	(1)	(2)	(3)
Early health shocks (i)	−0.142	0.065	−0.204***
	(0.131)	(0.124)	(0.047)
Early health shocks (j)	0.213	0.008	
	(0.130)	(0.123)	

Results: Child Human Capital

	Height *z*-score (1)	Weight *z*-score (2)	BMI *z*-score (3)	Health status (4)
Panel (a): 2SLS estimates				
Early health shocks	−0.100	−0.422***	−0.395***	−0.513***
	(0.130)	(0.118)	(0.151)	(0.078)
Health investments†	0.070	0.118**	0.160**	0.047
	(0.064)	(0.059)	(0.077)	(0.039)
Panel (b): reduced-form estimates				
Early health shocks	−0.004	−0.263***	−0.201*	−0.449***
	(0.096)	(0.086)	(0.113)	(0.057)

	Literature		Mathematics	
	Score (1)	Relative measure (2)	Score (3)	Relative measure (4)
Panel (a): 2SLS estimates				
Early health shocks	−3.990*	−0.168	−4.697*	−0.496***
	(2.045)	(0.145)	(2.432)	(0.157)
Educational investments†	6.124	0.904**	3.598	0.170
	(6.313)	(0.426)	(7.459)	(0.466)
Panel (b): reduced-form estimates				
Early health shocks	−5.142***	−0.352***	−5.372***	−0.531***
	(1.665)	(0.110)	(1.996)	(0.127)

Discussion

- Health shocks increase parental health investments but reduce educational investments.

$\Rightarrow$ Parents equalize resources between children

$\Rightarrow$ Not controlling for parental investments

- **underestimates** the biological effect of health shocks on health...
- ...and **overstates** the biological effect on education.

Further Studies

- Carneiro et al. (2021):
  - Timing of family income matters for child development.
  - Early and late period investments are more productive than middle ones.
  - Balanced flow of income is better than a front or back loaded one.
- Dai and Heckman (2013) :
  - Siblings contribute to skill formation.
  - Older brother $\rightarrow$ mathematical achievement
  - Older sister $\rightarrow$ English achievement
  - Findings consistent with psychology literature.

Further Studies

- Heckman and Raut (2016):
  - Preschool investments boost cognitive and non-cognitive skills.
  - Standard Mincer earnings functions overestimate returns to schooling.
  - Tax financed free preschool programs for low-SES children can generate positive net gains to society.
- Heckman et al. (2018):
  - Cognitive and noncognitive endowments affect schooling as well as earnings and health.
  - Selection bias present at all levels of schooling for all outcomes
  - Sorting gains at higher levels of schooling for wages

The ‘Heckman Curve’ – Evaluating Interventions

The "Heckman Curve"

- In recent years: meta-studies try to assess evidence for "Heckman curve".
- Rea and Burton (2020): Idea of returns diminishing with age has **no empirical support**.
- Heckman's riposte: the theory is not about **average returns** but **marginal returns**.
- Rosholm et al. (2021): Early interventions are more effective **on average**, but not always.
- So how should the "Heckman curve" be assessed empirically?
- Are resources optimally distributed across ages?

Marginal Value of Public Funds

- Hendren and Sprung-Keyser (2020): Comparative welfare analysis of **133 historical public policies** (e.g social insurance, cash transfers, education programs).
- Estimate the Marginal Value of Public Funds **(MVPF)**

$$\text{MVPF} = \frac{\text{Willingness to Pay}}{\text{Net Cost (government)}}$$

Examples:

- Willingness to pay = Private costs + earnings gains
- Net Costs: Cost of the policy - taxes revenues related with the policy

Main Results

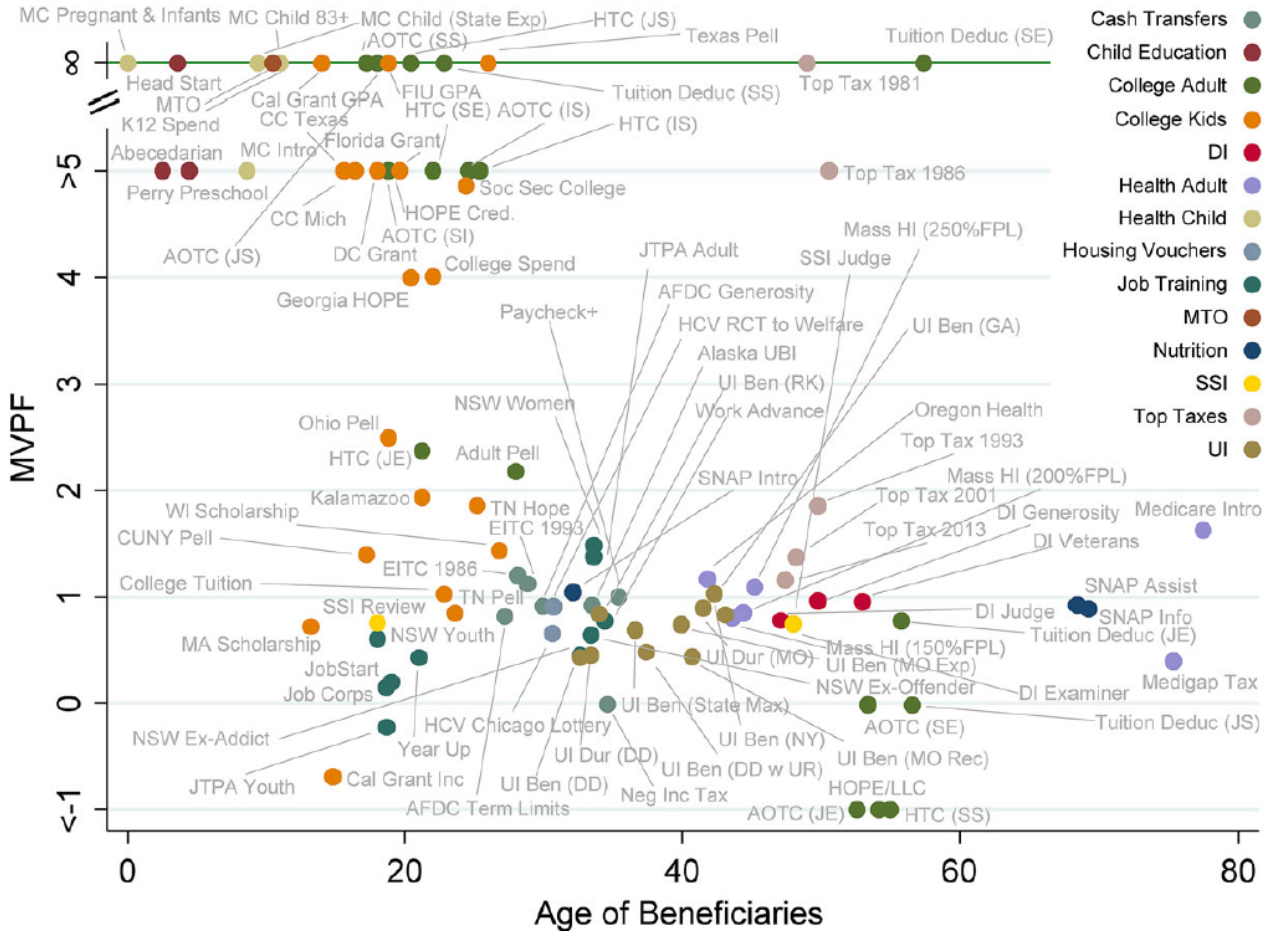

Figure 5. MVPF Estimates by Age of Policy Beneficiary, Source: Hendren and Sprung-Keyser (2020)

Conclusion

- MVPF **high through childhood**. Policies targeting older children or adolescents can be extremely effective.
- No evidence for Heckman Curve but MVPFs are lower for adults (labor market distortions)
- Many programs pay for themselves.
- **Type of policy matters**. Not all policies targeting children bring high MVPF.
- Re-allocation of inputs towards young adults could be more **efficient** (also family spillovers).

Summary and Conclusions

Summary and Conclusions

- Early environment and parental investments in early stages of life are among the most important predictors of skills and **ability** in later life.
- Cunha et al. (2010) develop a theoretical investment model.
- Investing in disadvantaged children is justifiable not only on equity, but also on economic efficiency grounds.
- They analyze the process of **skill formation**, distinguishing between **cognitive** and **noncognitive** skills.
- Postulate that both types of skills play an important part on outcomes and success in life.
- Empirical evidence shows that parents partly compensate for adverse health shocks.

Literature I

Carneiro, P., I. L. García, K. G. Salvanes, and E. Tominey (2021): "Intergenerational mobility and the timing of parental income," *Journal of Political Economy*, 129, 757–788.

Cunha, F. and J. Heckman (2007): "The technology of skill formation," *American economic review*, 97, 31–47.

Cunha, F. and J. J. Heckman (2010): "Investing in Our Young People. NBER Working Paper No. 16201." *National Bureau of Economic Research*.

Cunha, F., J. J. Heckman, and S. M. Schennach (2010): "Estimating the technology of cognitive and noncognitive skill formation," *Econometrica*, 78, 883–931.

Dai, X. and J. J. Heckman (2013): "Older siblings' contributions to young child's cognitive skills," *Economic modelling*, 35, 235–248.

Dalgaard, C.-J. and H. Strulik (2014): "Optimal aging and death: understanding the Preston curve," *Journal of the European Economic Association*, 12, 672–701.

Fischer, M., U.-G. Gerdtham, G. Heckley, M. Karlsson, G. Kjellsson, and T. Nilsson (2021): "Education and health: long-run effects of peers, tracking and years," *Economic Policy*, 36, 3–49.

Grossman, M. (1972): "On the Concept of Health Capital and the Demand for Health," *The Journal of Political Economy*, 80, 223–255.

Gutman, L. M. and I. Schoon (2016): "A synthesis of causal evidence linking non-cognitive skills to later outcomes for children and adolescents," in *Non-cognitive skills and factors in educational attainment*, Brill, 171–198.

Heckman, J. J. (2008): "The case for investing in disadvantaged young children," *CESifo DICE Report*, 6, 3–8.

Heckman, J. J., J. E. Humphries, and G. Veramendi (2018): "Returns to education: The causal effects of education on earnings, health, and smoking," *Journal of Political Economy*, 126, S197–S246.

Heckman, J. J. and L. K. Raut (2016): "Intergenerational long-term effects of preschool-structural estimates from a discrete dynamic programming model," *Journal of econometrics*, 191, 164–175.

Hendren, N. and B. Sprung-Keyser (2020): "A unified welfare analysis of government policies," *The Quarterly Journal of Economics*, 135, 1209–1318.

Rea, D. and T. Burton (2020): "New evidence on the Heckman curve," *Journal of Economic Surveys*, 34, 241–262.

Literature II

Rosholm, M., A. Paul, D. Bleses, A. Højen, P. S. Dale, P. Jensen, L. M. Justice, M. Svarer, and S. Calmar Andersen (2021): "Are impacts of early interventions in the Scandinavian welfare state consistent with a Heckman curve? A meta-analysis," *Journal of Economic Surveys*, 35, 106–140.

Yi, J., J. J. Heckman, J. Zhang, and G. Conti (2015): "Early health shocks, intra-household resource allocation and child outcomes," *The Economic Journal*, 125, F347–F371.