

The Formation and Evolution of Childhood Skill Acquisition

Evidence From India

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Objective

- Research on determinants of a child's socio-economic success in later life has traditionally focused on schooling
- Focus has shifted to early childhood influences and self/cross productivity
- Cognitive and Non-cognitive skills as powerful determinants of success in life
- Investigate in a comprehensive manner the **determinants of childhood skill acquisition in a developing country context**
- Large potential implications for policy interventions

Nature vs Nurture

- Early economic analysis of child development assumed that childhood consisted of a single homogeneous phase (Becker and Tomes, 1986).
- Psychological research demonstrated that child development is comprised of multiple stages (Thompson and Nelson, 2001).
- 2 main influences shaping a child's abilities during this multistage development process:
 - Child's genetic endowment
 - Inputs received from the outside world, including family and the wider environment.
- Importance of genetic variance in determining child development (Scarr and Richard, 1983; Teasdale and Owen, 1985; Wilson, 1983)

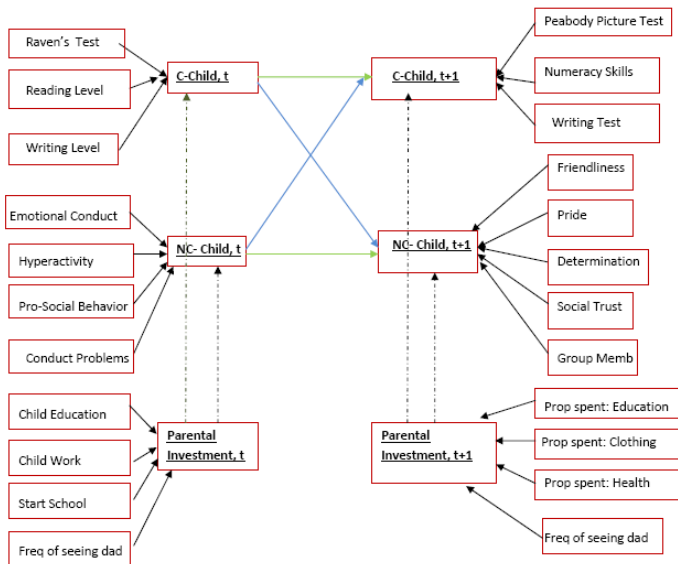
Context

- Bulk of this research undertaken in industrialized countries.
- In most developing countries school quality is low and achievement levels of children above all in rural schools still continue to lag (Gonzalez et al., 2004)
- Strong reason to shift focus from schooling towards factors influencing a child's development of cognitive and non-cognitive traits during early childhood:
 - Grantham-McGregor et al. (2007) find that both poverty and bad home environment condition result in child stuntedness
 - Walker et al. (2007) chart out channels that are most likely to affect early childhood development: 'Psycho-social Risk Factors' (PRF) and childhood poverty.
- Galab et. al. (2006): Previous analysis using the first round of data of the 'Young Lives' survey find that there is a clear interplay between school and home.

Outline

- Little is known as to how a child's cognitive and non-cognitive skills interact and how a child's environment, including family, affects cognitive as well as non-cognitive development in a **developing country context**
- Focus on productivity effects:
 - Self-productivity refers to any effect of **past period's** cognitive/noncognitive skills on **current period's** cognitive/noncognitive skills respectively
 - Cross-productivity refers to any effect of **past period's** cognitive/noncognitive skills on **current period** noncognitive/cognitive skills.
- We estimate a Linear Structural Relations (LISREL) model: Allows us to estimate latent cognitive and non-cognitive skill levels as well as parental investment and to link these variables to observed child, parental and household characteristics

Method - Structure



Empirical Model

$$\theta_t^k = f(\theta_{t-1}^k, \theta_t^I, X_t) \quad (1)$$

- θ_t^k denotes a child's latent skill level of skill k for age t , with $k \in \{C, N\}$ and $t \in \{0, \dots, T\}$.
- θ_t^I denotes latent parental investment at age t
- X_t denotes a vector of child, caregiver and household characteristics.
- Self-productivity: θ_{t-1}^N and θ_{t-1}^C having an effect on θ_t^N and θ_t^C respectively
- Cross-productivity: θ_{t-1}^N and θ_{t-1}^C having an effect on θ_t^C and θ_t^N respectively.

Empirical Model

- Recursive System

$$\begin{pmatrix} \theta_{t-1}^C \\ \theta_{t-1}^N \end{pmatrix} = \Gamma_{t-1} \theta_{t-1}^I + \Upsilon_{t-1} X_{t-1} + \begin{pmatrix} \zeta_{t-1}^C \\ \zeta_{t-1}^N \end{pmatrix} \quad (2a)$$

$$\begin{pmatrix} \theta_t^C \\ \theta_t^N \end{pmatrix} = B_t \begin{pmatrix} \theta_{t-1}^C \\ \theta_{t-1}^N \end{pmatrix} + \Gamma_t \theta_t^I + \Upsilon_t X_t + \begin{pmatrix} \zeta_t^C \\ \zeta_t^N \end{pmatrix} \quad (2b)$$

- Assumptions: $E(B) = 0$, $E(\Gamma) = 0$, $E(\Upsilon) = 0$, $Cov(B, \Gamma) = 0$, $Cov(B, \Upsilon) = 0$ and $Cov(\Upsilon, \Gamma) = 0$

Factor Models

- One-factor model

$$x_{i,t}^k = b_{io,t}^k + b_{i1,t}^k \theta_t^k + u_{i,t}^k \quad (3)$$

- x observed measures of the latent variable with $i = 1, \dots, m_i^k$ denoting different indicators for specific latent variable
- θ is the factor for the latent variable k with $k \in \{C, N, I\}$
- b_{i1} represent factor loadings, $b_{io,t}^k$ is a measure-specific intercept
- u is an error term where θ and u are unobserved
- Assume:
 - Factor and the error term are uncorrelated and have an expected value of zero.
 - Errors are independent over time and across children.
 - The relationship between the factor and the observed variables is linear.
 - The scale of the common factor is fixed by setting the first factor loading equal to one.

Factor Models

- Factor models for the latent skill variables:

$$X_{i,t-1}^C = \Lambda_{oi,t-1} + \Lambda_{1i,t-1}^C \theta_{t-1}^C + \epsilon_{1i,t-1}^C \quad (4a)$$

$$X_{i,t-1}^N = \Lambda_{oi,t-1} + \Lambda_{2i,t-1}^N \theta_{t-1}^N + \epsilon_{2i,t-1}^N \quad (4b)$$

$$X_{i,t}^C = \Lambda_{oi,t} + \Lambda_{3i,t}^C \theta_t^C + \epsilon_{3i,t}^C \quad (4c)$$

$$X_{i,t}^N = \Lambda_{oi,t} + \Lambda_{4i,t}^N \theta_t^N + \epsilon_{4i,t}^N \quad (4d)$$

- Factor models for the latent parental investment variables:

$$X_{i,t-1}^I = \Lambda_{oi,t-1} + \Lambda_{1i,t-1}^I \theta_{t-1}^I + \delta_{i,t-1}^I \quad (5a)$$

$$X_{i,t}^I = \Lambda_{oi,t} + \Lambda_{2i,t}^I \theta_t^I + \delta_{i,t}^I \quad (5b)$$

Assumptions

- Allow latent cognitive and non cognitive skill variables for the same age of a child to covary, and for parental investment indicators also across age.
- Set all off-diagonal elements of the variance-covariance matrix for the errors of the factor models to zero, i.e., $Cov(\epsilon_t^q, \epsilon_t^p) = 0$, $Cov(\epsilon_t^q, \epsilon_{t-1}^p) = 0$ and $Cov(\epsilon_t^q, \epsilon_{t-1}^q) = 0$ for $q, p \in \{C, N, I\}$.
- Allow for off-diagonal elements not equal to zero in variance-covariance matrix Σ for the system (2) for equations for the same age of a child.

Estimation

- **Younger cohort:**
 - Objectives:
 - Establish links between childhood poverty, PRF and early child health
 - Test whether early childhood health impacts cognitive/non-cognitive outcomes at age five
 - Model simplifies as only observed child health feeds into equation for t
 - Instead of parental investment for one-year old children, latent PRF used
- **Older cohort:**
 - Objectives:
 - Investigate the presence and importance of self- and cross-productivity of skill levels.
 - Estimate the full dynamic measurement model.
- System estimated by Full Information Maximum Likelihood (FIML)

Survey Design

- Data from India part of the Young Lives (YL) Project.
- Two cohorts of children over two rounds of data collection: Round 1 (2002) & Round 2 (2006)
 - **Younger cohort:** 2,000 children; Round 1 (age 1), Round 2 (age 5)
 - **Older cohort:** 1,000 children; Round 1 (age 8), Round 2 (age 12)
- Sample is representative of the three regions of Andhra Pradesh: Rayalseema, Coastal Andhra and Telangana.
 - Six districts selected based on poor/non-poor classification
 - Twenty sentinel sites within these districts were identified based on the same classification.
 - One village was randomly selected from approximately four to five villages that comprised a sentinel site.
 - Questionnaires were administered to around 100 (Younger Cohort) to 50 (Older cohort) households

Latent Variable Indicators

Table 1 : Measurement Model Indicators

| | Cognitive Ability | Non Cognitive Ability | Parental Investment |
|---|---|---|--|
| <u>Age 8:</u> Older Cohort, Round 1 | <ul style="list-style-type: none"> Scores from the Raven's Progressive Matrices Aptitude Test Reading Level Writing Level | Child Mental Ability Indicators from the Strengths and Difficulties Questionnaire (SDQ) devised by Dr. Robert Goodman <ul style="list-style-type: none"> Emotional Conduct Hyperactivity Pro-Social Behavior Conduct Problems | <ul style="list-style-type: none"> Do parents spend money on child's education? Does child work at home or outside? How many years back was child made to start formal schooling? How often does child see father (daily, weekly, once a month, once in the year) |
| <u>Age 12:</u> Older Cohort, Round 2 | <ul style="list-style-type: none"> IRT scores from the Peabody Picture Vocabulary Test Numeracy: child can perform simple multiplication Writing Level | Child Personality Measures: Indicated from questions rated on the Likehart Scale by child <ul style="list-style-type: none"> Friendliness Pride Determination Social Trust Group Membership | <ul style="list-style-type: none"> Proportion of total household expenditure on following received by child: <ul style="list-style-type: none"> Education Health Clothing How often does child see father (daily, weekly, once a month, once a year) |
| <u>Age 1:</u> Younger Cohort, Round 1 | | | Psychosocial Risk Factors: <ul style="list-style-type: none"> Caregiver Education No Doctor present at birth? Months left without breastfeeding Level of antenatal care Unwanted pregnancy? Caregiver Depression |
| <u>Age 5:</u> Younger Cohort, Round 2 | <ul style="list-style-type: none"> IRT scores from the Peabody Picture Vocabulary Test Scores from the Cognitive Development Assessment - Quantitative Test | <ul style="list-style-type: none"> Level of fluency and communication in native language Performance in pre-school (interactive and social nature) Does child travel to school with friends, parents or alone? | <ul style="list-style-type: none"> Proportion of total household expenditure on following received by child: <ul style="list-style-type: none"> Education Health Clothing How often does child see father (daily, weekly, once a month, once a year) |

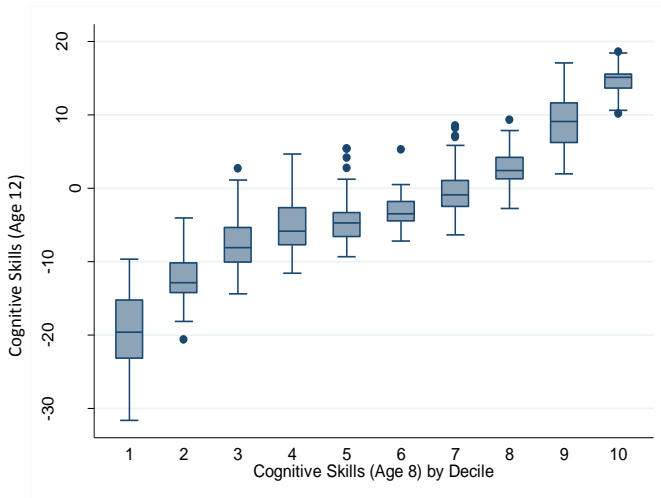
Home Environment

- As measures for home environment:
 - Household size
 - Location (whether urban or rural)
 - Primary occupation (whether non-agricultural/salaried or other)
 - Social networks (given by indicators such as number of groups a household is affiliated to, community based participation of household, kinship ties within the community of household)
 - Household mean educational attainment, caste
 - Asset ownership
 - Household Poverty

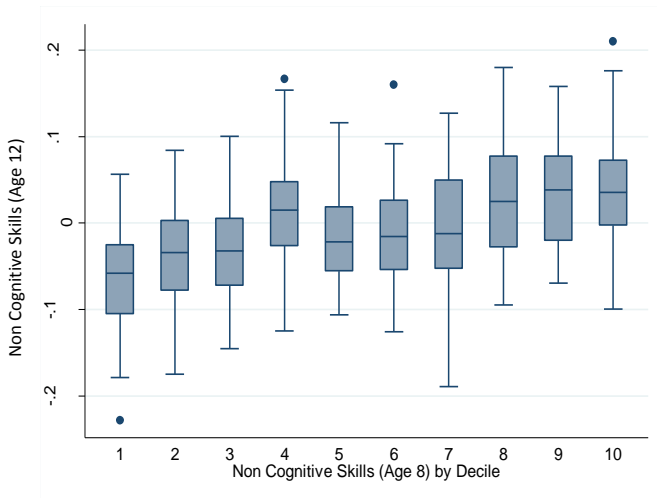
Child and Caregiver

- As measures for child characteristics:
 - Long term health of a child (child weight and height for the 'younger' cohort)
 - Number of siblings
 - Gender
 - Number of years of schooling attained
 - Child's own perception of well being at home
 - School type (public or private)
- As measures for caregiver characteristics:
 - Education of the caregiver
 - Degree of parental altruism towards the child

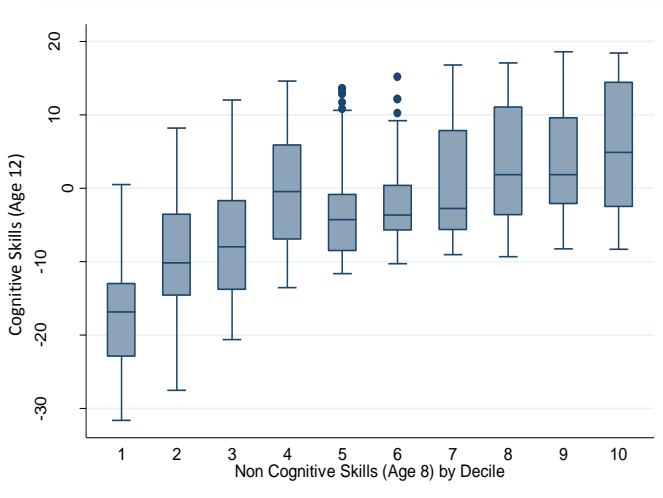
Cognitive (Age 8) vs Cognitive (Age 12) Skill Levels



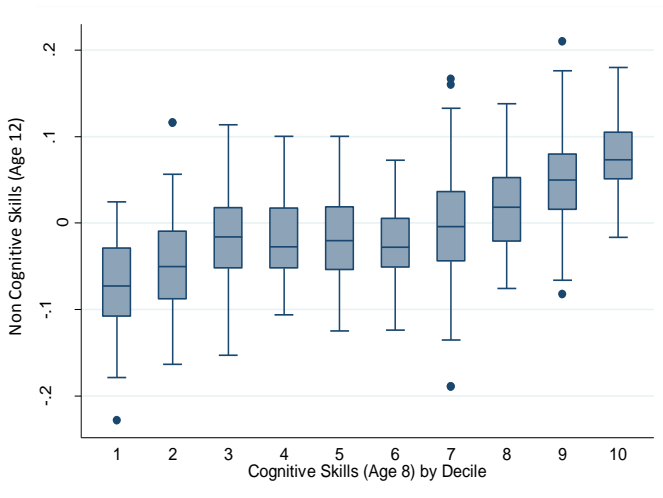
Non Cognitive (Age 8) vs Non Cognitive (Age 12) Skill Levels



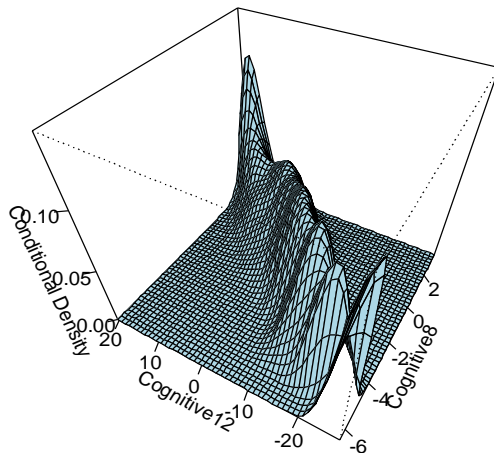
Non Cognitive (Age 8) vs Cognitive (Age 12) Skill Levels



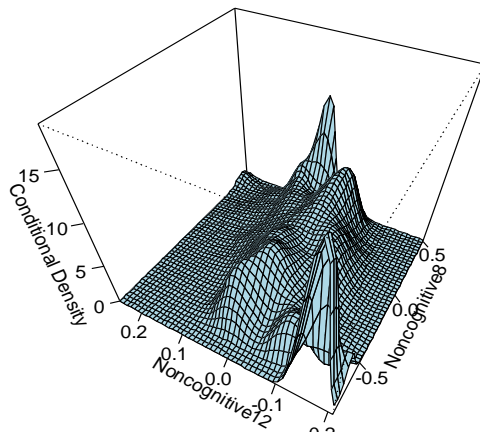
Cognitive (Age 8) vs Non Cognitive (Age 12) Skill Levels



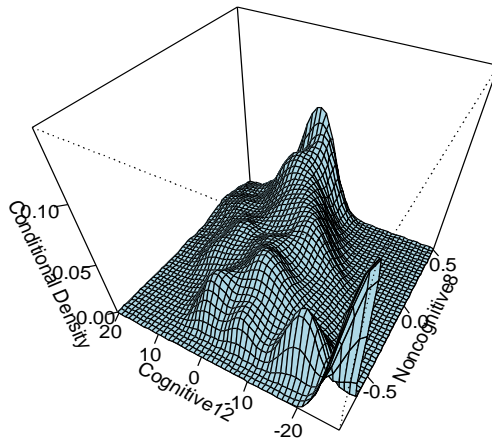
Cognitive (Age 8) vs Cognitive (Age 12): Conditional Probability Density Function



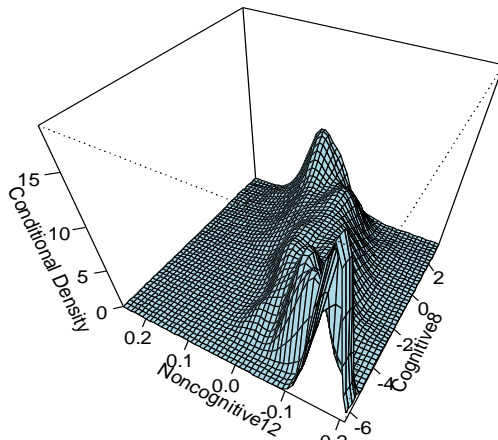
Non Cognitive (Age 8) vs Non Cognitive (Age 12) Skill Levels: Conditional Probability Density Function



Non Cognitive (Age 8) vs Cognitive (Age 12) Skill Levels: Conditional Probability Density Function



Cognitive (Age 8) vs Non Cognitive (Age 12) Skill Levels: Conditional Probability Density Function



Pairwise Spearman Rank Correlation Matrix

Table A: Age 1 and 5

| | CS (Age 5) | NCS (Age 5) | Child Health (Age 1) | PI (Age 5) | PRF (Age 1) |
|------|------------|-------------|----------------------|------------|-------------|
| C5 | 1.0000 | | | | |
| NC5 | 0.8708** | 1.0000 | | | |
| CH1 | 0.8688* | 0.8617** | 1.0000 | | |
| PI5 | 0.7400** | 0.7285** | 0.7711** | 1.0000 | |
| PRF1 | -0.9341** | -0.8964** | -0.9308** | -0.7497** | 1.0000 |

Table B: Age 8 and 12

| | CS (Age 12) | NCS (Age 12) | CS (Age 8) | NCS (Age 8) | PI (Age 12) | PI (Age 8) |
|------|-------------|--------------|------------|-------------|-------------|------------|
| C12 | 1.0000 | | | | | |
| NC12 | 0.7641** | 1.0000 | | | | |
| C8 | 0.9348** | 0.6011** | 1.0000 | | | |
| NC8 | 0.6231** | 0.4276** | 0.7346** | 1.0000 | | |
| PI12 | 0.7231** | 0.7627** | 0.7128** | 0.7476** | 1.0000 | |
| PI8 | 0.7914** | 0.6373** | 0.8586** | 0.8328** | 0.7607** | 1.0000 |

Results: Younger Cohort

(a): Child Health-Age 1

| Dependent variable: | Child Health (Age 1) |
|-------------------------|-------------------------|
| PRF (Age 0) | -0.414 ** (0.181) |
| Poor | -0.236 ** (0.072) |
| CH Male | 0.211 ** (0.045) |
| CH Caste | 0.279 ** (0.084) |
| CH Birth Order | -0.092 ** (0.028) |
| HH Size | 0.004 (0.016) |
| HH Urban | 0.219 ** (0.097) |
| HH Non Ag Occupation | 0.001 (0.029) |
| HH Mean Education | 0.024 ** (0.010) |
| HH Social Connectedness | 0.081 (0.060) |
| Observations | 1950 |

Results: Younger Cohort

(b): Skill Accumulation-Age 5

| Dependent variable: | Cognitive Skills (Age 5) | Non Cognitive Skills (Age 5) |
|---------------------------|-----------------------------|---------------------------------|
| Child Health (Age 1) | 2.448 ** (0.527) | -0.013 (0.039) |
| Parental Investment | 33.272 ** (8.627) | 1.854 ** (0.569) |
| Parent Altruism | 25.686 † (15.778) | -0.684 † (0.395) |
| CH Siblings | 0.343 (0.793) | 0.077 * (0.049) |
| CG Educational Attainment | 1.517 ** (0.229) | 0.047 ** (0.011) |
| HH Size | -0.359 (0.432) | 0.013 (0.022) |
| HH Social Connectedness | 3.464 ** (1.526) | -0.127 † (0.067) |
| HH Assets | 1.860 (8.837) | 1.112 ** (0.395) |
| Observations | 1950 | 1950 |

Results: Older Cohort

(a): Skill Accumulation-Age 8

| Dependent variable: | Cognitive Skills (Age 8) | Non Cognitive Skills (Age 8) |
|-------------------------|-----------------------------|---------------------------------|
| Parental Investment | 10.877 ** (3.406) | 0.642 (0.392) |
| CH Health | 0.551 * (0.262) | 0.023 (0.059) |
| CH Well-Being | 0.695 (0.701) | -0.093 (0.144) |
| CH Siblings | 0.297 ** (0.128) | 0.001 (0.030) |
| Public School | -1.455 * (0.630) | -0.005 (0.088) |
| HH Size | -0.142 + (0.079) | -0.027 + (0.014) |
| HH Social Connectedness | 0.672 + (0.349) | 0.054 (0.087) |
| HH Urban | -0.560 ** (0.797) | 0.282 * (0.115) |
| HH Wage | 0.251 * (0.121) | 0.042 (0.030) |
| Observations | 994 | 994 |

Results: Older Cohort

(a): Skill Accumulation-Age 12

| Dependent variable: | Cognitive Skills (Age 12) | Non Cognitive Skills (Age 12) |
|------------------------------|------------------------------|----------------------------------|
| Cognitive Skills (Age 8) | 3.900 ** (1.509) | 0.011 ** (0.004) |
| Non Cognitive Skills (Age 8) | -0.534 (1.045) | -0.001 (0.005) |
| Parental Investment | 9.989 ** (3.823) | 0.196 ** (0.046) |
| CH Health | 0.282 (0.253) | -0.003 (0.002) |
| Parent Altruism | 0.014 (3.108) | -0.013 (0.017) |
| CH Well-Being | 1.354 (1.998) | 0.077 ** (0.029) |
| Public School | 3.045 ** (0.138) | 0.061 ** (0.001) |
| HH Social Connectedness | 0.751 + (0.443) | 0.002 (0.003) |
| HH Assets | 2.238 + (1.903) | 0.047 ** (0.011) |
| HH Wage Recipient | -1.056 * (0.474) | -0.008 ** (0.003) |
| HH Mean Education | 0.111 + (0.060) | 0.000 (0.001) |
| Observations | 994 | 994 |

Conclusion

- What constitutes an ‘enabling’ environment for a child’s successful development in a developing country?
- **Younger cohort:**
 - Psycho-social risk factors have a statistically significant effect on child health at age one
 - Child health as measured for children at age one is a statistically significant determinant for a child’s cognitive ability at age five
 - Parental investment exerts contemporaneously economically powerful positive influence on skill formation for five year old children.
- **Older cohort:**
 - Presence of self-productivity for cognitive skills and cross-productivity of cognitive on non-cognitive skills during the transition from eight to twelve years.
 - Parental investment exerts contemporaneously economically powerful positive influence on skill formation for eight and twelve year old children.