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THE EXTENSIVE AND INTENSIVE MARGINS OF TIME INVESTMENTS ON THE SKILL DEVELOPMENT OF CHILDREN AND ADOLESCENTS

TAN YI, RACHEL

SINGAPORE MANAGEMENT UNIVERSITY
2019

THE EXTENSIVE AND INTENSIVE MARGINS OF TIME INVESTMENTS ON THE SKILL DEVELOPMENT OF CHILDREN AND ADOLESCENTS

TAN YI, RACHEL

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In

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The Extensive and Intensive Margins of Time Investments on the Skill Development of Children and Adolescents

Tan Yi, Rachel

Submitted to School of Economics
in partial fulfilment of the requirements for the
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Singapore Management University
2019

I hereby declare that this Master's thesis is my original work
and it has been written by me in its entirety.
I have duly acknowledged all the sources of information
which have been used in this thesis.

This Master's thesis has also not been submitted for any degree
in any university previously.

_____

Tan Yi, Rachel
5 July 2019

The Extensive and Intensive Margins of Time Investments on the Skill Development of Children and Adolescents

Tan Yi, Rachel

Abstract

The literature on time investments and skill development has focused on estimating the intensive margins of time investments; This study explores whether including extensive margins might provide additional insights. The extensive and intensive margins of maternal time investments and child time investments (or child self-investments) in three categories of activities (educational, structured and unstructured) on the cognitive and non-cognitive skill development of children (6 to 10 years) and adolescents (11 to 15 years) are quantified by fitting skill production functions with ordinary least squares and family fixed effects specifications. Cognitive skills are assessed by three achievement test scores which indicate the children's vocabulary level along with their passage comprehension and mathematical abilities. Non-cognitive skills are assessed by indexes which measure the children's problem behaviours and emotional/social abilities.

Results indicate that including the extensive margins of time investments is beneficial as they influence cognitive skill development. Furthermore, there are instances where the extensive and intensive margins act in opposite directions. For example, adolescents who engage in educational activities independently (make self-investments in educational activities) during childhood have higher comprehension skills than those who do not (i.e. positive extensive margin).

However, they have lower comprehension skills with every additional hour invested (i.e. negative intensive margin).

While cognitive skills are affected by time investments, non-cognitive skills are generally not significantly affected by time investments. Since this is the case, the remainder of the analysis concentrates on cognitive skill development. A subgroup analysis reveals that time investments affect gender sub-groups and racial sub-groups differently, suggesting that gender and family background factors influence the effects of time investments. In addition, there is evidence that paternal time investments affect cognitive skill development.

Keywords: time investment; time usage; child time; maternal time; skill development; cognitive; non-cognitive; child outcomes; child development; adolescent outcomes; adolescent development

JEL Classification: J13, D1

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1. Introduction

Skills influence individuals' decisions and life outcomes – course grades, schooling choices, occupational choices, labour market outcomes, health status and more (Almlund, Duckworth, Heckman, & Kautz, 2011; Heckman, Stixrud, & Urzua, 2006; Keane & Wolpin, 1997). Given the importance of skills, researchers have sought to uncover the factors which influence skill development and to model the process of skill formation.

The skill development of children and adolescents is influenced by the quantity of time which mothers spend with their children/adolescent children (maternal time investments) and the amount of time which children/adolescents spend by themselves (child time investments or self-investments) in various activities (Carneiro & Rodrigues, 2009; Del Boca, Monfardini, & Nicoletti, 2017; Del Bono, Francesconi, Kelly, & Sacker, 2016; Fiorini & Keane, 2014; Hsin & Felfe, 2014). Aside from the amount of time invested (intensive margins of time investments), might the decision of whether to participate in specific activities also affect skill development? In other words, do the extensive margins of time investments matter? Potentially, extensive margins may provide additional insights into the relationship between time investments and skill development. For example, it is plausible that children who choose to engage in homework/studying activity attain higher skill levels than those who do not (i.e. positive extensive margin). Yet, spending excessive amounts of time on homework/studying might undo the positive impact of participation if every additional hour spent reduces scores instead (i.e. negative intensive margin).

Whether the extensive and intensive margins of time investments work in opposite directions will be investigated in this study, which aims to explore

whether including extensive margins may provide greater insights into the relationship between time investments and skill development. To achieve this goal, data from the Panel Study of Income Dynamics is used to quantify the extensive and intensive margins of time investments by fitting cognitive and non-cognitive skill production functions for children (6 to 10 years) and adolescents (11 to 15 years) using ordinary least squares and family fixed effects specifications. Cognitive skills are assessed by three achievement test scores while non-cognitive skills are assessed by indexes of the children's problem behaviours and emotional/social abilities.

Findings indicate that including the extensive margins is beneficial as the extensive margins of certain time investments significantly affect cognitive skill development. Furthermore, there are cases where the intensive and extensive margins work in opposite directions. For instance, adolescents who invest time in educational activities independently (engage in self-investments in educational activities) during childhood have higher comprehension skill levels than others (i.e. positive extensive margin) but have lower comprehension skill levels with every additional hour which they spend on such activities per week (i.e. negative intensive margin).

While the development of cognitive skills is influenced by time investments, non-cognitive skills are generally insensitive to time investments. Since this is the case, subsequent subgroup analyses and sensitivity analyses were conducted solely on cognitive skill development. From these, notable findings include the following. Firstly, there are heterogeneous effects of time investments on cognitive skill development with respect to gender and race. These may reflect inherent differences in skill development between genders and the influence of

family background factors on the impact of time investments respectively. Secondly, paternal time investments also affect the cognitive skill development of children (6 to 10 years).

The remainder of the paper is organised as follows. Section 2 provides an overview of the related literature on skills, skill development and time investments. Section 3 presents the data and sample selection techniques. Section 4 discusses the conceptual framework behind skill production functions and econometric models used to estimate the production functions. Section 5 presents the results and a discussion of the findings. Section 6 provides sensitivity analyses and Section 7 concludes the paper.

2. Review of Related Literature

2.1 Cognitive Skills, Non-Cognitive Skills and Skill Development

People possess multiple types of skills (Heckman & Mosso, 2014). In Economics, skills have been classified into two broad categories – cognitive skills and non-cognitive skills (Borghans, Duckworth, Heckman, & Weel, 2008). Cognitive skills refer to "conceptual and intellectual skills such as intelligence, knowledge, analytical thinking, mathematics, and reading, among others" while non-cognitive skills refer to "aspects related to specific attributes (interpersonal skills, communication skills, social skills, leadership, etc.) as well as personality traits (motivation, perseverance, self-control and self-confidence, charm, etc.)" (Blázquez, Herrarte, & Llorente-Heras, 2018).

The malleability of skill levels depends on the type of skills and the age of the individual. During certain periods of life, experiences may have strong effects on skill development (Knudsen, 2004). One example is the acquisition of language skills during childhood provided by Knudsen, Heckman, Cameron and

Shonkoff (2006). New-borns can learn any language and the exposure to multiple languages at young ages enables one to speak each with equal levels of proficiency. In contrast, a much greater amount of effort is needed to study a second language during adulthood and the grasp of the language attained is never the same. As the illustration suggests, cognitive skills are more easily moulded at younger ages (Francesconi & Heckman, 2016; Hopkins & Bracht, 1975). Compared to cognitive skills, non-cognitive skills are more malleable at later ages (Kautz, Heckman, Diris, Weel, & Borghans, 2014).

Returns to skill investments are heterogeneous. They are influenced by factors such as child characteristics (Cornelissen, Dustmann, Raute, & Schönberg, 2018), socio-economic status (Bitler, Hoynes, & Domina, 2014; Cascio & Schanzenbach, 2013) and gender (Anderson, 2008; Deming, 2009; Kalenkoski & Pabilonia, 2017).

2.2 Time Investments and Skill Development

The definition of time investments varies across studies. Some studies reserve the phrase "time investments" for time spent in a specific range of activities which are believed to be more beneficial to skill development than others (e.g. educational activities). Other studies have used the phrase to refer to a broader range of activities (e.g. organised leisure activities, drawing, singing). Still other studies do not use the phrase "time investments" at all, though their findings suggest that the time spent on activities affected skill development. In this study, time investments in activities refer to the time spent carrying out those activities, regardless of whether they are beneficial, neutral or detrimental to skill development.

The influence of time investments on the cognitive and non-cognitive skill development of children and adolescents has been examined with time use data in several recent studies. In these studies, cognitive skills were measured by achievement test scores. The types of non-cognitive skills focused on were measures of behaviour and social/emotional abilities.

Using the Child Development Supplement of the Panel Study of Income Dynamics (PSID-CDS), Carneiro and Rodrigues (2009) investigated the effects of maternal time and school/care time on the skill development of younger children (3 to 6 years) and older children (7 to 12 years) with generalised propensity score methods. While the level of behaviour problems exhibited by the children was unaffected by time expenditure, the cognitive scores of the children were influenced by maternal time investments. White children's scores were positively influenced by maternal time investments and adversely affected by school/care time. In contrast, young Black children obtained lower scores if they spent greater than 5 hours with their mothers every day, and had higher scores if they spent greater time in school/care. Older Black children's scores were unaffected by both maternal time and school/care time. Uncovering that Blacks were significantly disadvantaged in terms of family background, Carneiro and Rodrigues (2009) postulated that the differences between races may be attributed to family environment factors.

Also utilising the PSID-CDS, Hsin and Felfe (2014) explored the possibility that the impact of maternal time investments on skill development depends on the type of activities which mothers engage in with their children. They found that participation in educational activities (e.g. homework and studying, reading) improved children's achievement test scores and increased the

frequency of the children exhibiting positive behaviour. Furthermore, maternal time investments in structured activities (e.g. organised leisure, sports) raised the children's social/emotional abilities. While investments in educational and structured activities had positive effects, time spent on unstructured activities (e.g. watching television, unspecified leisure) negatively affected children's achievement test scores.

Analysing UK Millennium Cohort Study data, Del Bono et al. (2016) provided additional evidence that maternal time investments positively affect the cognitive and non-cognitive skill development of children. Furthermore, they found that early investments are more productive for skill formation, especially for verbal skills. In addition, they discovered that both genders may be affected differently by time investments. Male children's cognitive skills were affected by maternal investments in recreational activities (e.g. outdoor recreation, indoor games, drawing, singing) while female children's cognitive skills were not.

The abovementioned studies focused on the impact of maternal time investments on skill development. Del Boca et al. (2017) contributed by providing evidence that children's own time investments (or self-investments) also affect their own skill development. Furthermore, their results suggested that the relative importance of maternal time investments and children's own time investments depends on the age of the child. During childhood (6 to 10 years), maternal time investments were more important than self-investments while the converse was true during adolescence (11 to 15 years).

The studies discussed thus far analysed the impact of time investments in specific categories of activities. These categories did not include all activities

which may be carried out within the day. In contrast to these studies, the categories of time investments used by Fiorini and Keane (2014) included all activities within the day. Using the Longitudinal Study of Australian Children, they concluded that the time spent by children on educational activities, especially with their parents, is the most productive activity for building cognitive skills. Like Carneiro and Rodrigues (2009), they found that non-cognitive skill development is unaffected by time investments.

A summary of the data sources, measures of cognitive and non-cognitive skills and estimation techniques used in the abovementioned studies is presented in Table 1. Overall, these studies provide evidence that maternal time investments and children's own time investments influence cognitive skill development. However, the effect of time investments on cognitive skills is more ambiguous. Furthermore, the studies suggest that there may be heterogeneity in returns to time investments on cognitive skill development by race and gender. Building on these studies, which focus on the intensive margins of time investments, this study estimates both the extensive and intensive margins.

Table 1: Studies on Time Investments and Skill Development

	Carneiro and Rodrigues (2009)	Hsin and Felfe (2014)	Fiorini and Keane (2014)	Del Bono et al. (2016)	Del Boca et al. (2017)
Skill Measure(s)	**Cognitive:** Woodcock-Johnson Revised Test (WJ-R) of Achievement: Letter-Word Identification and Applied Problems **Non-Cognitive:** Behaviour Problems Index	**Cognitive:** WJ-R Letter-Word Identification and Applied Problems **Non-Cognitive:** (1) Behaviour Problems Index; (2) Positive Behaviour Score	**Cognitive:** Peabody Picture Vocabulary Test, Matrix Reasoning Test, Who Am I? Test **Non-Cognitive:** (1) Behavioural problems; (2) Empathy, kindness, and friendliness; and (3) Emotional problems	**Cognitive:** Verbal skills from assessments: (1) the British Ability Scales (BAS) Naming Vocabulary Test; (2) BAS Word Reading Test **Non-Cognitive:** Total Difficulty Score	**Cognitive:** WJ-R Letter-Word Identification, Passage Comprehension and Applied Problems
Sample	Children (3 to 6 years; 7 to 12 years)	Children and Adolescents (0 to 18 years)	Children (4 to 8 years)	Children (3 to 7 years)	Adolescents (11 to 15 years)
Data Source	PSID-CDS*	PSID-CDS*	Longitudinal Study of Australian Children	UK Millennium Cohort Study	PSID-CDS*
Estimation Method	Generalised Propensity Scores	Individual Fixed Effects (FE), Linear Instrumental Variable (IV)	Ordinary Least Squares (OLS), Individual FE	OLS, IV, Generalised Method of Moments (GMM)	OLS (including new two-step estimator), Individual FE, Family FE

*****Panel Study of Income Dynamics – Child Development Supplement

3. Data

3.1 Panel Study of Income Dynamics and Child Development Supplement

The Panel Study of Income Dynamics (PSID) is a longitudinal study of individuals and families in the United States which began in 1968. It is a rich source of household data, providing demographic information on household heads, spouses and their children. Additional data on up to two children per PSID household was collected in the Child Development Supplement (CDS) over three waves. Children surveyed in the first wave (who were between 0 and 12 years of age) in 1997 were re-interviewed in subsequent waves in 2002 and 2007 respectively. The three waves of the CDS are useful as they provide measures of cognitive and non-cognitive skill levels of the children along with 24-hour time diaries which detail the amount of time spent on different activities by the children on a randomly selected weekday and a randomly selected weekend day.

3.2 Sample Preparation and Missing Data

Two samples were prepared for the investigation – the child sample (6 to 10 years) and the adolescent sample (11 to 15 years). In both samples, time investment variables, measures of cognitive and non-cognitive skills and demographic variables were obtained from the Child Development Supplement (CDS) or the main data from the Panel Study of Income Dynamics (PSID).

To obtain the child sample, adapting the method employed by Del Boca et al. (2017), three cohorts of children in the CDS (from 1997, 2002 and 2007) were pooled to form an initial sample of 2,715. Out of this sample, 35 children were removed as they did not have their mother's identification number (used as the family identifier) recorded. 14 children were observed twice, once when they

were 6 years of age and a second time at 10 years of age. These children (28 observations) were removed as children should only have been observed once between the ages of 6 and 10 years since they are surveyed in five-year intervals. Furthermore, 21 children (21 observations) were dropped as they were identified to have two other siblings in the sample when a maximum of two children per household were included in the CDS. From the resulting sample of 2,631, each child was retained if the following criteria were satisfied:

(1) The child's required covariates were recorded – time investments, measures of cognitive skills and non-cognitive skills, the child's age, the child's gender, his/her mother's age and the number of children born to the child's mother

(2) The child's biological mother was the child's primary caregiver

(3) The child was a biological child of a PSID household head

(4) The child was living together with both biological parents

(5) The number of children born to the child's biological mother was between 2 and 5

(6) The child had a sibling in the CDS

Following the filtering, the sample size was 510. More information on missing data in the child sample is presented in Table A1 in the Appendix.

To obtain the adolescent sample, two separate cohorts of adolescents (from 2002 and 2007) were pooled to form an initial sample of 2,876. 32 adolescents (32 observations) did not have their mother's identification number recorded and were removed from the sample. 24 adolescents were removed as they were observed twice during the ages of 11 to 15. In addition, 15 adolescents were removed as they were found to have two other siblings in the CDS though the CDS only includes up to two children per household. The criteria used to

determine whether to retain the remaining 2,781 adolescents was identical to that used for the child sample, except that adolescents were only required to be a biological child of a PSID household head and to have lived with their biological parents during childhood (6 to 10 years). Following the filtering, the total number of observations was 386. More information on missing data in the adolescent sample is presented in Table A2 in the Appendix.

3.3 Measures of Cognitive and Non-Cognitive Skills

3.3.1 Cognitive Skills

In the sample, measures of cognitive skills used are scores in three subtests of the Woodcock-Johnson Revised Tests of Achievement:

(1) *Letter-Word Identification (LW)* – Measures vocabulary level

(2) *Passage Comprehension (PC)* – Indication of comprehension ability

(3) *Applied Problems (AP)* – Assessment of mathematical ability

Standardised versions of the achievement test scores, which provide an indication of the participant's performance relative to the national average by age, were used for the investigation. These standardised scores were standardised within the sample before being used in the regressions as in Del Boca et al. (2017).

3.3.2 Non-Cognitive Skills

The measures of non-cognitive skills used are the following:

(1) *Behaviour Problems Index (BPI)* – It is an index of the level of behavioural problems exhibited. It measures the level of "externalising or aggressive behaviour" and "internalising, withdrawn or sad behaviour". (Hofferth, Davis-Kean, Davis, & Finkelstein, 1997). Higher BPI scores imply a greater level of behavioural problems.

(2) *Positive Behaviour Score (PBS)* – It provides a measure of the level of the emotional/social abilities of the child. It captures "positive aspects of children's behavioural development such as self-esteem, social competence, and persistence" (Hsin & Felfe, 2014). Higher PBS scores indicate more positive behaviour.

Both the BPI and PBS were constructed from responses by the primary caregiver of the child to survey questions on the child's behaviour. The BPI and PBS, like the achievement test scores, were standardised within the sample before being used for the analysis. Additional information on the BPI and PBS is provided in Sections G1 and G2 in the Appendix.

Table 2
Child Sample: Cognitive and Non-Cognitive Scores

	Mean	SD
Cognitive Scores (Standardised):		
Letter-Word Identification	109.47	16.74
Passage Comprehension	109.31	14.05
Applied Problems	111.33	16.84
Cognitive Scores (Raw):		
Letter-Word Identification	36.66	10.25
Passage Comprehension	20.37	7.46
Applied Problems	30.77	7.0
Non-Cognitive Scores (Raw):		
Behaviour Problems Index	8.31	7.20
Positive Behaviour Score	4.22	0.53

Number of observations = 510

Table 3
Adolescent Sample: Cognitive and Non-Cognitive Scores

	Child's Age Range 6-10		Child's Age Range 11-15	
	Mean	**SD**	**Mean**	**SD**
Cognitive Scores (Standardised):				
Letter-Word Identification	110.10	16.81	106.67	16.73
Passage Comprehension	10.01	14.38	104.67	15.03
Applied Problems	111.63	16.99	108.53	15.46
Cognitive Scores (Raw):				

Letter-Word Identification	36.29	10.43	48.31	5.15
Passage Comprehension	20.06	7.51	28.93	4.79
Applied Problems	30.42	7.10	41.93	6.16
Non-Cognitive Scores (Raw):				
Behaviour Problems Index	7.15	5.58	17.86	11.64
Positive Behaviour Score	4.23	0.54	4.17	0.57

Number of observations = 386

3.4 Time Investments

3.4.1 Categories of Time Investments

Time investments in 3 categories of activities are explored:

(1) *Educational* – general homework/studying activity, reading or being read to, using the computer for homework/research, using the computer/internet to acquire specialised information and educational games

(2) *Structured* – sports and leisure classes and activities

(3*) Unstructured* – passive leisure activities and media usage such as watching the television, listening to the radio, playing computer games and unspecified leisure activities

A complete list of the activities included in each category is provided in Appendix E. It is to be noted that the activities included in the three categories (educational, structured and unstructured) do not encompass all possible activities which the child may have engaged in during a 24-hour time period. For example, school time and sleep time have not been included in any of the three categories. The exclusion of some activities has implications on the interpretation of the results, which will be mentioned in Section 5.

3.4.2 Weekly Time Investments and Preliminary Analysis

To obtain time investments, the time spent by children in the Child Development Supplement (CDS) in each category of activities was separated into two mutually exclusive groups: (1) time spent by the child/adolescent

independently (child's time investment or self-investment) and (2) time spent by the child when his/her mother was actively involved in the activity (mother's time investment). These two groups are not comprehensive. For instance, time spent by the child together with people other than his/her mother has been excluded.

The weekly quantity of child time investments and maternal time investments in each category of activities (educational, structured and unstructured) was computed by multiplying the time spent on the weekday by five, multiplying the time spent on the weekend day by two, and summing both components. In this calculation, the implicit assumption is that the time allocations on the randomly selected weekday and weekend day were representative of how time was spent on all weekdays and weekend days respectively.

Summary statistics on time investments in the child sample (6 to 10 years) and the adolescent sample (11 to 15 years) are presented in Table 4 and Table 5 respectively. Referring to Table 4, more than 50% of those in the child sample did not invest time in educational activities and structured activities independently. Over 60% of children did not have maternal time investments in educational and structured activities. Among those who made positive time investments, there was substantial variance in time investments. This motivates the investigation of both the extensive and intensive margins of time investments in this study. From Table 5, as the children grew older, they were likely to spend more time on educational activities independently. Furthermore, mothers were less likely to spend any time with their children in educational and structured activities.

A closer examination of the child sample revealed that 8 children out of the 510 in the sample had no child time investments and maternal time investments in all three categories. As for the adolescent sample, 8 adolescents out of the 386 in the sample had no child time investments and maternal time investments in all categories of activities during adolescence (11 to 15 years). In addition, 10 adolescents had no child time investments and maternal time investments during childhood (6 to 10 years).

To provide the reader with a better understanding of the distribution of the time investments, histograms of the time investments have been included in Appendix F. Additional summary statistics on time investments may be found in Tables A3 and A4 in Appendix A.

Table 4
Child Sample: Child's and Mother's Time Investment

	% Zeros	Mean	SD
Child's Own Time Investment:			
Educational	53.73	4.17	3.31
Structured	71.96	3.12	2.64
Unstructured	33.92	7.20	7.45
Mother's Time Investment:			
Educational	60.20	3.65	3.05
Structured	62.35	4.36	3.20
Unstructured	37.06	4.98	4.48

Note: The table presents weekly time investments in hours. Mean and SD are calculated excluding the zeros. Number of observations = 510

Table 5
Adolescent Sample: Child's and Mother's Time Investment

	Child's Age Range 6-10			Child's Age Range 11-15		
	% Zeros	Mean	SD	% Zeros	Mean	SD
Child's Own Time Investment:						
Educational	52.33	4.03	3.12	30.05	7.43	6.20
Structured	72.28	3.16	2.37	74.09	3.07	2.63

Unstructured	36.79	6.68	6.60	17.62	10.73	10.56
Mother's Time Investment:						
Educational	59.33	3.54	2.98	88.08	3.58	2.73
Structured	59.33	4.63	3.52	75.39	4.58	3.78
Unstructured	37.31	4.72	4.32	44.04	6.41	6.03

Note: The table presents weekly time investments in hours. Mean and SD are calculated excluding the zeros. Number of observations = 386

3.5 Covariates of Time Use

Covariates include the child's age, gender, mother's age, birth order of the child with respect to his/her mother's biological children and a dummy for the birth cohort of the child. Additional summary statistics on covariates are provided in Tables A3 and A4 in Appendix A.

Table 6
Child Sample: Regression Covariates

	Mean	SD
Child's Age	8.05	1.43
Mother's Age	36.63	5.25
Male	0.50	0.50
Birth Order	1.88	0.84
Child in 2002	0.44	0.50
Child in 2007	0.05	0.21

Number of observations = 510

Table 7
Adolescent Sample: Regression Covariates

	Mean	SD
Child's Age	12.96	1.41
Mother's Age	41.55	4.88
Male	0.47	0.50
Birth Order	1.85	0.82
Adolescent in 2007	0.47	0.50

Number of observations = 386

4. Skill Production Functions

Referencing Todd and Wolpin (2003), Bernal (2008), Fiorini and Keane (2014) and Del Boca et al. (2017), the production function for cognitive skill or non-cognitive skill Y of child *i* from household *j* at age *t* has the following inputs:

(1) Time inputs $\boldsymbol{T_{ijt}}$ – maternal time investments $\left(\boldsymbol{M_{ijt}}\right)$, child time investments or self-investments $\left(\boldsymbol{I_{ijt}}\right)$, time investments by other family members $\left(\boldsymbol{R_{ijt}}\right)$ and school/care time $\left(\boldsymbol{S_{ijt}}\right)$

(2) Goods inputs $\boldsymbol{G_{ijt}}$ which may include, for example, the quantity of books and calorie consumption of the child

(3) Vector of controls for the starting level of the child's skill $\boldsymbol{K_{ijt}}$

(4) Individual fixed effect μ_i and family fixed effect η_{ij}, which capture the unobserved skill endowment of the child

(5) Random (idiosyncratic) shock in period *t*, ε_{ijt}

$\boldsymbol{T_{ijt}}$ and $\boldsymbol{G_{ijt}}$ do not just include the inputs at time *t* but include the complete histories of inputs up to time *t*. If the production function is linear and separable in inputs, it may be represented in the following form:

$$Y_{ijt} = \boldsymbol{\alpha T_{ijt}} + \boldsymbol{\gamma G_{ijt}} + \boldsymbol{\theta K_{ijt}} + \mu_i + \eta_{ij} + \varepsilon_{ijt}$$

4.1 Estimation Issues

There are several issues involved in the estimation of skill production functions. One issue identified by Fiorini and Keane (2014) is that detailed information about the child's activities (i.e. $\boldsymbol{T_{ijt}}$) is often unavailable Given these restrictions, studies have tended to focus on a limited range of time investments and to classify the time investments into more general categories. For instance,

some studies have only compared the time spent by the mother with the child with the time which the child spends at childcare.

Another issue identified by Fiorini and Keane (2014) is the difficulty of distinguishing between a correlation between time investments and skills and the causal effect of time investments on skills. This difficulty arises from the possibility of endogeneity, which may stem from three sources. One possible source is omitted variables bias, which may occur as certain inputs in the production function are unobserved. Potentially, omitted variables bias may be mitigated by including previous test scores as explanatory variables (Del Bono et al., 2016). Another possible source of endogeneity is simultaneity bias or reverse causality. To see why this problem might occur, consider that children with higher cognitive skill levels may be motivated to spend more time on homework/studying. The problem of simultaneity tends to be an issue when contemporaneous inputs are used to explain scores (Del Bono et al., 2016). A third possible source of endogeneity is measurement error. There may be errors in time use recordings, which may be a result of parents lacking a good understanding of their child's behaviour or intentionally misreporting their child's behaviour (Del Bono et al., 2016).

Aside from the abovementioned issues, a third issue is that models may suffer from feedback effects (Del Bono et al., 2016). These effects may be present as parents may change their resource (i.e. $\boldsymbol{G_{ijt}}$) and time investments ($\boldsymbol{M_{ijt}}$ and possibly $\boldsymbol{R_{ijt}}$) based on past observations of their children's cognitive skills and non-cognitive skills. Del Bono et al. (2016) provide evidence of feedback effects using a Generalised Method of Moments (GMM) method which uses twice lagged measures of skills as instruments.

The rich time diary data used in this study precludes the first estimation issue. To address the second issue, like Fiorini and Keane (2014), this study employs different production function models (detailed in the following section) combined with robustness checks. Unfortunately, whether the models suffer from feedback effects cannot be investigated as twice lagged measures of skills are unavailable.

4.2 Models of Skill Production Functions

Drawing insights from Todd and Wolpin (2003), Fiorini and Keane (2014), Del Bono et al. (2016) and Del Boca et al. (2017), different models of skill production functions and a discussion of the assumptions pertaining to each are presented in this section. The models of skill production functions were adapted to include dummy variables for estimating the extensive margins alongside continuous time investment variables used to estimate the intensive margins.

The components of the skill production functions are as follows, where the child is indexed by *i*, the child's household is indexed by *j* and the year is indexed by *t*:

- $D_{ijt}^{E,i}$ is a dummy variable taking the value of 1 if there is a positive amount of time spent on educational activities (E) by child *i* in household *j* weekly in year *t* and 0 otherwise. $D_{ijt}^{ST,i}$ and $D_{ijt}^{U,i}$ are similar dummies for structured (ST) and unstructured (U) activities
- $X_{ijt}^{E,i}$ denotes the weekly time spent on educational activities by child *i* in household *j* independently during year *t*. $X_{ijt}^{ST,i}$ and $X_{ijt}^{U,i}$ are similar variables for the structured and unstructured activities

- $D_{ijt}^{E,m}$, $D_{ijt}^{ST,m}$, $D_{ijt}^{U,m}$ $X_{ijt}^{E,m}$, $X_{ijt}^{ST,m}$ and $X_{ijt}^{U,m}$ are defined similarly for the weekly time spent on activities when the child's mother was actively involved
- Y_{ijt} is the measure of cognitive skill (Letter-Word Identification, Passage Comprehension or Applied Problems) or non-cognitive skill (Behaviour Problems Index or Positive Behaviour Score)
- $\boldsymbol{I_{ijt}} = \left[D_{ijt}^{E,i}, X_{ijt}^{E,i}, D_{ijt}^{ST,i}, X_{ijt}^{ST,i}, D_{ijt}^{U,i}, X_{ijt}^{U,i}\right]$ is a vector of child time investments
- $\boldsymbol{M_{ijt}} = \left[D_{ijt}^{E,m}, X_{ijt}^{E,m}, D_{ijt}^{ST,m}, X_{ijt}^{ST,m}, D_{ijt}^{U,m}, X_{ijt}^{U,m}\right]$ is a vector of maternal time investments
- $\boldsymbol{\delta}$ is a vector of parameters and $\boldsymbol{B_{ijt}}$ is a vector of control variables – the child's age, sex, mother's age, birth order of the child with respect to his/her mother and a dummy for the birth cohort of the child
- μ_i represents the individual fixed effect
- η_{ij} represents the family fixed effect
- ε_{ijt} represents the random (idiosyncratic) shock

Parameters are assumed to remain constant throughout the five years of adolescence and the five years of childhood (if applicable). However, the parameters may differ between these two life stages. All production functions are assumed to be linear and additively separable in inputs. Skill production functions are fitted using ordinary least squares (OLS) and family fixed effects (family FE) specifications. It is possible to use the family FE specification as there are siblings in the CDS and the family FE specification is useful as it eliminates unobserved heterogeneity between households.

4.2.1 Contemporaneous Inputs (Model 1)

In this model, cognitive and non-cognitive skills are only related to contemporaneous time investments. The unobserved ability endowment of the child as well as omitted variables are proxied with family-specific covariates (Fiorini & Keane, 2014).

$$Y_{ijt} = \beta_0 + \boldsymbol{\beta_1 I_{ijt}} + \boldsymbol{\beta_2 M_{ijt}} + \boldsymbol{\delta B_{ijt}} + \mu_i + \eta_{ij} + \varepsilon_{ijt}$$

Key assumptions of this model include the following: (1) only contemporaneous inputs are important in determining present skills (alternatively, contemporaneous time investments sufficiently capture all past inputs) and (2) contemporaneous inputs are not correlated with unobserved endowments of cognitive ability.

4.2.2 Contemporaneous Inputs and Lagged Skill (Model 2)

This specification assumes that skills are related to contemporaneous time investments and a lagged measure of skill, believed to be enough to capture the individual's unobserved ability endowment. For estimates to be consistent, OLS regressions require the assumption that the effect of observed inputs, unobserved inputs and unobserved endowments in ability decline at the rate of λ_t with age.

$$Y_{ijt} = \beta_0 + \boldsymbol{\beta_1 I_{ijt}} + \boldsymbol{\beta_2 M_{ijt}} + \boldsymbol{\delta B_{ijt}} + \lambda_t Y_{ij,t-5} + \mu_i + \eta_{ij} + \varepsilon_{ijt}$$

4.2.3 Contemporaneous Inputs and Lagged Inputs (Model 3)

This model allows for skills to depend on both contemporaneous time investments and lagged time investments.

$$Y_{ijt} = \beta_0 + \boldsymbol{\beta_1 I_{ijt}} + \boldsymbol{\beta_2 M_{ijt}} + \boldsymbol{\beta_3 I_{ij,t-5}} + \boldsymbol{\beta_4 M_{ij,t-5}} + \boldsymbol{\delta B_{ijt}} + \mu_i + \eta_{ij} + \varepsilon_{ijt}$$

To achieve consistency, OLS regressions require that observed inputs are uncorrelated with the unobserved endowment of ability and with unobserved inputs. Family FE regressions require the assumption that differences in observed inputs among siblings are uncorrelated with differences in their unobserved endowments and differences in their unobserved inputs.

The OLS assumption may be violated since it is likely that maternal time investments and the child's own time investments are correlated with the child's unobserved ability and other investments during early childhood (Del Boca et al., 2017).

4.2.4 Contemporaneous & Lagged Inputs and Lagged Skill (Model 4)

This model is the largest of all four models. It allows for skill levels to depend on contemporaneous time investments, lagged time investments and lagged measures of skills.

$$Y_{ijt} = \beta_0 + \boldsymbol{\beta_1 I_{ijt}} + \boldsymbol{\beta_2 M_{ijt}} + \boldsymbol{\beta_3 I_{ij,t-5}} + \boldsymbol{\beta_4 M_{ij,t-5}} + \boldsymbol{\delta B_{ijt}} + \lambda_t Y_{i,t-5} + \mu_i + \eta_{ij} + \varepsilon_{ijt}$$

This model relaxes the assumption that the effect of observed inputs declines over time at the constant rate of λ_t (assumed in model 2). For estimates to be consistent, the OLS requires the following assumptions: (1) observed inputs are uncorrelated with the error term conditional on the lagged measure of the cognitive or non-cognitive skill $Y_{i,t-5}$ and (2) the lagged measure of cognitive or non-cognitive skill $Y_{i,t-5}$ is uncorrelated with unobserved ability and the error term ϵ_{it}.

Family FE regressions require the following assumptions for estimates to be consistent: (1) observed differences in inputs between siblings are uncorrelated with differences in error terms between siblings, conditional on the difference

in the lagged measure of cognitive or non-cognitive skill between siblings and (2) the difference in the lagged measure of cognitive or non-cognitive skill between siblings is uncorrelated with the difference in unobserved ability between siblings and the difference in error terms between siblings.

5. Results and Discussion

Estimation results are reported in tables 8 to 11. The coefficients of interest are the coefficients of the dummy variables for time investments and the continuous time investment variables, which provide estimates of the extensive and intensive margins respectively. As mentioned in section 3.4, not every activity which the child engages in within 24 hours is included in one of the three categories of time investments (educational, structured and unstructured). As such, the coefficients of time investments are interpreted as relative effects rather than absolute effects. Specifically, they are effects relative to time investments in activities which have been excluded from the analysis. Henceforth, all effects discussed are relative effects.

Only model 1 production functions are fitted for the child sample because lagged scores are not available. As for the adolescent sample, only model 2 and model 4 are discussed as these models include lagged measures of skills which are statistically significant in regressions. Estimates of the other two models are presented in section B1.

In the following discussion, all achievement test scores referred to are in-sample standardised scores. Continuous time variables are in terms of the weekly number of hours spent on the specific categories of activities. Error terms are clustered by mother's identification number (family identifier) in both OLS regressions and family FE regressions.

5.1 Cognitive Skill Development of Children

Table 8 presents the estimated coefficients in the child cognitive skill production functions. The size of the child sample is 510.

5.1.1 Letter-Word Identification

Every additional hour which children spend with their mothers on unstructured activities lowers their scores by 0.0385 according to the OLS specification (i.e. intensive margin effect is 0.0385). This result is statistically significant at the 1% level. The family FE specification indicates a similar negative effect, though it is not statistically significant.

5.1.2 Passage Comprehension

Children who invest time in educational activities independently score 0.320 higher than those who do not according to the OLS specification (i.e. extensive margin effect is 0.320). This result is significant at the 5% level. A positive effect is also observed in the family FE specification, though it is not statistically significant. Children score 0.0168 higher for every additional hour which they spend on unstructured activities independently according to the family FE specification. The OLS specification also reports positive effects, though they are not statistically significant. Furthermore, the OLS specification indicates that Passage Comprehension scores are reduced with every additional hour spent by the child's mother on unstructured activities with the child. Specifically, every additional hour spent lowers scores by 0.0330. This result is statistically significant at the 5% level. However, the family FE specification reports an effect in the opposite direction, though the estimate lacks statistical significance.

5.1.3 Applied Problems

Like Passage Comprehension scores, children's Applied Problems scores are positively affected by the amount of time which they spend on unstructured activities independently. The family FE model indicates that scores improve by 0.0174 with every additional hour spent, and this result is significant at the 5% level. The OLS specification also provides a positive estimate, though it is not statistically significant.

Every additional hour spent by mothers with their children on educational activities raises the scores of their children by 0.0662 according the family FE specification. This positive effect is also seen in the OLS specification, though it lacks statistical significance. In addition, the family FE model indicates that children whose mothers spend time on structured activities with them perform better than others by 0.460. This result is significant at the 5% level.

5.1.4 Overall

Child time investments in educational activities positively influence cognitive scores on both the extensive and intensive margins. In fact, participating in some educational activities improves children's Letter-Word Identification and Passage Comprehension scores by at least 0.1 and Applied Problems scores by at least 0.07. These estimates are significantly larger than the intensive margin effects. However, some positive estimates are not statistically significant.

On the other hand, maternal time investments in educational activities negatively affect all cognitive scores on the extensive margin and have an ambiguous effect on the intensive margin. In the absence of more detailed information, it is difficult to pinpoint the exact reason for the direction of these estimated effects. It may be that the negative result reflects a selection effect.

Mothers may spend more time with children whom they believe are more disadvantaged in terms of skills. Alternatively, the negative estimate may reflect the quality of the investment provided by mothers.

The effects of time investments in structured activities and unstructured activities are not uniform across the three scores. It may be that time investments affect the development of different types of cognitive skills in different ways.

5.2 Cognitive Skill Development of Adolescents

Tables 9, 10 and 11 present the estimated coefficients for the adolescent cognitive skill production functions. The number of observations in the adolescent sample is 386.

5.2.1 Letter-Word Identification

Every additional hour which adolescents spend on educational activities by themselves raises their scores by 0.0141 - 0.0197 according to the OLS specification. This result is statistically significant at the 10% level in model 2 and at the 5% level in model 4. A similar positive effect is seen in the family FE model, though it is lower in magnitude and lacks statistical significance.

Adolescents' scores decrease by 0.152 - 0.173 with every hour which they spend on educational activities with their mothers during adolescence according to the family FE specification. This result is statistically significant at the 5% level. A similar negative effect is seen in the OLS model, though the estimate is not statistically significant. The negative effects may reflect the quality of the investment provided by mothers. Alternatively, they may reflect a selection effect. Mothers may spend more time with children whom they believe have lower skill levels.

According to the family FE specification, adolescents who spend time with their mothers in unstructured activities during childhood have scores which are 0.248 lower than those who do not (i.e. extensive margin effect is 0.248). The negative effect of unstructured activities on scores corroborates findings by Hsin and Felfe (2014). In contrast, the OLS specification indicates a positive effect.

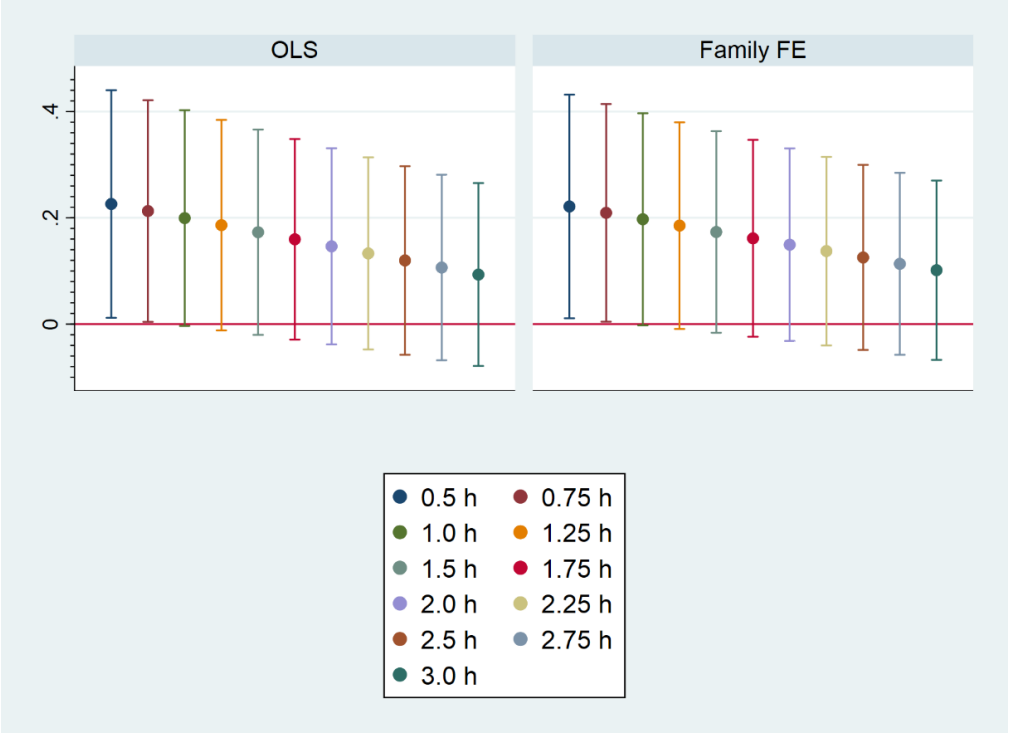
5.2.2 Passage Comprehension

Adolescents whose mothers spent time in unstructured activities with them during adolescence have Passage Comprehension scores which are 0.172 – 0.239 higher. The coefficients are significant at the 5% level in the OLS specification and at the 10% level in model 2 of the family FE specification. However, children whose mothers spent time in unstructured activities with them during childhood score 0.335 worse than those who did not according to the family FE model. The opposite effect of the same time investments during childhood and adolescence suggests that the age of the child influences the effectiveness of investments.

Adolescents who spent time on educational activities independently during childhood score 0.247 – 0.253 more than others (i.e. extensive margin effect of 0.247 – 0.253). These positive effects are significant in both the OLS and family FE specifications. Interestingly, spending excessive amounts of time on educational activities may be detrimental. Every additional hour spent on educational activities during childhood lowers scores by 0.0402 – 0.0531 (i.e. intensive margin effect of 0.0402 – 0.0531). The opposite directions of the two margins suggests that investing excessive amounts of time may be counterproductive. Alternatively, the opposite directions of the two margins may reflect endogenous investment decisions. Possibly, children who had lower

skill levels than their peers attempted to compensate for their disadvantage by spending more time on educational activities. Estimating the effects of self-investments in educational activities during childhood in 0.5-hour intervals (refer to Figure 1) reveals that adolescents who spent around 1.5 hours or more on educational activities independently during childhood may perform worse than those who do not spend any time in such activities at all.

Figure 1
Effect of Self-investments in Educational Activities During Childhood on Passage Comprehension Scores



Furthermore, adolescents who spent time on structured activities by themselves during childhood score 0.279 – 0.416 better than those who do not. In addition, the family FE specification indicates that every additional hour which adolescents spent on structured activities during childhood reduced their scores by 0.0712. This negative effect is also seen in the OLS specification, though it lacks statistical significance.

5.2.3 Applied Problems

Every additional hour which adolescents spend on educational activities raises their scores by 0.0183 – 0.0187 according to the OLS model. A similar positive effect is observed in the family FE specification, though it is not statistically significant.

Adolescents who spend time in structured activities by themselves have scores which are 0.277 – 0.279 higher than others according to the family FE specification. The OLS specification also estimates a positive effect, though it is not statistically significant. Furthermore, adolescents who engaged in structured activities during childhood score 0.329 more than those who do not according to the OLS specification. This result is significant at the 5% level. A positive effect is also estimated in the family FE specification, though it is lower in magnitude and not significant. Perhaps participating in organised sports and leisure activities may raise adaptability levels, improve reaction time and lower stress levels, contributing to better academic performance. Alternatively, the result might reflect a selection effect, where children with higher skill levels can afford to spend more time in structured activities on their own.

Adolescents who spend time with their mothers in unstructured activities score 0.182 – 0.386 higher than others. Yet, every additional hour spent on unstructured activities with the child's mother lowers scores by 0.0139 – 0.0204. Perhaps certain types of unstructured activities like unspecified play may aid in the development of problem-solving skills which are useful for mathematics. It could also be that children who choose to engage in greater amounts of time in unstructured activities possess characteristics which make them likely to have lower scores than their peers.

Every additional hour spent with their mothers on educational activities during childhood reduces adolescents' scores by 0.0483 - 0.0544, and this estimate is statistically significant in both the OLS and family FE specifications.

5.2.4 Overall

The cognitive skill development of adolescents is affected by time investments made during childhood and adolescence. Time investments affected the three cognitive scores in distinct ways, which suggests that different forms of cognitive skills may be affected differently by time investments. For example, maternal time investments in unstructured activities positively influence Passage Comprehension and Applied Problems scores on the extensive margin but negatively influence Letter-Word Identification scores on the extensive margin.

Sometimes, the extensive and intensive margins of time investments may act in opposite directions. When there are positive extensive margins and negative intensive margins of time investments on scores, investing excessive amounts of time may be detrimental.

The importance of the lagged measures of skills in explaining skill levels suggests that cognitive skill levels are highly persistent. This finding, which corroborates that of Del Boca et al. (2017), provides support for existing literature on the malleability of cognitive skill levels over time.

Table 8
Child Cognitive Skill Production Function

			Letter-Word Identification		Passage Comprehension		Applied Problems	
			OLS	Family FE	OLS	Family FE	OLS	Family FE
CHILD TIME INVESTMENT	**Educational**	*Extensive*	0.166	0.121	0.320**	0.197	0.126	0.0713
			(0.128)	(0.144)	(0.127)	(0.161)	(0.130)	(0.128)
		Intensive	0.0281	0.0339	0.00408	0.0119	0.0180	0.0306
			(0.0197)	(0.0213)	(0.0188)	(0.0287)	(0.0181)	(0.0229)
	Structured	*Extensive*	0.0616	0.00700	-0.00876	-0.134	0.157	-0.0367
			(0.143)	(0.167)	(0.151)	(0.188)	(0.152)	(0.170)
		Intensive	0.0118	0.0163	0.0165	0.0369	-0.0425	-0.00984
			(0.0371)	(0.0374)	(0.0418)	(0.0509)	(0.0337)	(0.0379)
	Unstructured	*Extensive*	-0.0457	0.0534	-0.0870	-0.167	0.0405	0.0127
			(0.112)	(0.151)	(0.104)	(0.163)	(0.116)	(0.148)
		Intensive	-0.000888	0.00736	0.00100	0.0168*	0.00534	0.0174**
			(0.00636)	(0.00880)	(0.00699)	(0.0100)	(0.00899)	(0.00845)
MATERNAL TIME INVESTMENT	**Educational**	*Extensive*	-0.00566	-0.0190	-0.0467	-0.221	-0.0992	-0.255
			(0.129)	(0.165)	(0.118)	(0.173)	(0.129)	(0.164)
		Intensive	-0.0107	-0.0174	-0.00837	0.0223	0.0161	0.0662**
			(0.0197)	(0.0249)	(0.0184)	(0.0291)	(0.0198)	(0.0299)
	Structured	*Extensive*	-0.00755	-0.0306	-0.0533	-0.0313	0.120	0.460**
			(0.140)	(0.204)	(0.134)	(0.197)	(0.139)	(0.190)
		Intensive	0.00698	0.00684	-0.00682	-0.0139	-0.00968	-0.0474

			(0.0230)	(0.0241)	(0.0238)	(0.0267)	(0.0239)	(0.0298)
	Unstructured	*Extensive*	0.161	-0.0974	0.144	-0.168	0.0360	-0.0633
			(0.119)	(0.172)	(0.109)	(0.177)	(0.116)	(0.169)
		Intensive	-0.0385***	-0.00390	-0.0330**	0.00221	-0.0104	0.00827
			(0.0116)	(0.0196)	(0.0143)	(0.0244)	(0.0123)	(0.0187)

*** p<0.01, ** p<0.05, * p<0.1

Table 9
Adolescent Cognitive Skill Production Function: Letter-Word Identification

			Model 2		**Model 4**	
			OLS	Family FE	OLS	Family FE
CHILD TIME INVESTMENT	**Educational**	*Extensive*	-0.0381	-0.0910	-0.0963	-0.121
			(0.105)	(0.138)	(0.105)	(0.146)
		Intensive	0.0141*	0.00142	0.0197**	0.00469
			(0.00841)	(0.00882)	(0.00867)	(0.00857)
	Structured	*Extensive*	-0.0308	-0.108	-0.0719	-0.0853
			(0.154)	(0.172)	(0.145)	(0.186)
		Intensive	0.0483	0.0608	0.0498	0.0590
			(0.0372)	(0.0403)	(0.0374)	(0.0423)
	Unstructured	*Extensive*	-0.0530	0.114	-0.0685	0.0893
			(0.120)	(0.122)	(0.118)	(0.129)
		Intensive	0.00360	0.000819	0.00208	0.000669
			(0.00483)	(0.00532)	(0.00466)	(0.00554)

MATERNAL TIME INVESTMENT	**Educational**	*Extensive*	0.227	0.269	0.203	0.307
			(0.199)	(0.247)	(0.198)	(0.249)
		Intensive	-0.0209	-0.152**	-0.0177	-0.173**
			(0.0355)	(0.0675)	(0.0361)	(0.0670)
	Structured	*Extensive*	-0.0502	-0.274	-0.0722	-0.275
			(0.120)	(0.184)	(0.124)	(0.183)
		Intensive	0.0135	0.0316	0.0115	0.0307
			(0.0182)	(0.0207)	(0.0182)	(0.0220)
	Unstructured	*Extensive*	0.00484	-0.0308	-0.00623	-0.0475
			(0.0934)	(0.127)	(0.0937)	(0.129)
		Intensive	-0.00487	0.00889	-0.00507	0.0117
			(0.0103)	(0.0150)	(0.0103)	(0.0158)
LAG (CHILD TIME INVESTMENT)	**Educational**	*Extensive*			0.0169	0.151
					(0.132)	(0.139)
		Intensive			-0.0192	0.0109
					(0.0214)	(0.0212)
	Structured	*Extensive*			0.239	0.0554
					(0.147)	(0.192)
		Intensive			-0.0245	0.0272
					(0.0274)	(0.0354)
	Unstructured	*Extensive*			-0.0535	0.0685
					(0.0936)	(0.114)
		Intensive			0.0109	0.0120
					(0.00805)	(0.00951)
LAG (MATERNAL	**Educational**	*Extensive*			-0.0432	0.0465

TIME INVESTMENT)					(0.110)	(0.141)
		Intensive			-0.00837	-0.0203
					(0.0195)	(0.0242)
	Structured	*Extensive*			0.0918	0.0698
					(0.131)	(0.209)
		Intensive			0.0165	-0.0179
					(0.0230)	(0.0329)
	Unstructured	*Extensive*			0.0572	-0.248*
					(0.0995)	(0.138)
		Intensive			-0.00943	0.00313
					(0.0108)	(0.0150)
	Lagged Score		0.536***	0.346***	0.532***	0.316***
			(0.0524)	(0.0583)	(0.0532)	(0.0607)

*** p<0.01, ** p<0.05, * p<0.1

Table 10
Adolescent Cognitive Skill Production Function: Passage Comprehension

			Model 2		**Model 4**	
			OLS	Family FE	OLS	Family FE
CHILD	**Educational**	*Extensive*	0.0354	-0.0741	-0.0284	-0.170
TIME INVESTMENT			(0.109)	(0.139)	(0.110)	(0.148)
		Intensive	0.00891	-0.000800	0.0157*	0.00476
			(0.00853)	(0.0126)	(0.00915)	(0.0132)
	Structured	*Extensive*	0.181	-0.0968	0.152	-0.108

			(0.142)	(0.173)	(0.145)	(0.174)
		Intensive	-0.0133	0.0265	-0.0153	0.0234
			(0.0282)	(0.0345)	(0.0283)	(0.0357)
	Unstructured	*Extensive*	0.0177	0.103	0.0115	0.0577
			(0.122)	(0.158)	(0.121)	(0.168)
		Intensive	0.00476	-8.15e-05	0.00408	0.00182
			(0.00443)	(0.00580)	(0.00450)	(0.00627)
MATERNAL TIME INVESTMENT	**Educational**	*Extensive*	-0.226	-0.141	-0.246	-0.208
			(0.138)	(0.220)	(0.150)	(0.224)
		Intensive	0.0450	-0.0143	0.0469	-0.0220
			(0.0284)	(0.0784)	(0.0285)	(0.0743)
	Structured	*Extensive*	0.239*	0.112	0.183	0.0240
			(0.124)	(0.170)	(0.127)	(0.162)
		Intensive	-0.0189	-0.0107	-0.0166	0.00828
			(0.0183)	(0.0213)	(0.0175)	(0.0238)
	Unstructured	*Extensive*	0.217**	0.239*	0.185**	0.172
			(0.0907)	(0.139)	(0.0926)	(0.134)
		Intensive	-0.00734	-0.00142	-0.00530	0.00662
			(0.00853)	(0.0156)	(0.00825)	(0.0155)
LAG (CHILD TIME INVESTMENT)	**Educational**	*Extensive*			0.253**	0.247*
					(0.115)	(0.144)
		Intensive			-0.0531***	-0.0402*
					(0.0187)	(0.0232)
	Structured	*Extensive*			0.279*	0.416**
					(0.148)	(0.160)

		Intensive			-0.0491	-0.0712**
					(0.0355)	(0.0355)
	Unstructured	*Extensive*			0.0165	0.0137
					(0.0956)	(0.156)
		Intensive			0.00402	0.0191
					(0.00670)	(0.0128)
LAG (MATERNAL TIME INVESTMENT)	**Educational**	*Extensive*			-0.105	-0.0206
					(0.114)	(0.180)
		Intensive			0.00637	-0.00550
					(0.0218)	(0.0356)
	Structured	*Extensive*			0.114	0.00163
					(0.126)	(0.231)
		Intensive			0.0240	0.00821
					(0.0185)	(0.0438)
	Unstructured	*Extensive*			-0.0130	-0.335**
					(0.101)	(0.137)
		Intensive			0.00663	0.0249
					(0.0107)	(0.0174)
	Lagged Score		0.557***	0.361***	0.553***	0.340***
			(0.0504)	(0.0626)	(0.0520)	(0.0664)

*** p<0.01, ** p<0.05, * p<0.1

Table 11
Adolescent Cognitive Skill Production Function: Applied Problems

			Model 2		Model 4	
			OLS	Family FE	OLS	Family FE
CHILD TIME INVESTMENT	**Educational**	*Extensive*	-0.0279	-0.0524	-0.0352	-0.0795
			(0.0908)	(0.125)	(0.0926)	(0.135)
		Intensive	0.0183**	0.0118	0.0187**	0.0134
			(0.00779)	(0.00866)	(0.00824)	(0.00916)
	Structured	*Extensive*	0.237	0.277*	0.227	0.279*
			(0.149)	(0.166)	(0.139)	(0.165)
		Intensive	-0.0289	-0.0376	-0.0249	-0.0346
			(0.0334)	(0.0384)	(0.0296)	(0.0334)
	Unstructured	*Extensive*	0.0802	0.0908	0.0609	0.0593
			(0.115)	(0.158)	(0.113)	(0.161)
		Intensive	0.00455	0.00767	0.00380	0.00702
			(0.00362)	(0.00544)	(0.00395)	(0.00582)
MATERNAL TIME INVESTMENT	**Educational**	*Extensive*	-0.201	-0.178	-0.187	-0.143
			(0.174)	(0.216)	(0.164)	(0.208)
		Intensive	0.0441	-0.0290	0.0433	-0.0437
			(0.0423)	(0.0669)	(0.0379)	(0.0618)
	Structured	*Extensive*	0.0170	-0.0120	-0.0283	0.0104
			(0.119)	(0.138)	(0.120)	(0.152)
		Intensive	0.0209	0.0255	0.0225	0.0207
			(0.0189)	(0.0206)	(0.0186)	(0.0226)

	Unstructured	*Extensive*	0.194**	0.386***	0.182*	0.362***
			(0.0916)	(0.121)	(0.0929)	(0.127)
		Intensive	-0.0166**	-0.0204	-0.0139*	-0.0195
			(0.00755)	(0.0129)	(0.00727)	(0.0133)
LAG (CHILD TIME INVESTMENT)	**Educational**	*Extensive*			0.119	0.198
					(0.107)	(0.141)
		Intensive			-0.0191	-0.0185
					(0.0164)	(0.0211)
	Structured	*Extensive*			0.329**	0.0471
					(0.140)	(0.167)
		Intensive			-0.0488	-0.0169
					(0.0320)	(0.0388)
	Unstructured	*Extensive*			-0.00224	0.0425
					(0.0946)	(0.141)
		Intensive			-0.00365	0.00188
					(0.00764)	(0.0105)
LAG (MATERNAL TIME INVESTMENT)	**Educational**	*Extensive*			0.0977	0.109
					(0.105)	(0.142)
		Intensive			-0.0483***	-0.0544**
					(0.0172)	(0.0228)
	Structured	*Extensive*			-0.0670	-0.195
					(0.124)	(0.200)
		Intensive			0.00124	-0.00337
					(0.0179)	(0.0315)
	Unstructured	*Extensive*			-0.0232	-0.204

				(0.0965)	(0.142)
	Intensive			0.00572	0.000861
				(0.0111)	(0.0151)
Lagged Score		0.636***	0.405***	0.640***	0.425***
		(0.0410)	(0.0624)	(0.0403)	(0.0634)

*** p<0.01, ** p<0.05, * p<0.1

5.3 Non-Cognitive Skill Development

Non-cognitive skills are generally unaffected by time investments, which echoes findings of Carneiro and Rodrigues (2009) and Fiorini and Keane (2014). However, there are some exceptions. Child time investments in structured activities negatively affect the Behaviour Problems Index (BPI) and positively affect the Positive Behaviour Score (PBS) of children (6 to 10 years) on the intensive margin at the 10% level according to the family FE specification. The OLS specification also indicates effects in the same directions, though the estimates lack statistical significance. In addition, child time investments in educational activities negatively influence the BPI of adolescents on the intensive margin at the 5% significance level according to the family FE specification. This negative effect is also reflected in the OLS specification, though it is only significant in model 4. Furthermore, maternal time investments in unstructured activities positively affect the PBS of adolescents on the extensive margin and negatively affect them on the intensive margin according to the OLS specification. Moreover, the OLS specification also suggests that maternal time investments in educational activities made during childhood negatively affect adolescents' PBS scores on the intensive margin. The family FE model also indicates effects in the same directions as the OLS specification, though estimates are not always significant. Coefficient estimates are presented in section B2.

5.4 Heterogeneity

To detect heterogeneity along the dimensions of gender and race, skill production functions were adapted to include relevant dummy variables and interaction terms between the dummy variables and time investment variables.

5.4.1 Gender

Time investments influence the cognitive skill development of males and females differently, corroborating findings of Del Bono et al. (2016). Detailed results are provided in section C1.

Child Cognitive Skills: The estimated margins were in opposite directions for both genders in several cases. Some instances include educational self-investments on Letter-Word Identification scores and Applied Problems scores on the intensive margin, self-investments in structured activities on Passage Comprehension scores on both margins and maternal time investments in educational activities on Letter-Word Identification scores on the extensive margin.

Adolescent Cognitive Skills: Again, there are various cases where the estimated margins were in opposite directions. For example, females' Letter-Word Identification scores benefit from self-investments in structured activities made during childhood on the extensive margin while males' scores are adversely affected by the same time investments. In addition, male children's Passage Comprehension scores are positively influenced by self-investments in educational activities made during adolescence on the intensive margin while the opposite is true for females. Furthermore, maternal time investments in structured activities made during adolescence positively influence the Applied Problems scores of females on the extensive margin while the opposite is true for males.

Overall, the results hint that the process of skill development is gender-specific. Self-investments and maternal time investments in some activities may have opposite effects on both genders. A possible application is that male and female

children could be encouraged to participate in different activities in order to build skills and address skill disadvantages more effectively.

5.4.2 Race

Time investments affect White children and Black children in different ways, which supports the findings of Carneiro and Rodrigues (2009). There are fewer observations (452 observations in the child sample and 344 observations in the adolescent sample) as children who did not have their race recorded were dropped and only White and Black children were included in the analysis. Estimates are presented in section C2.

Child Cognitive Skills: All three cognitive scores of White children improve with child self-investments in educational activities on the extensive margin. In contrast, Black children do not gain as much and may even do worse by investing time in educational activities independently. On the other hand, Black children's Letter-Word Identification (LW) and Passage Comprehension (PC) scores improve when they engage in self-investments in structured activities while White children's LW and PC scores suffer instead.

Adolescent Cognitive Skills: The LW and PC scores of White children are positively affected by educational self-investments made during adolescence on the extensive margin. However, the same time investment negatively affects LW and PC scores of Black children on the extensive margin. In addition, maternal time investments in educational activities made during adolescence positively influence White children's PC scores on the intensive margin but negatively influence Black children's scores on the same margin. Maternal time investments in educational activities made during childhood have a greater

negative impact on Black children's Applied Problems scores on the intensive margin than White children.

Possibly, differences in the impacts of time investments may have their origins in family background factors not controlled for by mothers' characteristics as White and Black children typically have different family environments.

6. Sensitivity Analyses

The sensitivity analyses in this section focus on cognitive skill development as non-cognitive skills are generally unaffected by time investments. The positive extensive margin and negative intensive margin of child time investments in educational activities during childhood on Passage Comprehension scores remained significant in the OLS specification in all cases.

6.1 Alternative Error Specification

Robust standard errors were used instead of clustered standard errors. Generally, estimated results were robust to the change in error specification. Regression results are presented in section D1.

6.2 OLS Regressions Including Children Without Siblings in the CDS

In the main analysis, children and adolescents were only included in the OLS regressions if they had a sibling in the Child Development Supplement (CDS). Including children without siblings increased the size of the child sample and the adolescent sample to 941 and 684 respectively. Time investments which were significant in the main analysis generally remained significant after the addition. However, various estimates from the enlarged sample were observed to be different from that of the main sample, both in terms of the direction of effects and significance levels. Detailed estimates are reported in section D2.

6.3 Non-Linear Functional Form

The implicit assumption in the use of linear production functions in the main analysis was that the effect of time investments does not depend on the quantity of time invested. To relax this assumption, squared time investment variables were included in the skill production functions. The time investment variables which significantly affected the Letter-Word Identification and Passage Comprehension scores of children (6 to 10 years) in the main analysis remained significant. As for the adolescent sample, results which remained significant after the change in functional form include: (1) the positive extensive margin and negative intensive margin of self-investments made during childhood on Passage Comprehension (PC) scores in the OLS model; (2) the positive extensive margin of self-investments in structured activities made during childhood on PC scores; (3) the negative extensive margin of maternal time investments in unstructured activities made during childhood on PC scores in the family FE specification; (4) the positive extensive margin of maternal time investments in unstructured activities made during adolescence on Applied Problems scores and (5) the positive extensive margin of child self-investments in structured activities made during childhood on Applied Problems scores in the OLS specification. Apart from these, several marginal effects estimated from the non-linear model were considerably different from the main results, indicating that estimates may be sensitive to functional form specifications and that the linearity assumption might be questionable. Detailed results are provided in section D3.

6.4 Paternal Time Investments

Paternal time investment variables were added to the cognitive skill production functions of children (6 to 10 years). They were found to be important determinants of all three cognitive scores of children (6 to 10 years). For example, paternal time investments in structured activities improve children's Passage Comprehension scores on the intensive margin by 0.0897 – 0.0967. This result is significant at the 1% level. Detailed estimates may be found in section D4. The estimated significance levels of child time investments and maternal time investments generally remained the same. Unfortunately, the effect of paternal time investments on the skill development of adolescents (11 to 15 years) could not be explored as the sample size was too small to make meaningful inferences.

7. Conclusion

Various studies have found that the amount of time invested in activities by mothers (maternal time investments) and children themselves (child time investments or self-investments) matter in skill development. Aside from the quantity of time invested (i.e. intensive margin of time investments), might the decision to spend time on/not to spend time on specific activities also shed light on the process of skill development? In other words, do the extensive margins of time investments matter? Might they provide additional insights into the relationship between time investments and skill development?

To address these questions, this study estimates the extensive and intensive margins of child time investments and maternal time investments in three categories of activities (educational, structured and unstructured) on the skill development of children (6 to 10 years) and adolescents (11 to 15 years). To

quantify the margins, using data from the Panel Study of Income Dynamics, skill production functions with maternal time investments and child time investments as inputs were fitted using ordinary least squares (OLS) and family fixed effects (family FE) specifications.

Estimates uncovered that the extensive margins of time investments affect cognitive skill development. Furthermore, in some instances, the extensive and intensive margins may act in opposite directions. For example, adolescents' self-investments in educational activities during childhood positively affected their Passage Comprehension (PC) scores on the extensive margin but negatively affected their PC scores on the intensive margin. In other words, adolescents who spent time on educational activities independently during childhood have higher Passage Comprehension scores than those who did not. However, every additional hour spent on educational activities independently during childhood adversely affected PC scores.

While cognitive skills were affected by time investments, non-cognitive skills were generally unaffected. Therefore, the remaining heterogeneity analyses and sensitivity analyses focused on time investments and cognitive skill development. Exploring heterogeneity along the gender dimension revealed that males and females are affected differently by time investments on both margins. This hints that the process of skill development differs for each gender and implies that programmes intended to remediate disadvantages in skills may be more effective if they are gender-specific. In addition, time investments affect White and Black children in different ways. Since Whites and Blacks typically experience different family environments, this finding may indicate that family background factors influence the impact of time investments on skill

development. Furthermore, paternal time investments were found to affect the cognitive skill development of children.

There are several useful directions for future research. Firstly, it would be interesting to investigate whether factors other than time investments (e.g. holistic development programmes, parenting style and peer effects) are more important in non-cognitive skill development. Secondly, since this study suggests that time investments may affect each gender differently, further investigations into whether other inputs in skill production also affect both genders differently will be informative.

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Appendix A: Missing Data and Summary Statistics

Table A1
Child Sample: Missing Data

Variable	Number Recorded	% Missing
Contemporaneous Time Investments	2,219	15.7
Cognitive Scores:		
Letter-Word Identification	2,207	16.1
Passage Comprehension	2,192	16.7
Applied Problems	2,202	16.3
Non-Cognitive Scores:		
Behaviour Problems Index	2,429	7.7
Positive Behaviour Score	2,482	5.7
Child's Age	2,631	0.0
Child's Gender	2,631	0.0
Mother's Age	2,559	2.7
Mother is Primary Caregiver	1,971	25.1
Biological Child of Household Head	2,318	11.9
Living Together with Both Biological Parents	1,441	45.2
Number of Children Born to Biological Mother between 2 and 5	2,242	14.8
Sibling Present in Child Development Supplement	1,498	43.1

Number of observations = 2,631

Table A2
Adolescent Sample: Missing Data

Variable	Number Recorded	% Missing
Contemporaneous Time Investments	2,311	16.9
Cognitive Scores:		
Letter-Word Identification	2,344	15.7
Passage Comprehension	2,339	15.9
Applied Problems	2,341	15.8
Non-Cognitive Scores:		
Behaviour Problems Index	2,515	9.6
Positive Behaviour Score	2,547	8.4
Lagged Time Investments	2,172	21.9
Lagged Cognitive Scores:		
Letter-Word Identification	1,952	29.8
Passage Comprehension	1,923	30.9
Applied Problems	1,948	30.0
Lagged Non-Cognitive Scores:		
Behaviour Problems Index	2,143	22.9
Positive Behaviour Score	2,189	21.3
Child's Age	2,781	0.0
Child's Gender	2,781	0.0
Mother's Age	2,662	4.3

Mother is Primary Caregiver during Childhood and Adolescence	1,508	45.8
Biological Child of Household Head during Childhood	2,399	13.7
Living Together with Both Biological Parents during Childhood	1,344	51.7
Number of Children Born to Biological Mother between 2 and 5	2,377	14.5
Sibling Present in Child Development Supplement	1,598	42.5

Number of observations = 2,781

Table A3
Child Sample: Summary Statistics

	Mean	SD	Min	Max	% Zeros
Child's Own Time Investment:					
Educational	4.17	3.31	0.1	24	53.73
Structured	3.12	2.64	0.07	15	71.96
Unstructured	7.20	7.45	0.1	45	33.92
Mother's Time Investment:					
Educational	3.65	3.05	0.07	20	60.20
Structured	4.36	3.20	0.07	17	62.35
Unstructured	4.98	4.48	0.17	30	37.06
Cognitive Scores (Standardised):					
Letter-Word Identification	109.47	16.74	54	158	
Passage Comprehension	109.31	14.05	62	152	
Applied Problems	111.33	16.84	56	156	
Cognitive Scores (Raw):					
Letter-Word Identification	36.66	10.25	6	57	
Passage Comprehension	20.37	7.46	0	38	
Applied Problems	30.77	7.0	12	48	
Non-Cognitive Scores (Raw):					
Behaviour Problems Index	8.31	7.20	0	30	
Positive Behaviour Score	4.22	0.53	1.5	5	
Covariates:					
Child's Age	8.05	1.43	6	10	
Mother's Age	36.63	5.25	23	52	
Male	0.50	0.50	0	1	
Birth Order	1.88	0.84	1	5	
Child in 2002	0.44	0.50	0	1	
Child in 2007	0.05	0.21	0	1	

The table presents weekly time investments in hours. The mean, SD, min and max of time investments are calculated excluding zero values.
Number of observations = 510

Table A4
Adolescent Sample: Summary Statistics

	Mean	SD	Min	Max	% Zeros
Child's Age 6 to 10 years					
Child's Own Time Investment:					
Educational	4.03	3.12	0.1	18	52.33
Structured	3.16	2.37	0.07	10.67	72.28
Unstructured	6.68	6.60	0.1	44.1	36.79
Mother's Time Investment:					
Educational	3.54	2.98	0.5	20	59.33
Structured	4.63	3.52	0.07	17	59.33
Unstructured	4.72	4.32	0.17	30	37.31
Cognitive Scores (Standardised):					
Letter-Word Identification	110.10	16.81	54	158	
Passage Comprehension	10.01	14.38	62	152	
Applied Problems	111.63	16.99	56	156	
Cognitive Scores (Raw):					
Letter-Word Identification	36.29	10.43	6	57	
Passage Comprehension	20.06	7.51	0	38	
Applied Problems	30.42	7.10	12	48	
Non-Cognitive Scores (Raw):					
Behaviour Problems Index	7.15	5.58	0	24	
Positive Behaviour Score	4.23	0.54	1.5	5	
Child's Age 11 to 15 years					
Child's Own Time Investment:					
Educational	7.43	6.20	0.17	33.67	30.05
Structured	3.07	2.63	0.07	15	74.09
Unstructured	10.73	10.56	0.17	61.77	17.62
Mother's Time Investment:					
Educational	3.58	2.73	0.33	12.33	88.08
Structured	4.58	3.78	0.2	20	75.39
Unstructured	6.41	6.03	0.23	37	44.04
Cognitive Scores (Standardised):					
Letter-Word Identification	106.67	16.73	53	174	
Passage Comprehension	104.67	15.03	59	143	
Applied Problems	108.53	15.46	52	166	
Cognitive Scores (Raw):					
Letter-Word Identification	48.31	5.15	23	57	
Passage Comprehension	28.93	4.79	11	40	
Applied Problems	41.93	6.16	20	59	
Non-Cognitive Scores (Raw):					
Behaviour Problems Index	17.86	11.64	0	30	

	Mean	SD	Min	Max	% Zeros
Positive Behaviour Score	4.17	0.57	1	5	
Covariates:					
Child's Age	12.96	1.41	11	15	
Mother's Age	41.55	4.88	28	54	
Male	0.47	0.50	0	1	
Birth Order	1.85	0.82	1	5	
Adolescent in 2007	0.47	0.50	0	1	

The table presents weekly time investments in hours. The mean, SD, min and max of time investments are calculated excluding zero values.
Number of observations = 386

Appendix B: Additional Tables

B1 Adolescent Skill Production Functions

Table B1.1
Adolescent Cognitive Skill Production Function: Letter-Word Identification

			Model 1		Model 3	
			OLS	Family FE	OLS	Family FE
CHILD TIME INVESTMENT	**Educational**	*Extensive*	0.00811	-0.0694	-0.0711	-0.104
			(0.125)	(0.149)	(0.125)	(0.153)
		Intensive	0.0180	0.000348	0.0240**	0.00496
			(0.0111)	(0.0102)	(0.0111)	(0.00958)
	Structured	*Extensive*	0.179	-0.0902	0.156	-0.0495
			(0.173)	(0.173)	(0.161)	(0.184)
		Intensive	0.0424	0.0566	0.0315	0.0525
			(0.0450)	(0.0450)	(0.0428)	(0.0463)
	Unstructured	*Extensive*	-0.0168	0.132	-0.0699	0.0850
			(0.147)	(0.129)	(0.145)	(0.134)
		Intensive	0.00381	-0.00117	0.00369	-0.00126
			(0.00644)	(0.00607)	(0.00639)	(0.00614)
MATERNAL TIME INVESTMENT	**Educational**	*Extensive*	0.0852	0.219	0.0985	0.286
			(0.224)	(0.270)	(0.228)	(0.255)
		Intensive	-0.00256	-0.150*	-0.00664	-0.178**
			(0.0416)	(0.0796)	(0.0432)	(0.0753)
	Structured	*Extensive*	-0.120	-0.245	-0.116	-0.260
			(0.140)	(0.183)	(0.144)	(0.170)
		Intensive	0.0141	0.0146	0.00674	0.0145
			(0.0234)	(0.0247)	(0.0222)	(0.0234)

	Unstructured	*Extensive*	0.0632	0.0182	0.0230	-0.000618
			(0.115)	(0.140)	(0.114)	(0.142)
		Intensive	-0.0145	0.00786	-0.00929	0.0113
			(0.0139)	(0.0173)	(0.0143)	(0.0183)
LAG (CHILD TIME INVESTMENT)	**Educational**	*Extensive*			0.163	0.232
					(0.159)	(0.147)
		Intensive			-0.00973	0.00640
					(0.0250)	(0.0227)
	Structured	*Extensive*			0.297*	0.0653
					(0.178)	(0.200)
		Intensive			-0.0191	0.0434
					(0.0353)	(0.0362)
	Unstructured	*Extensive*			-0.0990	0.0827
					(0.118)	(0.123)
		Intensive			0.00989	0.0147
					(0.00859)	(0.00947)
LAG (MATERNAL TIME INVESTMENT)	**Educational**	*Extensive*			-0.0503	0.00321
					(0.129)	(0.150)
		Intensive			-0.0103	-0.0174
					(0.0217)	(0.0238)
	Structured	*Extensive*			0.0823	0.0624
					(0.156)	(0.200)
		Intensive			0.0218	-0.0204
					(0.0275)	(0.0306)
	Unstructured	*Extensive*			0.125	-0.226
					(0.128)	(0.156)
		Intensive			-0.0307**	-0.00302
					(0.0137)	(0.0167)
	Controls					

Child's age	0.144	-0.462	0.0879	-0.461
	(0.707)	(0.582)	(0.740)	(0.683)
(Child's age)^2	-0.00886	0.0170	-0.00677	0.0163
	(0.0270)	(0.0223)	(0.0283)	(0.0262)
Mother's age	0.267*	-0.197	0.211	-0.338
	(0.140)	(0.335)	(0.138)	(0.341)
(Mother's age)^2	-0.00277	-0.00351	-0.00221	-0.00274
	(0.00170)	(0.00272)	(0.00166)	(0.00247)
Male	-0.253***	-0.182	-0.265***	-0.217**
	(0.0924)	(0.112)	(0.0962)	(0.105)
Birth order	-0.229***	-0.0564	-0.214***	-0.0418
	(0.0834)	(0.140)	(0.0804)	(0.134)
Adolescent in 2007	0.0242	2.340	0.0487	2.642
	(0.121)	(1.518)	(0.117)	(1.651)
Constant	-6.189	16.53	-4.571	20.95
	(5.353)	(12.00)	(5.399)	(13.53)
Observations	386	386	386	386
R-squared	0.152	0.120	0.195	0.195
Number of sibling groups		193		193

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table B1.2
Adolescent Cognitive Skill Production Function: Passage Comprehension

			Model 1		**Model 3**	
			OLS	Family FE	OLS	Family FE
CHILD TIME	**Educational**	*Extensive*	0.0671	-0.0673	-0.0114	-0.163
			(0.134)	(0.147)	(0.135)	(0.154)

INVESTMENT		*Intensive*	0.0187*	-0.000414	0.0252**	0.00597
			(0.00979)	(0.0131)	(0.0105)	(0.0139)
	Structured	*Extensive*	0.204	-0.133	0.214	-0.115
			(0.155)	(0.187)	(0.158)	(0.195)
		Intensive	0.00446	0.0386	-0.0124	0.0314
			(0.0344)	(0.0367)	(0.0325)	(0.0395)
	Unstructured	*Extensive*	0.0893	0.143	0.0590	0.0948
			(0.143)	(0.177)	(0.143)	(0.192)
		Intensive	0.00536	0.00125	0.00635	0.00324
			(0.00624)	(0.00658)	(0.00614)	(0.00691)
MATERNAL TIME INVESTMENT	**Educational**	*Extensive*	-0.298	-0.00102	-0.281	-0.0645
			(0.189)	(0.265)	(0.199)	(0.245)
		Intensive	0.0600	-0.0457	0.0541	-0.0555
			(0.0523)	(0.0899)	(0.0514)	(0.0814)
	Structured	*Extensive*	0.0915	0.0461	0.0674	-0.0491
			(0.153)	(0.188)	(0.157)	(0.173)
		Intensive	-0.00808	-0.0234	-0.0109	-0.00511
			(0.0221)	(0.0270)	(0.0212)	(0.0271)
	Unstructured	*Extensive*	0.224**	0.173	0.160	0.0992
			(0.113)	(0.151)	(0.113)	(0.143)
		Intensive	-0.0154	0.00797	-0.00776	0.0179
			(0.0119)	(0.0150)	(0.0120)	(0.0151)
LAG (CHILD TIME INVESTMENT)	**Educational**	*Extensive*			0.475***	0.400***
					(0.141)	(0.148)
		Intensive			-0.0569**	-0.0605**
					(0.0231)	(0.0251)
	Structured	*Extensive*			0.260	0.343*
					(0.179)	(0.185)
		Intensive			-0.0319	-0.0393
					(0.0425)	(0.0411)

	Unstructured	*Extensive*			-0.0630	-0.0139
					(0.119)	(0.168)
		Intensive			0.00108	0.0222
					(0.00865)	(0.0137)
LAG (MATERNAL TIME INVESTMENT)	**Educational**	*Extensive*			-0.141	-0.153
					(0.136)	(0.196)
		Intensive			0.00817	0.0103
					(0.0260)	(0.0355)
	Structured	*Extensive*			0.109	-0.0385
					(0.148)	(0.242)
		Intensive			0.0271	-0.00206
					(0.0230)	(0.0446)
	Unstructured	*Extensive*			0.0542	-0.384**
					(0.121)	(0.154)
		Intensive			-0.00996	0.0302
					(0.0132)	(0.0188)
	Controls					
	Child's age		0.762	0.455	0.354	-0.279
			(0.661)	(0.718)	(0.663)	(0.720)
	(Child's age)^2		-0.0326	-0.0170	-0.0170	0.0105
			(0.0254)	(0.0278)	(0.0255)	(0.0277)
	Mother's age		0.463***	0.400	0.398***	0.0604
			(0.131)	(0.316)	(0.120)	(0.357)
	(Mother's age)^2		-0.00500***	-0.00475*	-0.00431***	-0.00490**
			(0.00158)	(0.00261)	(0.00145)	(0.00241)
	Male		-0.00977	-0.0384	0.0324	-0.0725
			(0.0995)	(0.116)	(0.0994)	(0.104)
	Birth order		-0.271***	-0.0363	-0.268***	-0.0577
			(0.0805)	(0.158)	(0.0777)	(0.155)

Adolescent in 2007	-0.000949	-0.106	-0.00675	1.611
	(0.123)	(1.288)	(0.120)	(1.639)
Constant	-14.64***	-11.30	-10.70**	7.243
	(4.478)	(10.84)	(4.346)	(13.82)
Observations	386	386	386	386
R-squared	0.176	0.066	0.232	0.162
Number of sibling groups		193		193

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table B1.3
Adolescent Cognitive Skill Production Function: Applied Problems

			Model 1		Model 3	
			OLS	Family FE	OLS	Family FE
CHILD	**Educational**	*Extensive*	-0.142	-0.150	-0.180	-0.198
TIME			(0.121)	(0.135)	(0.125)	(0.143)
INVESTMENT		*Intensive*	0.0310***	0.0143	0.0333***	0.0182*
			(0.00907)	(0.0102)	(0.00943)	(0.0105)
	Structured	*Extensive*	0.344**	0.344*	0.355**	0.376**
			(0.163)	(0.178)	(0.164)	(0.185)
		Intensive	-0.0421	-0.0450	-0.0487	-0.0491
			(0.0316)	(0.0346)	(0.0318)	(0.0338)
	Unstructured	*Extensive*	0.239*	0.0581	0.208	0.0386
			(0.136)	(0.164)	(0.137)	(0.175)
		Intensive	-1.88e-05	0.00746	0.000187	0.00725
			(0.00546)	(0.00632)	(0.00567)	(0.00689)
MATERNAL	**Educational**	*Extensive*	-0.290	-0.220	-0.247	-0.198

TIME INVESTMENT			(0.258)	(0.288)	(0.250)	(0.286)
		Intensive	0.0516	-0.0423	0.0436	-0.0579
			(0.0648)	(0.0917)	(0.0617)	(0.0893)
	Structured	*Extensive*	-0.0507	-0.161	-0.0771	-0.157
			(0.154)	(0.153)	(0.154)	(0.161)
		Intensive	0.0138	0.0220	0.0127	0.0174
			(0.0259)	(0.0240)	(0.0257)	(0.0246)
	Unstructured	*Extensive*	0.150	0.298**	0.0987	0.261*
			(0.115)	(0.134)	(0.116)	(0.141)
		Intensive	-0.0171*	-0.0108	-0.0100	-0.00493
			(0.00922)	(0.0144)	(0.00928)	(0.0156)
LAG (CHILD TIME INVESTMENT)	**Educational**	*Extensive*			0.333**	0.340**
					(0.145)	(0.160)
		Intensive			-0.0319	-0.0409*
					(0.0246)	(0.0243)
	Structured	*Extensive*			0.282	-0.0438
					(0.175)	(0.177)
		Intensive			-0.0408	0.0129
					(0.0351)	(0.0416)
	Unstructured	*Extensive*			-0.0390	0.00496
					(0.122)	(0.157)
		Intensive			-0.00447	0.00965
					(0.00900)	(0.0120)
LAG (MATERNAL TIME INVESTMENT)	**Educational**	*Extensive*			0.0106	-0.0971
					(0.132)	(0.173)
		Intensive			-0.0309	-0.0221
					(0.0193)	(0.0254)
	Structured	*Extensive*			0.0592	-0.0610
					(0.165)	(0.221)
		Intensive			-0.00381	-0.0199

				(0.0243)	(0.0341)
Unstructured	*Extensive*			0.0634	-0.168
				(0.134)	(0.161)
	Intensive			-0.00829	0.00646
				(0.0144)	(0.0183)
Controls					
Child's age		-0.355	-0.851	-0.689	-1.377*
		(0.711)	(0.681)	(0.743)	(0.713)
(Child's age)^2		0.00947	0.0314	0.0224	0.0508*
		(0.0272)	(0.0264)	(0.0285)	(0.0276)
Mother's age		0.268**	-0.140	0.221*	-0.298
		(0.127)	(0.325)	(0.126)	(0.365)
(Mother's age)^2		-0.00258*	-0.00249	-0.00207	-0.00301
		(0.00155)	(0.00214)	(0.00154)	(0.00224)
Male		0.195**	0.148	0.230**	0.132
		(0.0980)	(0.101)	(0.0971)	(0.107)
Birth order		-0.205***	-0.0726	-0.202***	-0.111
		(0.0771)	(0.131)	(0.0775)	(0.130)
Adolescent in 2007		0.0997	1.868	0.119	2.880*
		(0.121)	(1.452)	(0.118)	(1.669)
Constant		-3.592	14.95	-0.474	25.65*
		(5.295)	(12.50)	(5.343)	(14.49)
Observations		386	386	386	386
R-squared		0.176	0.097	0.209	0.151
Number of sibling groups			193		193

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

B2 Non-Cognitive Skill Production Functions

Table B2.1
Child Non-Cognitive Skill Production Functions

			Behaviour Problems Index		Positive Behaviour Score	
			OLS	Family FE	OLS	Family FE
CHILD TIME INVESTMENT	**Educational**	*Extensive*	0.108	0.0572	-0.143	-0.0134
			(0.0942)	(0.119)	(0.140)	(0.184)
		Intensive	-0.0186	0.00789	0.0193	-0.0185
			(0.0134)	(0.0148)	(0.0208)	(0.0225)
	Structured	*Extensive*	0.0232	0.103	0.0210	0.0297
			(0.0914)	(0.110)	(0.127)	(0.149)
		Intensive	-0.0222	-0.0452*	0.0445	0.0568*
			(0.0208)	(0.0264)	(0.0278)	(0.0342)
	Unstructured	*Extensive*	0.00159	-0.0926	-0.0473	0.0184
			(0.0785)	(0.0946)	(0.111)	(0.157)
		Intensive	0.00820	0.00177	-0.0142	-0.00403
			(0.00640)	(0.00941)	(0.00885)	(0.0124)
MATERNAL TIME INVESTMENT	**Educational**	*Extensive*	0.00801	0.0852	-0.0153	-0.177
			(0.0908)	(0.107)	(0.129)	(0.160)
		Intensive	-0.0155	-0.00692	-0.00540	-0.00435
			(0.0149)	(0.0212)	(0.0230)	(0.0297)
	Structured	*Extensive*	-0.0278	-0.00357	0.0584	-0.0186
			(0.0931)	(0.130)	(0.140)	(0.186)
		Intensive	0.0156	-0.000418	-0.0134	0.0144
			(0.0150)	(0.0195)	(0.0221)	(0.0328)
	Unstructured	*Extensive*	-0.0610	0.0582	0.0671	0.0836
			(0.0880)	(0.110)	(0.116)	(0.173)
		Intensive	0.00594	-0.0116	-0.0236	-0.0121

	(0.0112)	(0.0153)	(0.0168)	(0.0173)
Controls				
Child's age	0.158	-0.169	0.115	0.255
	(0.317)	(0.343)	(0.419)	(0.440)
(Child's age)^2	-0.00776	0.0163	-0.00884	-0.0172
	(0.0199)	(0.0210)	(0.0264)	(0.0274)
Mother's age	-0.00672	-0.147	-0.174*	-0.535**
	(0.0663)	(0.175)	(0.0992)	(0.268)
(Mother's age)^2	-0.000150	-0.00159	0.00257*	0.00638**
	(0.000883)	(0.00175)	(0.00134)	(0.00273)
Male	0.0297	0.135**	-0.114	-0.266***
	(0.0621)	(0.0687)	(0.0828)	(0.0982)
Birth order	0.0188	0.191*	-0.0158	-0.0612
	(0.0424)	(0.105)	(0.0637)	(0.153)
Child in 2002	-0.0411	1.096	-0.0937	0.125
	(0.0745)	(0.727)	(0.106)	(1.093)
Child in 2007	2.734***	4.737***	-0.185	0.324
	(0.117)	(1.431)	(0.238)	(2.140)
Constant	-0.585	6.587	2.774	10.16
	(1.761)	(4.941)	(2.544)	(7.693)
Observations	510	510	510	510
R-squared	0.445	0.515	0.049	0.102
Number of sibling groups		255		255

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table B2.2
Adolescent Non-Cognitive Skill Production Function: Behaviour Problems Index (BPI)

			Model 1		Model 2		Model 3		Model 4	
			OLS	Family FE	OLS	Family FE	OLS	Family FE	OLS	Family FE
CHILD	**Educational**	*Extensive*	0.0742	0.0972	0.0623	0.0904	0.0769	0.0939	0.0693	0.0834
TIME			(0.0590)	(0.0753)	(0.0573)	(0.0771)	(0.0597)	(0.0752)	(0.0581)	(0.0770)
INVESTMENT		*Intensive*	-0.00669	-0.0137**	-0.00654	-0.0135**	-0.00796	-0.0152**	-0.00833*	-0.0150**
			(0.00465)	(0.00565)	(0.00434)	(0.00578)	(0.00528)	(0.00600)	(0.00494)	(0.00600)
	Structured	*Extensive*	0.0164	-0.0289	0.0362	0.0153	0.0213	-0.0389	0.0435	0.00411
			(0.0653)	(0.0830)	(0.0643)	(0.0839)	(0.0683)	(0.0880)	(0.0672)	(0.0892)
		Intensive	-0.0132	-0.0154	-0.0132	-0.0218	-0.0116	-0.0137	-0.0121	-0.0206
			(0.0125)	(0.0163)	(0.0131)	(0.0171)	(0.0144)	(0.0169)	(0.0149)	(0.0182)
	Unstructured	*Extensive*	0.00105	0.0549	0.00847	0.0695	-0.00162	0.0511	0.00427	0.0708
			(0.0630)	(0.0922)	(0.0630)	(0.0938)	(0.0626)	(0.106)	(0.0630)	(0.106)
		Intensive	0.00219	-0.000584	0.00189	-0.000913	0.000966	-0.00105	0.000840	-0.00159
			(0.00274)	(0.00428)	(0.00263)	(0.00403)	(0.00261)	(0.00445)	(0.00246)	(0.00410)
MATERNAL	**Educational**	*Extensive*	0.0689	0.173	0.0877	0.136	0.0508	0.165	0.0731	0.118
TIME			(0.0720)	(0.109)	(0.0619)	(0.114)	(0.0766)	(0.116)	(0.0681)	(0.118)
INVESTMENT		*Intensive*	-0.0120	-0.0313	-0.0121	-0.0281	-0.00968	-0.0262	-0.00984	-0.0214
			(0.0131)	(0.0335)	(0.0118)	(0.0348)	(0.0146)	(0.0383)	(0.0135)	(0.0397)
	Structured	*Extensive*	-0.0121	-0.0745	0.0145	-0.0517	-0.0342	-0.127*	-0.00709	-0.106
			(0.0688)	(0.0732)	(0.0628)	(0.0742)	(0.0725)	(0.0762)	(0.0658)	(0.0772)
		Intensive	-0.00563	-0.000454	-0.00893	-0.00492	-0.00289	0.00849	-0.00604	0.00480
			(0.00948)	(0.0101)	(0.00877)	(0.0112)	(0.0100)	(0.0113)	(0.00927)	(0.0120)
	Unstructured	*Extensive*	-0.00653	0.0152	0.00671	0.0101	0.00282	0.0397	0.0135	0.0331
			(0.0527)	(0.0729)	(0.0518)	(0.0699)	(0.0542)	(0.0761)	(0.0522)	(0.0711)
		Intensive	0.00194	0.00773	0.000382	0.00782	0.000694	0.00694	-0.000508	0.00781
			(0.00566)	(0.00718)	(0.00567)	(0.00646)	(0.00565)	(0.00767)	(0.00547)	(0.00711)

LAG (CHILD TIME INVESTMENT)	**Educational**	*Extensive*					-0.0205	-0.0544	-0.0250	-0.0655
							(0.0556)	(0.0867)	(0.0543)	(0.0833)
		Intensive					0.00175	0.0139	0.00314	0.0124
							(0.00891)	(0.0135)	(0.00896)	(0.0133)
	Structured	*Extensive*					0.0569	0.111	0.0539	0.106
							(0.0805)	(0.103)	(0.0773)	(0.107)
		Intensive					0.00971	0.0150	0.0116	0.0207
							(0.0222)	(0.0249)	(0.0201)	(0.0262)
	Unstructured	*Extensive*					0.0377	0.0371	0.0326	0.0435
							(0.0564)	(0.0786)	(0.0532)	(0.0790)
		Intensive					0.00476	-0.00150	0.00285	-0.00148
							(0.00511)	(0.00635)	(0.00475)	(0.00621)
LAG (MATERNAL TIME INVESTMENT)	**Educational**	*Extensive*					-0.0175	0.0624	-0.0136	0.0407
							(0.0570)	(0.104)	(0.0548)	(0.107)
		Intensive					-0.000100	0.00764	0.000217	0.00777
							(0.0110)	(0.0151)	(0.0106)	(0.0159)
	Structured	*Extensive*					-0.0174	-0.111	-0.0220	-0.112
							(0.0571)	(0.120)	(0.0562)	(0.117)
		Intensive					-0.00407	0.0238	-0.00670	0.0251
							(0.00798)	(0.0165)	(0.00799)	(0.0170)
	Unstructured	*Extensive*					-0.00777	0.0468	0.0130	0.0479
							(0.0528)	(0.0924)	(0.0529)	(0.0913)
		Intensive					0.00907	0.00803	0.00749	0.0104
							(0.00692)	(0.0103)	(0.00652)	(0.0107)
	Lagged Score				0.113***	0.0943**			0.114***	0.104**
					(0.0274)	(0.0466)			(0.0271)	(0.0440)
	Controls									
	Child's age		0.00623	-0.298	-0.131	-0.376	0.0663	-0.0556	-0.0811	-0.144

	(0.314)	(0.339)	(0.294)	(0.323)	(0.329)	(0.355)	(0.304)	(0.329)
(Child's age)^2	-0.00166	0.0120	0.00371	0.0145	-0.00419	0.00270	0.00161	0.00541
	(0.0120)	(0.0131)	(0.0113)	(0.0126)	(0.0127)	(0.0137)	(0.0117)	(0.0128)
Mother's age	-0.0148	-0.0736	-0.0291	-0.0945	-0.00668	0.00314	-0.0199	-0.0215
	(0.0570)	(0.168)	(0.0570)	(0.175)	(0.0567)	(0.182)	(0.0576)	(0.190)
(Mother's age)^2	0.000212	0.000391	0.000396	0.000522	0.000100	0.000426	0.000280	0.000585
	(0.000659)	(0.00130)	(0.000661)	(0.00133)	(0.000661)	(0.00132)	(0.000671)	(0.00134)
Male	0.0157	0.115**	0.0141	0.0979*	0.00228	0.117**	0.00321	0.0959*
	(0.0403)	(0.0554)	(0.0385)	(0.0541)	(0.0404)	(0.0576)	(0.0385)	(0.0547)
Birth order	0.000124	0.0697	0.00253	0.0406	-0.000978	0.0857	0.00349	0.0497
	(0.0319)	(0.0750)	(0.0314)	(0.0720)	(0.0319)	(0.0745)	(0.0314)	(0.0696)
Adolescent in 2007	1.854***	1.917***	1.861***	2.012***	1.854***	1.513*	1.861***	1.625*
	(0.0440)	(0.714)	(0.0453)	(0.747)	(0.0441)	(0.862)	(0.0451)	(0.887)
Constant	-0.460	3.065	0.672	4.316	-0.987	-1.721	0.168	-0.263
	(2.072)	(5.895)	(1.939)	(6.082)	(2.234)	(7.081)	(2.074)	(7.155)
Observations	386	386	386	386	386	386	386	386
R-squared	0.846	0.811	0.858	0.819	0.851	0.823	0.863	0.831
Number of sibling groups		193		193		193		193

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table B2.3
Adolescent Non-Cognitive Skill Production Function: Positive Behaviour Score (PBS)

			Model 1		**Model 2**		**Model 3**		**Model 4**	
			OLS	Family FE	OLS	Family FE	OLS	Family FE	OLS	Family FE
CHILD	**Educational**	*Extensive*	-0.0959	-0.00964	-0.0729	-0.0324	-0.0836	-0.0340	-0.0812	-0.0635
TIME			(0.144)	(0.184)	(0.132)	(0.180)	(0.148)	(0.202)	(0.133)	(0.198)
INVESTMENT		*Intensive*	0.00467	0.000687	0.00730	0.00307	0.00518	0.00155	0.00959	0.00398

				(0.00999)	(0.0124)	(0.00908)	(0.0122)	(0.0102)	(0.0125)	(0.00897)	(0.0123)
	Structured	*Extensive*	0.0352	0.0541	0.0669	0.00303	-0.0516	0.0202	-0.0183	-0.0318
			(0.157)	(0.179)	(0.148)	(0.183)	(0.158)	(0.194)	(0.148)	(0.200)
		Intensive	0.0231	0.0317	0.00383	0.0335	0.0311	0.0347	0.0116	0.0384
			(0.0303)	(0.0386)	(0.0328)	(0.0380)	(0.0273)	(0.0360)	(0.0295)	(0.0355)
	Unstructured	*Extensive*	0.0199	-0.141	-0.0498	-0.211	0.0278	-0.151	-0.0371	-0.216
			(0.141)	(0.274)	(0.137)	(0.250)	(0.140)	(0.311)	(0.139)	(0.287)
		Intensive	-0.0101	-0.00527	-0.00426	-0.00554	-0.00677	-0.00668	-0.00187	-0.00683
			(0.00713)	(0.00755)	(0.00554)	(0.00723)	(0.00630)	(0.00765)	(0.00499)	(0.00729)
MATERNAL TIME INVESTMENT	**Educational**	*Extensive*	-0.0528	-0.311	-0.0344	-0.214	-0.0875	-0.318	-0.0663	-0.203
			(0.246)	(0.374)	(0.209)	(0.386)	(0.252)	(0.376)	(0.216)	(0.379)
		Intensive	-0.0396	0.0769	-0.0404	0.0628	-0.0234	0.0723	-0.0279	0.0542
			(0.0468)	(0.121)	(0.0431)	(0.125)	(0.0471)	(0.125)	(0.0419)	(0.128)
	Structured	*Extensive*	-0.165	0.0707	-0.264	0.0140	-0.163	0.0399	-0.265	-0.0208
			(0.193)	(0.242)	(0.182)	(0.218)	(0.209)	(0.293)	(0.199)	(0.264)
		Intensive	0.0252	-0.0120	0.0441*	-0.00309	0.0219	-0.00606	0.0415*	0.00310
			(0.0244)	(0.0238)	(0.0228)	(0.0214)	(0.0253)	(0.0313)	(0.0231)	(0.0274)
	Unstructured	*Extensive*	0.309**	0.0575	0.268**	0.0611	0.286**	0.0515	0.245**	0.0593
			(0.119)	(0.168)	(0.109)	(0.171)	(0.124)	(0.170)	(0.113)	(0.172)
		Intensive	-0.0317***	-0.0341*	-0.0200*	-0.0318	-0.0315***	-0.0308	-0.0201*	-0.0289
			(0.0119)	(0.0197)	(0.0115)	(0.0213)	(0.0113)	(0.0211)	(0.0107)	(0.0219)
LAG (CHILD TIME INVESTMENT)	**Educational**	*Extensive*					-0.209	0.0268	-0.118	0.0623
							(0.151)	(0.211)	(0.136)	(0.197)
		Intensive					0.0211	-0.0210	0.0104	-0.0213
							(0.0247)	(0.0291)	(0.0217)	(0.0290)
	Structured	*Extensive*					0.182	0.0263	0.159	0.0105
							(0.183)	(0.217)	(0.166)	(0.214)
		Intensive					-0.0364	0.0231	-0.0439	0.0200
							(0.0455)	(0.0484)	(0.0388)	(0.0471)
	Unstructured	*Extensive*					-0.136	0.00189	-0.0876	0.0205

								(0.145)	(0.210)	(0.138)	(0.202)
		Intensive						-0.0201	-0.00308	-0.0144	-0.00120
								(0.0133)	(0.0144)	(0.0115)	(0.0147)
LAG (MATERNAL TIME INVESTMENT)	**Educational**	*Extensive*						0.250	0.124	0.230*	0.175
								(0.156)	(0.254)	(0.130)	(0.251)
		Intensive						-0.0653***	-0.0478	-0.0489**	-0.0470
								(0.0225)	(0.0354)	(0.0200)	(0.0355)
	Structured	*Extensive*						0.165	-0.0105	0.210	-0.00105
								(0.158)	(0.304)	(0.137)	(0.308)
		Intensive						-0.00442	0.00837	-0.00406	0.00704
								(0.0256)	(0.0367)	(0.0198)	(0.0369)
	Unstructured	*Extensive*						-0.109	-0.0190	-0.132	-0.0385
								(0.125)	(0.213)	(0.113)	(0.202)
		Intensive						-0.00126	0.00229	0.000966	0.00416
								(0.0158)	(0.0265)	(0.0152)	(0.0261)
	Lagged Score				0.414***	0.147				0.401***	0.146
					(0.0741)	(0.163)				(0.0758)	(0.163)
	Controls										
	Child's age		-1.080	-0.414	-0.645	-0.271	-1.028	-0.397	-0.652	-0.233	
			(0.731)	(0.817)	(0.662)	(0.792)	(0.766)	(0.850)	(0.688)	(0.845)	
	(Child's age)^2		0.0439	0.0180	0.0272	0.0126	0.0426	0.0172	0.0281	0.0112	
			(0.0279)	(0.0312)	(0.0252)	(0.0302)	(0.0293)	(0.0325)	(0.0263)	(0.0321)	
	Mother's age		-0.0846	0.653*	0.0677	0.699**	-0.0999	0.535	0.0324	0.567	
			(0.158)	(0.367)	(0.129)	(0.343)	(0.158)	(0.400)	(0.129)	(0.383)	
	(Mother's age)^2		0.000926	-0.00698**	-0.000965	-0.00794***	0.00117	-0.00642**	-0.000517	-0.00735***	
			(0.00186)	(0.00277)	(0.00152)	(0.00244)	(0.00187)	(0.00302)	(0.00153)	(0.00265)	
	Male		-0.316***	-0.521***	-0.267***	-0.483***	-0.308***	-0.511***	-0.262***	-0.468***	
			(0.110)	(0.130)	(0.0967)	(0.141)	(0.111)	(0.127)	(0.0986)	(0.135)	

Birth order	0.0585	0.0113	0.0461	0.0335	0.0679	-0.00113	0.0536	0.0231
	(0.0771)	(0.145)	(0.0769)	(0.136)	(0.0777)	(0.157)	(0.0753)	(0.151)
Adolescent in 2007	0.162	-0.163	0.258**	0.0360	0.205*	0.238	0.282***	0.475
	(0.121)	(1.561)	(0.107)	(1.454)	(0.117)	(1.688)	(0.103)	(1.613)
Constant	8.469	-12.10	2.555	-13.35	8.388	-8.381	3.269	-9.342
	(5.584)	(13.83)	(4.887)	(12.86)	(5.752)	(15.38)	(5.022)	(14.52)
Observations	386	386	386	386	386	386	386	386
R-squared	0.085	0.158	0.237	0.173	0.133	0.171	0.272	0.186
Number of sibling groups		193		193		193		193

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Appendix C: Heterogeneity

C1 Child Gender

Table C1.1
Child Cognitive Skill Production Functions – by Child Gender

			Letter-Word Identification		Passage Comprehension		Applied Problems	
			Female	Male	Female	Male	Female	Male
CHILD	**Educational**	*Extensive*	0.227	0.0468	0.269*	0.386**	0.228	0.0248
TIME			(0.157)	(0.201)	(0.144)	(0.191)	(0.155)	(0.207)
INVESTMENT		*Intensive*	-0.000502	0.0620*	0.000882	0.00311	-0.00504	0.0353
			(0.0241)	(0.0318)	(0.0212)	(0.0296)	(0.0215)	(0.0288)
	Structured	*Extensive*	0.107	0.0619	-0.147	0.0581	-0.104	0.375*
			(0.205)	(0.202)	(0.175)	(0.228)	(0.202)	(0.212)
		Intensive	0.0220	-0.00337	0.0590	-0.00636	0.0139	-0.0745*
			(0.0574)	(0.0459)	(0.0463)	(0.0561)	(0.0437)	(0.0408)
	Unstructured	*Extensive*	-0.0532	-0.0317	-0.141	-0.0272	-0.226	0.321*
			(0.143)	(0.163)	(0.133)	(0.165)	(0.144)	(0.171)
		Intensive	0.00124	-0.00124	0.00472	-0.00107	0.0263***	-0.0135
			(0.00888)	(0.00904)	(0.00837)	(0.0108)	(0.00985)	(0.0113)
MATERNAL	**Educational**	*Extensive*	0.118	-0.111	-0.0429	-0.0659	-0.0175	-0.207
TIME			(0.181)	(0.174)	(0.159)	(0.176)	(0.174)	(0.172)
INVESTMENT		*Intensive*	-0.0164	-0.0128	-0.0106	-0.00715	0.00442	0.0283
			(0.0263)	(0.0296)	(0.0258)	(0.0275)	(0.0262)	(0.0290)
	Structured	*Extensive*	0.122	-0.106	-0.102	-0.00937	-0.0443	0.156
			(0.186)	(0.187)	(0.176)	(0.188)	(0.176)	(0.189)
		Intensive	-0.0279	0.0398	-0.0144	-0.00061	0.00525	-0.00571
			(0.0310)	(0.0332)	(0.0318)	(0.0359)	(0.0317)	(0.0349)
	Unstructured	*Extensive*	0.0643	0.308*	0.192	0.129	-0.0305	0.172

		(0.153)	(0.166)	(0.153)	(0.161)	(0.156)	(0.170)
	Intensive	-0.0386**	-0.0416***	-0.0376*	-0.0300*	-0.00694	-0.0190
		(0.0158)	(0.0141)	(0.0218)	(0.0173)	(0.0155)	(0.0186)
Controls							
Child's age		0.469		1.096**		0.707*	
		(0.428)		(0.427)		(0.420)	
(Child's age)^2		-0.0317		-0.0764***		-0.0445*	
		(0.0267)		(0.0264)		(0.0262)	
Mother's age		0.194**		0.265***		0.201**	
		(0.0837)		(0.0863)		(0.0961)	
(Mother's age)^2		-0.00228**		-0.00308***		-0.00187	
		(0.00112)		(0.00115)		(0.00130)	
Male		-0.288		-0.389*		-0.123	
		(0.235)		(0.221)		(0.227)	
Birth order		-0.221***		-0.259***		-0.124*	
		(0.0671)		(0.0673)		(0.0646)	
Child in 2002		0.0277		0.172*		-0.230**	
		(0.101)		(0.0959)		(0.101)	
Child in 2007		0.192		-0.0813		-0.336	
		(0.196)		(0.208)		(0.223)	
		-5.176**		-8.601***		-7.213***	
Constant		(2.260)		(2.217)		(2.481)	
Observations		510		510		510	
R-squared		0.150		0.197		0.188	

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table C1.2
Adolescent Cognitive Skill Production Functions – by Child Gender

			Letter-Word Identification				Passage Comprehension			
			Model 2		Model 4		Model 2		Model 4	
			Female	Male	Female	Male	Female	Male	Female	Male
CHILD TIME INVESTMENT	**Educational**	*Extensive*	0.0146	-0.0895	-0.0695	-0.185	0.139	-0.0821	0.00104	-0.156
			(0.148)	(0.150)	(0.151)	(0.156)	(0.136)	(0.173)	(0.140)	(0.173)
		Intensive	0.0145	0.00798	0.0257**	0.0204	-0.00857	0.0372***	-6.92e-05	0.0458***
			(0.00978)	(0.0152)	(0.0105)	(0.0158)	(0.0105)	(0.0129)	(0.0103)	(0.0139)
	Structured	*Extensive*	0.214	-0.352**	0.0226	-0.224	0.210	0.113	0.122	0.337
			(0.223)	(0.167)	(0.186)	(0.170)	(0.169)	(0.268)	(0.186)	(0.257)
		Intensive	0.0543	0.0406	0.0843*	0.0202	-0.0311	0.0171	-0.0220	-0.0340
			(0.0491)	(0.0503)	(0.0451)	(0.0497)	(0.0329)	(0.0559)	(0.0409)	(0.0517)
	Unstructured	*Extensive*	0.0357	0.0176	0.0470	-0.0427	0.0300	-0.0739	0.0793	-0.135
			(0.179)	(0.169)	(0.153)	(0.161)	(0.143)	(0.203)	(0.140)	(0.195)
		Intensive	-0.00141	0.00221	-0.000712	-0.00162	-5.46e-05	0.00872	-0.00141	0.00605
			(0.00554)	(0.00697)	(0.00631)	(0.00628)	(0.00563)	(0.00645)	(0.00609)	(0.00699)
MATERNAL TIME INVESTMENT	**Educational**	*Extensive*	0.150	0.338	0.110	0.425	-0.135	-0.737**	-0.0908	-0.644*
			(0.290)	(0.247)	(0.300)	(0.263)	(0.178)	(0.321)	(0.198)	(0.346)
		Intensive	-0.00648	-0.0571	0.00870	-0.0872	0.0336	0.133	0.0255	0.113
			(0.0402)	(0.0611)	(0.0400)	(0.0734)	(0.0258)	(0.0846)	(0.0376)	(0.0864)
	Structured	*Extensive*	-0.0236	-0.0631	-0.137	-0.0549	0.374**	0.0682	0.207	-0.00669
			(0.186)	(0.143)	(0.185)	(0.140)	(0.161)	(0.227)	(0.160)	(0.246)
		Intensive	0.0176	0.000921	0.0282	-0.00396	-0.0310	-0.000611	-0.0117	-0.00688
			(0.0254)	(0.0250)	(0.0220)	(0.0229)	(0.0298)	(0.0247)	(0.0267)	(0.0277)
	Unstructured	*Extensive*	-0.0525	0.0262	-0.0515	0.0536	0.352***	0.0116	0.291**	-0.00546
			(0.126)	(0.162)	(0.127)	(0.165)	(0.109)	(0.155)	(0.120)	(0.156)
		Intensive	0.0787	0.00698	0.105	0.0129	-0.0171*	0.00676	-0.0144*	0.0130
			(0.207)	(0.0232)	(0.214)	(0.0226)	(0.00872)	(0.0157)	(0.00833)	(0.0146)

LAG (CHILD TIME INVESTMENT)	**Educational**	*Extensive*		-0.151	0.401**		0.193	0.389**
				(0.159)	(0.177)		(0.157)	(0.173)
		Intensive		0.00121	-0.0639**		-0.0434	-0.0801***
				(0.0236)	(0.0306)		(0.0288)	(0.0275)
	Structured	*Extensive*		0.635***	-0.185		0.187	0.345
				(0.234)	(0.181)		(0.192)	(0.232)
		Intensive		-0.101**	0.0420		-0.0228	-0.0357
				(0.0509)	(0.0335)		(0.0576)	(0.0493)
	Unstructured	*Extensive*		-0.0241	-0.137		0.172	-0.214
				(0.129)	(0.145)		(0.132)	(0.147)
		Intensive		0.0117	0.0118		0.00153	0.00794
				(0.0107)	(0.00841)		(0.00979)	(0.00961)
LAG (MATERNAL TIME INVESTMENT)	**Educational**	*Extensive*		0.0787	-0.244		0.0557	-0.242
				(0.151)	(0.159)		(0.137)	(0.202)
		Intensive		-0.0131	0.00277		0.0114	-0.00210
				(0.0249)	(0.0293)		(0.0300)	(0.0405)
	Structured	*Extensive*		0.0533	0.146		0.424**	-0.123
				(0.197)	(0.141)		(0.174)	(0.168)
		Intensive		0.0553	-0.0240		-0.00187	0.0235
				(0.0373)	(0.0213)		(0.0283)	(0.0246)
	Unstructured	*Extensive*		-0.193	0.239*		0.0281	-0.0636
				(0.144)	(0.134)		(0.125)	(0.160)
		Intensive		0.0166	-0.0382***		-0.00294	0.00916
				(0.0122)	(0.0141)		(0.0106)	(0.0196)
	Lagged Score		0.526***			0.524***		
			(0.0516)			(0.0508)		
	Controls							

Child's age	-0.321	-0.616	-0.233	-0.381
	(0.615)	(0.640)	(0.556)	(0.560)
(Child's age)^2	0.0102	0.0223	0.00874	0.0153
	(0.0234)	(0.0244)	(0.0213)	(0.0214)
Mother's age	0.0915	0.0930	0.291***	0.254***
	(0.102)	(0.102)	(0.101)	(0.0958)
(Mother's age)^2	-0.000766	-0.000878	-0.00317**	-0.00282**
	(0.00122)	(0.00123)	(0.00122)	(0.00115)
Male	0.0446	0.202	0.244	0.728**
	(0.239)	(0.294)	(0.264)	(0.342)
Birth order	-0.0842	-0.0815	-0.132**	-0.135**
	(0.0576)	(0.0521)	(0.0603)	(0.0611)
Adolescent in 2007	-0.0252	-0.0291	-0.122	-0.160
	(0.0909)	(0.0883)	(0.0984)	(0.0978)
Constant	0.0718	1.903	-5.041	-3.583
	(4.445)	(4.430)	(3.916)	(3.980)
Observations	386	386	386	386
R-squared	0.441	0.501	0.455	0.516

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table C1.3
Adolescent Cognitive Skill Production Function – by Child Gender

			Applied Problems			
			Model 2		**Model 4**	
			Female	Male	Female	Male
CHILD	**Educational**	*Extensive*	-0.0156	-0.00498	-0.0282	-0.0226
TIME			(0.139)	(0.126)	(0.138)	(0.129)
INVESTMENT		*Intensive*	0.0125	0.0248**	0.0139	0.0234**

			(0.0106)	(0.00996)	(0.0113)	(0.0113)
	Structured	*Extensive*	0.533***	-0.250	0.432**	-0.101
			(0.177)	(0.247)	(0.168)	(0.248)
		Intensive	-0.0740**	0.0632	-0.0584*	0.0493
			(0.0330)	(0.0599)	(0.0300)	(0.0585)
	Unstructured	*Extensive*	0.201	-0.0735	0.199	-0.0665
			(0.163)	(0.173)	(0.155)	(0.165)
		Intensive	0.00397	0.00408	0.00426	0.00213
			(0.00477)	(0.00538)	(0.00495)	(0.00596)
MATERNAL TIME INVESTMENT	**Educational**	*Extensive*	-0.268	-0.209	-0.267	-0.141
			(0.198)	(0.352)	(0.215)	(0.318)
		Intensive	0.0714	0.0153	0.0737	-0.00263
			(0.0459)	(0.0663)	(0.0450)	(0.0633)
	Structured	*Extensive*	0.137	-0.175	0.0638	-0.165
			(0.152)	(0.211)	(0.163)	(0.205)
		Intensive	-0.00637	0.0431	0.00452	0.0407
			(0.0262)	(0.0297)	(0.0282)	(0.0297)
	Unstructured	*Extensive*	0.255*	0.109	0.247*	0.125
			(0.132)	(0.122)	(0.139)	(0.128)
		Intensive	-0.0226**	-0.0118	-0.0190*	-0.00756
			(0.0108)	(0.0112)	(0.0102)	(0.0119)
LAG (CHILD TIME INVESTMENT)	**Educational**	*Extensive*			0.0766	0.308*
					(0.142)	(0.176)
		Intensive			-0.0199	-0.0350
					(0.0226)	(0.0254)
	Structured	*Extensive*			0.497**	-0.00672
					(0.216)	(0.192)
		Intensive			-0.0520	-0.0219
					(0.0547)	(0.0397)
	Unstructured	*Extensive*			0.0746	-0.141

				(0.148)	(0.125)
		Intensive		0.000286	0.000122
				(0.0143)	(0.00945)
LAG (MATERNAL TIME INVESTMENT)	**Educational**	*Extensive*		-0.0762	0.307*
				(0.135)	(0.155)
		Intensive		-0.0123	-0.0860***
				(0.0190)	(0.0286)
	Structured	*Extensive*		-0.131	-0.0119
				(0.199)	(0.137)
		Intensive		0.0329	-0.0437**
				(0.0345)	(0.0202)
	Unstructured	*Extensive*		0.0414	-0.171
				(0.139)	(0.124)
		Intensive		0.00590	0.0163
				(0.0135)	(0.0206)
	Lagged Score		0.635***	0.658***	
			(0.0398)	(0.0405)	
	Controls				
	Child's age		-0.872	-1.445**	
			(0.557)	(0.613)	
	(Child's age)^2		0.0296	0.0525**	
			(0.0213)	(0.0236)	
	Mother's age		0.0917	0.0828	
			(0.0959)	(0.0991)	
	(Mother's age)^2		-0.000902	-0.000841	
			(0.00117)	(0.00119)	
	Male		0.405	0.715**	
			(0.259)	(0.278)	

Birth order	-0.125**	-0.144***
	(0.0516)	(0.0523)
Adolescent in 2007	0.225***	0.255***
	(0.0857)	(0.0861)
Constant	3.766	7.463*
	(4.043)	(4.461)
Observations	386	386
R-squared	0.532	0.574

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

C2 Child Race

Table C2.1
Child Cognitive Skill Production Functions – by Child Race

			Letter-Word Identification		Passage Comprehension		Applied Problems	
			White	Black	White	Black	White	Black
CHILD TIME INVESTMENT	**Educational**	*Extensive*	0.266*	-0.335	0.409***	0.0702	0.121	-0.146
			(0.139)	(0.373)	(0.137)	(0.411)	(0.142)	(0.431)
		Intensive	0.0231	0.108*	0.00976	0.00846	0.0240	0.0463
			(0.0209)	(0.0629)	(0.0173)	(0.0718)	(0.0182)	(0.0758)
	Structured	*Extensive*	-0.0331	0.591	-0.0314	0.0184	0.0605	0.253
			(0.153)	(0.497)	(0.156)	(0.381)	(0.158)	(0.639)
		Intensive	0.0152	-0.129	0.00906	0.0145	-0.0423	-0.0715
			(0.0399)	(0.105)	(0.0443)	(0.0890)	(0.0349)	(0.134)
	Unstructured	*Extensive*	-0.0392	0.0471	-0.172	0.254	-0.0110	0.336
			(0.127)	(0.295)	(0.117)	(0.302)	(0.127)	(0.348)
		Intensive	-0.00460	-0.00169	0.00200	-0.0223	0.00275	0.00202

			(0.00696)	(0.0272)	(0.00764)	(0.0292)	(0.00969)	(0.0315)
MATERNAL TIME INVESTMENT	**Educational**	*Extensive*	-0.103	0.148	-0.144	-0.151	-0.188	-0.264
			(0.141)	(0.437)	(0.135)	(0.392)	(0.146)	(0.362)
		Intensive	-0.0123	0.0401	-0.0148	0.0518	0.0236	0.0603
			(0.0188)	(0.0834)	(0.0212)	(0.0718)	(0.0239)	(0.0639)
	Structured	*Extensive*	-0.0170	0.521	-0.0325	0.341	0.217	0.379
			(0.145)	(0.352)	(0.139)	(0.320)	(0.151)	(0.438)
		Intensive	0.0153	-0.101*	-0.00265	-0.0870*	-0.00658	-0.0658
			(0.0240)	(0.0530)	(0.0256)	(0.0461)	(0.0263)	(0.0642)
	Unstructured	*Extensive*	0.0653	-0.00530	0.152	-0.248	0.106	-0.313
			(0.133)	(0.308)	(0.124)	(0.313)	(0.132)	(0.327)
		Intensive	-0.0394***	-0.00214	-0.0329**	0.00768	-0.0116	0.0257
			(0.0130)	(0.0275)	(0.0159)	(0.0277)	(0.0139)	(0.0303)
	Controls							
	Black		-0.581		-0.284		-0.424	
			(0.419)		(0.353)		(0.358)	
	Child's age		0.514		1.127**		0.969**	
			(0.447)		(0.442)		(0.446)	
	(Child's age)^2		-0.0326		-0.0770***		-0.0594**	
			(0.0277)		(0.0272)		(0.0276)	
	Mother's age		0.0958		0.125		0.114	
			(0.0885)		(0.0937)		(0.102)	
	(Mother's age)^2		-0.00107		-0.00131		-0.000838	
			(0.00116)		(0.00122)		(0.00137)	
	Male		-0.245***		-0.299***		0.178**	
			(0.0890)		(0.0893)		(0.0874)	
	Birth order		-0.208***		-0.256***		-0.0893	
			(0.0690)		(0.0692)		(0.0628)	
	Child in 2002		-0.00704		0.152		-0.282***	

	(0.109)	(0.0962)	(0.103)
Child in 2007	0.0798	-0.173	-0.354
	(0.183)	(0.200)	(0.241)
Constant	-3.387	-6.008**	-6.621**
	(2.360)	(2.434)	(2.569)
Observations	452	452	452
R-squared	0.183	0.234	0.196

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table C2.2
Adolescent Cognitive Skill Production Function: Letter-Word Identification – by Child Race

			Model 2		Model 4	
			White	Black	White	Black
CHILD	**Educational**	*Extensive*	0.0823	-0.455**	0.00580	-0.506**
TIME			(0.131)	(0.203)	(0.133)	(0.213)
INVESTMENT		*Intensive*	0.00921	0.0369*	0.0159	0.0340
			(0.00927)	(0.0202)	(0.01000)	(0.0213)
	Structured	*Extensive*	-0.0568	-0.573**	-0.110	-0.717**
			(0.168)	(0.251)	(0.163)	(0.309)
		Intensive	0.0311	0.264***	0.0281	0.361***
			(0.0312)	(0.0491)	(0.0310)	(0.0743)
	Unstructured	*Extensive*	-0.0177	0.0423	-0.0589	0.167
			(0.150)	(0.260)	(0.151)	(0.238)
		Intensive	0.00228	-0.00652	0.00148	-0.0100
			(0.00621)	(0.00698)	(0.00618)	(0.00692)
MATERNAL	**Educational**	*Extensive*	0.307	-0.644	0.277	0.659

TIME INVESTMENT			(0.215)	(0.550)	(0.215)	(0.630)
		Intensive	-0.0267	0.0154	-0.0270	-0.265*
			(0.0346)	(0.137)	(0.0378)	(0.152)
	Structured	*Extensive*	-0.0574	-0.0956	-0.0597	-0.268
			(0.132)	(0.226)	(0.145)	(0.298)
		Intensive	0.00820	0.00828	0.00234	0.0228
			(0.0275)	(0.0161)	(0.0275)	(0.0289)
	Unstructured	*Extensive*	-0.0395	0.261	-0.0267	0.114
			(0.112)	(0.169)	(0.117)	(0.166)
		Intensive	-0.00128	-0.0156	-0.00153	-0.00328
			(0.0125)	(0.0168)	(0.0126)	(0.0178)
LAG (CHILD TIME INVESTMENT)	**Educational**	*Extensive*			-0.00954	0.380
					(0.158)	(0.251)
		Intensive			-0.0132	-0.0476
					(0.0270)	(0.0444)
	Structured	*Extensive*			0.201	0.712
					(0.168)	(0.493)
		Intensive			-0.0310	-0.217*
					(0.0291)	(0.128)
	Unstructured	*Extensive*			0.000328	0.303
					(0.114)	(0.229)
		Intensive			0.00806	-0.0154
					(0.00868)	(0.0209)
LAG (MATERNAL TIME INVESTMENT)	**Educational**	*Extensive*			-0.0486	-0.278
					(0.124)	(0.293)
		Intensive			-0.00776	0.00648
					(0.0204)	(0.0520)
	Structured	*Extensive*			0.0738	0.166
					(0.152)	(0.260)
		Intensive			0.0327	-0.0128

			(0.0282)	(0.0322)
Unstructured	*Extensive*		0.0897	0.210
			(0.132)	(0.244)
	Intensive		-0.0126	0.0242
			(0.0135)	(0.0339)
Lagged Score		0.530***	0.519***	
		(0.0521)	(0.0538)	
Controls				
Black		-0.139	-0.450	
		(0.274)	(0.350)	
Child's age		-1.042*	-1.028	
		(0.620)	(0.689)	
(Child's age)^2		0.0379	0.0370	
		(0.0236)	(0.0263)	
Mother's age		0.0296	-0.00591	
		(0.125)	(0.140)	
(Mother's age)^2		-0.000183	0.000180	
		(0.00149)	(0.00167)	
Male		-0.111	-0.118	
		(0.0873)	(0.0943)	
Birth order		-0.0485	-0.0834	
		(0.0709)	(0.0650)	
Adolescent in 2007		-0.0370	0.00316	
		(0.102)	(0.106)	
Constant		6.351	7.176	
		(4.793)	(5.292)	
Observations		344	344	
R-squared		0.464	0.498	

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table C2.3
Adolescent Cognitive Skill Production Function: Passage Comprehension – by Child Race

			Model 2		Model 4	
			White	Black	White	Black
CHILD TIME INVESTMENT	**Educational**	*Extensive*	0.0536	-0.590**	0.000352	-0.585**
			(0.134)	(0.282)	(0.139)	(0.268)
		Intensive	0.00234	0.0919***	0.00699	0.0786***
			(0.00922)	(0.0321)	(0.00991)	(0.0241)
	Structured	*Extensive*	0.161	0.0548	0.126	-0.288
			(0.156)	(0.373)	(0.167)	(0.473)
		Intensive	-0.00974	0.0133	-0.0224	0.203**
			(0.0333)	(0.0531)	(0.0332)	(0.0881)
	Unstructured	*Extensive*	0.0583	0.00768	0.0145	0.249
			(0.150)	(0.247)	(0.152)	(0.250)
		Intensive	0.00313	-0.00345	0.00529	-0.00811
			(0.00562)	(0.0130)	(0.00612)	(0.0135)
MATERNAL TIME INVESTMENT	**Educational**	*Extensive*	-0.154	-0.348	-0.207	1.279*
			(0.133)	(0.893)	(0.156)	(0.734)
		Intensive	0.0565**	-0.184	0.0578**	-0.541***
			(0.0241)	(0.192)	(0.0283)	(0.158)
	Structured	*Extensive*	0.249	-0.0510	0.216	-0.235
			(0.151)	(0.358)	(0.164)	(0.310)
		Intensive	-0.0305	0.000200	-0.0287	0.0230
			(0.0278)	(0.0311)	(0.0319)	(0.0271)
	Unstructured	*Extensive*	0.154	0.631**	0.132	0.436
			(0.109)	(0.276)	(0.113)	(0.287)

		Intensive	-0.00392	-0.0359	0.000334	-0.0225
			(0.0110)	(0.0243)	(0.0109)	(0.0210)
LAG (CHILD TIME INVESTMENT)	**Educational**	*Extensive*			0.250*	0.329
					(0.139)	(0.306)
		Intensive			-0.0342	-0.0700
					(0.0212)	(0.0491)
	Structured	*Extensive*			0.225	1.284***
					(0.162)	(0.470)
		Intensive			-0.0477	-0.398***
					(0.0386)	(0.129)
	Unstructured	*Extensive*			0.0579	0.266
					(0.122)	(0.267)
		Intensive			-0.00421	-0.00851
					(0.00850)	(0.0243)
LAG (MATERNAL TIME INVESTMENT)	**Educational**	*Extensive*			-0.138	0.0738
					(0.134)	(0.332)
		Intensive			0.0175	-0.0553
					(0.0260)	(0.0617)
	Structured	*Extensive*			0.0924	0.00948
					(0.163)	(0.290)
		Intensive			0.0365	0.0129
					(0.0224)	(0.0432)
	Unstructured	*Extensive*			-0.0431	0.379
					(0.123)	(0.347)
		Intensive			0.379	0.0244
					(0.347)	(0.0502)
	Lagged Score		0.525***		0.515***	
			(0.0538)		(0.0566)	

Controls		
Black	-0.0354	-0.410
	(0.278)	(0.411)
Child's age	-0.420	-0.698
	(0.636)	(0.620)
(Child's age)^2	0.0160	0.0254
	(0.0243)	(0.0237)
Mother's age	0.254**	0.221*
	(0.118)	(0.128)
(Mother's age)^2	-0.00275*	-0.00237
	(0.00143)	(0.00154)
Male	0.158	0.200*
	(0.0969)	(0.102)
Birth order	-0.113	-0.175**
	(0.0755)	(0.0745)
Adolescent in 2007	-0.113	-0.0904
	(0.113)	(0.119)
Constant	-2.976	-0.253
	(4.677)	(4.650)
Observations	344	344
R-squared	0.426	0.477

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table C2.4
Adolescent Cognitive Skill Production Function: Applied Problems – by Child Race

			Model 2		Model 4	
			White	Black	White	Black
CHILD TIME INVESTMENT	**Educational**	*Extensive*	-0.0109	-0.115	-0.0266	-0.114
			(0.110)	(0.239)	(0.118)	(0.248)
		Intensive	0.0196**	-0.0289	0.0226**	-0.0398
			(0.00865)	(0.0305)	(0.00955)	(0.0290)
	Structured	*Extensive*	0.208	0.0377	0.199	0.0709
			(0.166)	(0.216)	(0.159)	(0.271)
		Intensive	-0.0322	0.0186	-0.0284	0.0662
			(0.0377)	(0.0355)	(0.0335)	(0.0460)
	Unstructured	*Extensive*	0.0974	0.287	0.0583	0.344
			(0.141)	(0.242)	(0.146)	(0.232)
		Intensive	0.00340	-0.00869	0.00210	-0.00709
			(0.00460)	(0.00820)	(0.00536)	(0.00857)
MATERNAL TIME INVESTMENT	**Educational**	*Extensive*	-0.138	-1.054**	-0.109	-0.496
			(0.160)	(0.529)	(0.167)	(0.615)
		Intensive	0.0360	0.0819	0.0309	-0.0846
			(0.0376)	(0.118)	(0.0341)	(0.145)
	Structured	*Extensive*	-0.0323	-0.120	-0.0836	-0.288
			(0.147)	(0.314)	(0.155)	(0.303)
		Intensive	0.0175	0.0423	0.0243	0.0481
			(0.0287)	(0.0480)	(0.0316)	(0.0401)
	Unstructured	*Extensive*	0.123	0.412**	0.118	0.360*
			(0.107)	(0.182)	(0.110)	(0.185)
		Intensive	-0.0199**	-0.0393***	-0.0187**	-0.0287*
			(0.00822)	(0.0134)	(0.00828)	(0.0153)

LAG (CHILD TIME INVESTMENT)	**Educational**	*Extensive*		0.101	0.410
				(0.122)	(0.257)
		Intensive		-0.0265	-0.0285
				(0.0200)	(0.0432)
	Structured	*Extensive*		0.320**	0.176
				(0.152)	(0.419)
		Intensive		-0.0474	-0.0910
				(0.0333)	(0.0878)
	Unstructured	*Extensive*		0.0355	0.246
				(0.119)	(0.225)
		Intensive		-0.00400	-0.0336**
				(0.00821)	(0.0170)
LAG (MATERNAL TIME INVESTMENT)	**Educational**	*Extensive*		-0.0170	0.477
				(0.118)	(0.317)
		Intensive		-0.0385**	-0.117**
				(0.0174)	(0.0571)
	Structured	*Extensive*		-0.0630	0.181
				(0.146)	(0.271)
		Intensive		0.00468	-0.00920
				(0.0184)	(0.0382)
	Unstructured	*Extensive*		-0.0317	0.188
				(0.120)	(0.198)
		Intensive		-0.00179	-0.0171
				(0.0132)	(0.0266)
	Lagged Score		0.579***	0.580***	
			(0.0452)	(0.0446)	
	Controls				
	Black		-0.270	-0.622*	

	(0.245)	(0.330)
Child's age	-1.101*	-1.434**
	(0.601)	(0.640)
(Child's age)^2	0.0388*	0.0519**
	(0.0230)	(0.0246)
Mother's age	-0.0298	-0.0511
	(0.0912)	(0.105)
(Mother's age)^2	0.000469	0.000670
	(0.00109)	(0.00124)
Male	0.0709	0.115
	(0.0873)	(0.0908)
Birth order	-0.0571	-0.0603
	(0.0562)	(0.0592)
Adolescent in 2007	0.162*	0.216**
	(0.0937)	(0.103)
Constant	8.024*	10.71**
	(4.218)	(4.565)
Observations	344	344
R-squared	0.525	0.562

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Appendix D: Sensitivity Analyses

D1 Alternative Error Specification

Table D1.1
Child Cognitive Skill Production Functions – Alternative Error Specification

			Letter-Word Identification		Passage Comprehension		Applied Problems	
			OLS	Family FE	OLS	Family FE	OLS	Family FE
CHILD	**Educational**	*Extensive*	0.166	0.121	0.320***	0.197	0.126	0.0713
TIME			(0.125)	(0.144)	(0.122)	(0.161)	(0.127)	(0.128)
INVESTMENT		*Intensive*	0.0281	0.0339	0.00408	0.0119	0.0180	0.0306
			(0.0194)	(0.0213)	(0.0180)	(0.0287)	(0.0174)	(0.0229)
	Structured	*Extensive*	0.0616	0.00700	-0.00876	-0.134	0.157	-0.0367
			(0.147)	(0.167)	(0.155)	(0.188)	(0.147)	(0.170)
		Intensive	0.0118	0.0163	0.0165	0.0369	-0.0425	-0.00984
			(0.0379)	(0.0374)	(0.0419)	(0.0509)	(0.0339)	(0.0379)
	Unstructured	*Extensive*	-0.0457	0.0534	-0.0870	-0.167	0.0405	0.0127
			(0.103)	(0.151)	(0.100)	(0.163)	(0.105)	(0.148)
		Intensive	-0.000888	0.00736	0.00100	0.0168*	0.00534	0.0174**
			(0.00606)	(0.00880)	(0.00687)	(0.0100)	(0.00833)	(0.00845)
MATERNAL	**Educational**	*Extensive*	-0.00566	-0.0190	-0.0467	-0.221	-0.0992	-0.255
TIME			(0.119)	(0.165)	(0.118)	(0.173)	(0.121)	(0.164)
INVESTMENT		*Intensive*	-0.0107	-0.0174	-0.00837	0.0223	0.0161	0.0662**
			(0.0184)	(0.0249)	(0.0184)	(0.0291)	(0.0193)	(0.0299)
	Structured	*Extensive*	-0.00755	-0.0306	-0.0533	-0.0313	0.120	0.460**
			(0.125)	(0.204)	(0.125)	(0.197)	(0.130)	(0.190)
		Intensive	0.00698	0.00684	-0.00682	-0.0139	-0.00968	-0.0474
			(0.0217)	(0.0241)	(0.0229)	(0.0267)	(0.0227)	(0.0298)

Unstructured	*Extensive*	0.161	-0.0974	0.144	-0.168	0.0360	-0.0633
		(0.108)	(0.172)	(0.110)	(0.177)	(0.106)	(0.169)
	Intensive	-0.0385***	-0.00390	-0.0330**	0.00221	-0.0104	0.00827
		(0.0107)	(0.0196)	(0.0139)	(0.0244)	(0.0117)	(0.0187)
Controls							
Child's age		0.451	1.217***	1.140***	1.641***	0.784*	1.503***
		(0.419)	(0.410)	(0.436)	(0.434)	(0.418)	(0.426)
(Child's age)^2		-0.0310	-0.0759***	-0.0788***	-0.107***	-0.0485*	-0.0882***
		(0.0261)	(0.0260)	(0.0271)	(0.0269)	(0.0260)	(0.0268)
Mother's age		0.206***	0.294	0.263***	0.483***	0.215**	0.312
		(0.0788)	(0.226)	(0.0827)	(0.186)	(0.0910)	(0.222)
(Mother's age)^2		-0.00242**	0.000735	-0.00305***	-0.00257	-0.00211*	0.000962
		(0.00106)	(0.00188)	(0.00109)	(0.00208)	(0.00122)	(0.00190)
Male		-0.194**	-0.0963	-0.245***	-0.304***	0.215**	0.312
		(0.0853)	(0.0919)	(0.0843)	(0.0982)	(0.0910)	(0.222)
Birth order		-0.241***	-0.0378	-0.261***	-0.0778	-0.125**	0.122
		(0.0578)	(0.145)	(0.0586)	(0.147)	(0.0551)	(0.128)
Child in 2002		0.0202	-1.916**	0.160*	-1.344	-0.255***	-2.283**
		(0.0899)	(0.889)	(0.0868)	(0.817)	(0.0918)	(1.112)
Child in 2007		0.227	-3.636**	-0.0741	-3.048*	-0.332	-4.510**
		(0.187)	(1.764)	(0.189)	(1.602)	(0.210)	(2.220)
Constant		-5.350**	-15.44**	-8.836***	-19.04***	-7.876***	-18.25**
		(2.137)	(6.456)	(2.179)	(5.369)	(2.356)	(7.373)
Observations		510	510	510	510	510	510
R-squared		0.135	0.083	0.192	0.151	0.163	0.152
Number of sibling groups			255		255		255

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table D1.2
Adolescent Cognitive Skill Production Function: Letter-Word Identification – Alternative Error Specification

			Model 1		Model 2		Model 3		Model 4	
			OLS	Family FE	OLS	Family FE	OLS	Family FE	OLS	Family FE
CHILD TIME INVESTMENT	**Educational**	*Extensive*	0.00811	-0.0694	-0.0381	-0.0910	-0.0711	-0.104	-0.0963	-0.121
			(0.125)	(0.149)	(0.102)	(0.138)	(0.125)	(0.153)	(0.102)	(0.146)
		Intensive	0.0180*	0.000348	0.0141*	0.00142	0.0240**	0.00496	0.0197**	0.00469
			(0.0106)	(0.0102)	(0.00828)	(0.00882)	(0.0106)	(0.00958)	(0.00839)	(0.00857)
	Structured	*Extensive*	0.179	-0.0902	-0.0308	-0.108	0.156	-0.0495	-0.0719	-0.0853
			(0.169)	(0.173)	(0.149)	(0.172)	(0.156)	(0.184)	(0.139)	(0.186)
		Intensive	0.0424	0.0566	0.0483	0.0608	0.0315	0.0525	0.0498	0.0590
			(0.0444)	(0.0450)	(0.0365)	(0.0403)	(0.0421)	(0.0463)	(0.0366)	(0.0423)
	Unstructured	*Extensive*	-0.0168	0.132	-0.0530	0.114	-0.0699	0.0850	-0.0685	0.0893
			(0.146)	(0.129)	(0.121)	(0.122)	(0.148)	(0.134)	(0.124)	(0.129)
		Intensive	0.00381	-0.00117	0.00360	0.000819	0.00369	-0.00126	0.00208	0.000669
			(0.00602)	(0.00607)	(0.00463)	(0.00532)	(0.00607)	(0.00614)	(0.00463)	(0.00554)
MATERNAL TIME INVESTMENT	**Educational**	*Extensive*	0.0852	0.219	0.227	0.269	0.0985	0.286	0.203	0.307
			(0.224)	(0.270)	(0.201)	(0.247)	(0.231)	(0.255)	(0.199)	(0.249)
		Intensive	-0.00256	-0.150*	-0.0209	-0.152**	-0.00664	-0.178**	-0.0177	-0.173**
			(0.0400)	(0.0796)	(0.0338)	(0.0675)	(0.0425)	(0.0753)	(0.0349)	(0.0670)
	Structured	*Extensive*	-0.120	-0.245	-0.0502	-0.274	-0.116	-0.260	-0.0722	-0.275
			(0.140)	(0.183)	(0.115)	(0.184)	(0.145)	(0.170)	(0.120)	(0.183)
		Intensive	0.0141	0.0146	0.0135	0.0316	0.00674	0.0145	0.0115	0.0307
			(0.0231)	(0.0247)	(0.0172)	(0.0207)	(0.0226)	(0.0234)	(0.0174)	(0.0220)
	Unstructured	*Extensive*	0.0632	0.0182	0.00484	-0.0308	0.0230	-0.000618	-0.00623	-0.0475
			(0.125)	(0.140)	(0.0985)	(0.127)	(0.123)	(0.142)	(0.0983)	(0.129)
		Intensive	-0.0145	0.00786	-0.00487	0.00889	-0.00929	0.0113	-0.00507	0.0117
			(0.0146)	(0.0173)	(0.0108)	(0.0150)	(0.0145)	(0.0183)	(0.0106)	(0.0158)

LAG (CHILD TIME INVESTMENT)	**Educational**	*Extensive*					0.163	0.232	0.0169	0.151
							(0.143)	(0.147)	(0.124)	(0.139)
		Intensive					-0.00973	0.00640	-0.0192	0.0109
							(0.0239)	(0.0227)	(0.0208)	(0.0212)
	Structured	*Extensive*					0.297*	0.0653	0.239	0.0554
							(0.180)	(0.200)	(0.148)	(0.192)
		Intensive					-0.0191	0.0434	-0.0245	0.0272
							(0.0351)	(0.0362)	(0.0270)	(0.0354)
	Unstructured	*Extensive*					-0.0990	0.0827	-0.0535	0.0685
							(0.110)	(0.123)	(0.0924)	(0.114)
		Intensive					0.00989	0.0147	0.0109	0.0120
							(0.00742)	(0.00947)	(0.00701)	(0.00951)
LAG (MATERNAL TIME INVESTMENT)	**Educational**	*Extensive*					-0.0503	0.00321	-0.0432	0.0465
							(0.128)	(0.150)	(0.112)	(0.141)
		Intensive					-0.0103	-0.0174	-0.00837	-0.0203
							(0.0210)	(0.0238)	(0.0187)	(0.0242)
	Structured	*Extensive*					0.0823	0.0624	0.0918	0.0698
							(0.145)	(0.200)	(0.121)	(0.209)
		Intensive					0.0218	-0.0204	0.0165	-0.0179
							(0.0256)	(0.0306)	(0.0215)	(0.0329)
	Unstructured	*Extensive*					0.125	-0.226	0.0572	-0.248*
							(0.117)	(0.156)	(0.0950)	(0.138)
		Intensive					-0.0307**	-0.00302	-0.00943	0.00313
							(0.0126)	(0.0167)	(0.0102)	(0.0150)
	Lagged Score				0.536***	0.346***			0.532***	0.316***
					(0.0487)	(0.0583)			(0.0497)	(0.0607)
	Controls									
	Child's age		0.144	-0.462	-0.424	-0.816	0.0879	-0.461	-0.472	-0.763

	(0.743)	(0.582)	(0.617)	(0.505)	(0.763)	(0.683)	(0.634)	(0.601)
(Child's age)^2	-0.00886	0.0170	0.0139	0.0297	-0.00677	0.0163	0.0159	0.0271
	(0.0285)	(0.0223)	(0.0235)	(0.0193)	(0.0293)	(0.0262)	(0.0242)	(0.0230)
Mother's age	0.267**	-0.197	0.101	-0.0853	0.211*	-0.338	0.0829	-0.226
	(0.125)	(0.335)	(0.100)	(0.345)	(0.126)	(0.341)	(0.104)	(0.342)
(Mother's age)^2	-0.00277*	-0.00351	-0.000915	-0.00334	-0.00221	-0.00274	-0.000762	-0.00246
	(0.00151)	(0.00272)	(0.00120)	(0.00260)	(0.00151)	(0.00247)	(0.00124)	(0.00241)
Male	-0.253***	-0.182	-0.121	-0.175*	-0.265***	-0.217**	-0.139*	-0.206**
	(0.0939)	(0.112)	(0.0776)	(0.103)	(0.0981)	(0.105)	(0.0820)	(0.0988)
Birth order	-0.229***	-0.0564	-0.0839	-0.0675	-0.214***	-0.0418	-0.0785	-0.0592
	(0.0746)	(0.140)	(0.0564)	(0.123)	(0.0740)	(0.134)	(0.0550)	(0.121)
Adolescent in 2007	0.0242	2.340	-0.0123	1.805	0.0487	2.642	-0.00448	2.078
	(0.106)	(1.518)	(0.0847)	(1.600)	(0.103)	(1.651)	(0.0834)	(1.646)
Constant	-6.189	16.53	0.745	14.30	-4.571	20.95	1.476	18.18
	(5.476)	(12.00)	(4.459)	(12.59)	(5.490)	(13.53)	(4.527)	(13.17)
Observations	386	386	386	386	386	386	386	386
R-squared	0.152	0.120	0.415	0.251	0.195	0.195	0.437	0.300
Number of sibling groups		193		193		193		193

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table D1.3
Adolescent Cognitive Skill Production Function: Passage Comprehension – Alternative Error Specification

			Model 1		Model 2		Model 3		Model 4	
			OLS	Family FE	OLS	Family FE	OLS	Family FE	OLS	Family FE
CHILD	**Educational**	*Extensive*	0.0671	-0.0673	0.0354	-0.0741	-0.0114	-0.163	-0.0284	-0.170
TIME			(0.131)	(0.147)	(0.109)	(0.139)	(0.130)	(0.154)	(0.108)	(0.148)
INVESTMENT		*Intensive*	0.0187*	-0.000414	0.00891	-0.000800	0.0252**	0.00597	0.0157*	0.00476

				(0.0100)	(0.0131)	(0.00832)	(0.0126)	(0.0104)	(0.0139)	(0.00864)	(0.0132)
	Structured	*Extensive*	0.204	-0.133	0.181	-0.0968	0.214	-0.115	0.152	-0.108
			(0.152)	(0.187)	(0.142)	(0.173)	(0.150)	(0.195)	(0.142)	(0.174)
		Intensive	0.00446	0.0386	-0.0133	0.0265	-0.0124	0.0314	-0.0153	0.0234
			(0.0354)	(0.0367)	(0.0288)	(0.0345)	(0.0335)	(0.0395)	(0.0295)	(0.0357)
	Unstructured	*Extensive*	0.0893	0.143	0.0177	0.103	0.0590	0.0948	0.0115	0.0577
			(0.138)	(0.177)	(0.115)	(0.158)	(0.138)	(0.192)	(0.114)	(0.168)
		Intensive	0.00536	0.00125	0.00476	-8.15e-05	0.00635	0.00324	0.00408	0.00182
			(0.00601)	(0.00658)	(0.00444)	(0.00580)	(0.00603)	(0.00691)	(0.00457)	(0.00627)
MATERNAL TIME INVESTMENT	**Educational**	*Extensive*	-0.298	-0.00102	-0.226	-0.141	-0.281	-0.0645	-0.246	-0.208
			(0.194)	(0.265)	(0.181)	(0.220)	(0.202)	(0.245)	(0.189)	(0.224)
		Intensive	0.0600	-0.0457	0.0450	-0.0143	0.0541	-0.0555	0.0469	-0.0220
			(0.0570)	(0.0899)	(0.0510)	(0.0784)	(0.0529)	(0.0814)	(0.0503)	(0.0743)
	Structured	*Extensive*	0.0915	0.0461	0.239*	0.112	0.0674	-0.0491	0.183	0.0240
			(0.160)	(0.188)	(0.136)	(0.170)	(0.163)	(0.173)	(0.136)	(0.162)
		Intensive	-0.00808	-0.0234	-0.0189	-0.0107	-0.0109	-0.00511	-0.0166	0.00828
			(0.0222)	(0.0270)	(0.0190)	(0.0213)	(0.0218)	(0.0271)	(0.0185)	(0.0238)
	Unstructured	*Extensive*	0.224*	0.173	0.217**	0.239*	0.160	0.0992	0.185**	0.172
			(0.117)	(0.151)	(0.0930)	(0.139)	(0.116)	(0.143)	(0.0935)	(0.134)
		Intensive	-0.0154	0.00797	-0.00734	-0.00142	-0.00776	0.0179	-0.00530	0.00662
			(0.0119)	(0.0150)	(0.00866)	(0.0156)	(0.0119)	(0.0151)	(0.00853)	(0.0155)
LAG (CHILD TIME INVESTMENT)	**Educational**	*Extensive*					0.475***	0.400***	0.253**	0.247*
							(0.135)	(0.148)	(0.114)	(0.144)
		Intensive					-0.0569**	-0.0605**	-0.0531***	-0.0402*
							(0.0227)	(0.0251)	(0.0187)	(0.0232)
	Structured	*Extensive*					0.260	0.343*	0.279**	0.416**
							(0.177)	(0.185)	(0.141)	(0.160)
		Intensive					-0.0319	-0.0393	-0.0491	-0.0712**
							(0.0416)	(0.0411)	(0.0334)	(0.0355)
	Unstructured	*Extensive*					-0.0630	-0.0139	0.0165	0.0137

							(0.114)	(0.168)	(0.0937)	(0.156)
		Intensive					0.00108	0.0222	0.00402	0.0191
							(0.00838)	(0.0137)	(0.00679)	(0.0128)
LAG (MATERNAL TIME INVESTMENT)	**Educational**	*Extensive*					-0.141	-0.153	-0.105	-0.0206
							(0.133)	(0.196)	(0.115)	(0.180)
		Intensive					0.00817	0.0103	0.00637	-0.00550
							(0.0259)	(0.0355)	(0.0222)	(0.0356)
	Structured	*Extensive*					0.109	-0.0385	0.114	0.00163
							(0.138)	(0.242)	(0.120)	(0.231)
		Intensive					0.0271	-0.00206	0.0240	0.00821
							(0.0213)	(0.0446)	(0.0176)	(0.0438)
	Unstructured	*Extensive*					0.0542	-0.384**	-0.0130	-0.335**
							(0.113)	(0.154)	(0.0955)	(0.137)
		Intensive					-0.00996	0.0302	0.00663	0.0249
							(0.0128)	(0.0188)	(0.0104)	(0.0174)
	Lagged Score				0.557***	0.361***			0.553***	0.340***
					(0.0473)	(0.0626)			(0.0493)	(0.0664)
	Controls									
	Child's age		0.762	0.455	-0.398	-0.443	0.354	-0.279	-0.712	-0.875
			(0.697)	(0.718)	(0.602)	(0.689)	(0.703)	(0.720)	(0.595)	(0.660)
	(Child's age)^2		-0.0326	-0.0170	0.0153	0.0179	-0.0170	0.0105	0.0274	0.0342
			(0.0268)	(0.0278)	(0.0231)	(0.0266)	(0.0271)	(0.0277)	(0.0229)	(0.0254)
	Mother's age		0.463***	0.400	0.299***	0.355	0.398***	0.0604	0.268***	0.0134
			(0.121)	(0.316)	(0.104)	(0.316)	(0.113)	(0.357)	(0.1000)	(0.335)
	(Mother's age)^2		-0.00500***	-0.00475*	-0.00326***	-0.00338	-0.00431***	-0.00490**	-0.00295**	-0.00291
			(0.00146)	(0.00261)	(0.00125)	(0.00271)	(0.00137)	(0.00241)	(0.00120)	(0.00249)
	Male		-0.00977	-0.0384	0.162*	0.0844	0.0324	-0.0725	0.182**	0.0535
			(0.0993)	(0.116)	(0.0850)	(0.109)	(0.0990)	(0.104)	(0.0834)	(0.102)

Birth order	-0.271***	-0.0363	-0.134**	-0.0671	-0.268***	-0.0577	-0.141**	-0.0734
	(0.0717)	(0.158)	(0.0584)	(0.145)	(0.0717)	(0.155)	(0.0584)	(0.143)
Adolescent in 2007	-0.000949	-0.106	-0.102	-0.412	-0.00675	1.611	-0.112	1.046
	(0.109)	(1.288)	(0.0888)	(1.152)	(0.107)	(1.639)	(0.0897)	(1.446)
Constant	-14.64***	-11.30	-4.143	-5.914	-10.70**	7.243	-1.500	9.631
	(4.808)	(10.84)	(4.404)	(10.34)	(4.740)	(13.82)	(4.229)	(12.29)
Observations	386	386	386	386	386	386	386	386
R-squared	0.176	0.066	0.429	0.206	0.232	0.162	0.465	0.277
Number of sibling groups		193		193		193		193

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table D1.4
Adolescent Cognitive Skill Production Function: Applied Problems – Alternative Error Specification

			Model 1		**Model 2**		**Model 3**		**Model 4**	
			OLS	Family FE	OLS	Family FE	OLS	Family FE	OLS	Family FE
CHILD	**Educational**	*Extensive*	-0.142	-0.150	-0.0279	-0.0524	-0.180	-0.198	-0.0352	-0.0795
TIME			(0.129)	(0.135)	(0.0947)	(0.125)	(0.130)	(0.143)	(0.0951)	(0.135)
INVESTMENT		*Intensive*	0.0310***	0.0143	0.0183**	0.0118	0.0333***	0.0182*	0.0187**	0.0134
			(0.0100)	(0.0102)	(0.00812)	(0.00866)	(0.0103)	(0.0105)	(0.00861)	(0.00916)
	Structured	*Extensive*	0.344**	0.344*	0.237	0.277*	0.355**	0.376**	0.227	0.279*
			(0.165)	(0.178)	(0.150)	(0.166)	(0.164)	(0.185)	(0.140)	(0.165)
		Intensive	-0.0421	-0.0450	-0.0289	-0.0376	-0.0487	-0.0491	-0.0249	-0.0346
			(0.0310)	(0.0346)	(0.0331)	(0.0384)	(0.0315)	(0.0338)	(0.0295)	(0.0334)
	Unstructured	*Extensive*	0.239*	0.0581	0.0802	0.0908	0.208	0.0386	0.0609	0.0593
			(0.132)	(0.164)	(0.109)	(0.158)	(0.132)	(0.175)	(0.107)	(0.161)
		Intensive	-1.88e-05	0.00746	0.00455	0.00767	0.000187	0.00725	0.00380	0.00702
			(0.00549)	(0.00632)	(0.00361)	(0.00544)	(0.00563)	(0.00689)	(0.00387)	(0.00582)

MATERNAL TIME INVESTMENT	**Educational**	*Extensive*	-0.290	-0.220	-0.201	-0.178	-0.247	-0.198	-0.187	-0.143
			(0.241)	(0.288)	(0.168)	(0.216)	(0.238)	(0.286)	(0.162)	(0.208)
		Intensive	0.0516	-0.0423	0.0441	-0.0290	0.0436	-0.0579	0.0433	-0.0437
			(0.0543)	(0.0917)	(0.0354)	(0.0669)	(0.0533)	(0.0893)	(0.0321)	(0.0618)
	Structured	*Extensive*	-0.0507	-0.161	0.0170	-0.0120	-0.0771	-0.157	-0.0283	0.0104
			(0.161)	(0.153)	(0.125)	(0.138)	(0.161)	(0.161)	(0.124)	(0.152)
		Intensive	0.0138	0.0220	0.0209	0.0255	0.0127	0.0174	0.0225	0.0207
			(0.0266)	(0.0240)	(0.0204)	(0.0206)	(0.0266)	(0.0246)	(0.0204)	(0.0226)
	Unstructured	*Extensive*	0.150	0.298**	0.194**	0.386***	0.0987	0.261*	0.182**	0.362***
			(0.116)	(0.134)	(0.0895)	(0.121)	(0.117)	(0.141)	(0.0913)	(0.127)
		Intensive	-0.0171*	-0.0108	-0.0166**	-0.0204	-0.0100	-0.00493	-0.0139*	-0.0195
			(0.00908)	(0.0144)	(0.00755)	(0.0129)	(0.00938)	(0.0156)	(0.00756)	(0.0133)
LAG (CHILD TIME INVESTMENT)	**Educational**	*Extensive*					0.333**	0.340**	0.119	0.198
							(0.139)	(0.160)	(0.105)	(0.141)
		Intensive					-0.0319	-0.0409*	-0.0191	-0.0185
							(0.0232)	(0.0243)	(0.0163)	(0.0211)
	Structured	*Extensive*					0.282	-0.0438	0.329**	0.0471
							(0.178)	(0.177)	(0.141)	(0.167)
		Intensive					-0.0408	0.0129	-0.0488	-0.0169
							(0.0364)	(0.0416)	(0.0323)	(0.0388)
	Unstructured	*Extensive*					-0.0390	0.00496	-0.00224	0.0425
							(0.119)	(0.157)	(0.0931)	(0.141)
		Intensive					-0.00447	0.00965	-0.00365	0.00188
							(0.00875)	(0.0120)	(0.00745)	(0.0105)
LAG (MATERNAL TIME INVESTMENT)	**Educational**	*Extensive*					0.0106	-0.0971	0.0977	0.109
							(0.124)	(0.173)	(0.101)	(0.142)
		Intensive					-0.0309	-0.0221	-0.0483***	-0.0544**
							(0.0192)	(0.0254)	(0.0168)	(0.0228)
	Structured	*Extensive*					0.0592	-0.0610	-0.0670	-0.195

						(0.151)	(0.221)	(0.119)	(0.200)
	Intensive					-0.00381	-0.0199	0.00124	-0.00337
						(0.0224)	(0.0341)	(0.0170)	(0.0315)
Unstructured	*Extensive*					0.0634	-0.168	-0.0232	-0.204
						(0.122)	(0.161)	(0.0914)	(0.142)
	Intensive					-0.00829	0.00646	0.00572	0.000861
						(0.0144)	(0.0183)	(0.0114)	(0.0151)
Lagged Score				0.636***	0.405***			0.640***	0.425***
				(0.0379)	(0.0624)			(0.0386)	(0.0634)
Controls									
Child's age		-0.355	-0.851	-1.039*	-1.550**	-0.689	-1.377*	-1.243**	-1.886***
		(0.744)	(0.681)	(0.592)	(0.612)	(0.767)	(0.713)	(0.619)	(0.670)
(Child's age)^2		0.00947	0.0314	0.0360	0.0579**	0.0224	0.0508*	0.0440*	0.0702***
		(0.0286)	(0.0264)	(0.0227)	(0.0236)	(0.0295)	(0.0276)	(0.0239)	(0.0257)
Mother's age		0.268**	-0.140	0.0621	0.0700	0.221*	-0.298	0.0523	-0.0398
		(0.119)	(0.325)	(0.0939)	(0.246)	(0.122)	(0.365)	(0.0978)	(0.296)
(Mother's age)^2		-0.00258*	-0.00249	-0.000576	-0.00206	-0.00207	-0.00301	-0.000488	-0.00197
		(0.00145)	(0.00214)	(0.00114)	(0.00202)	(0.00147)	(0.00224)	(0.00118)	(0.00208)
Male		0.195*	0.148	0.0807	0.0783	0.230**	0.132	0.0961	0.0611
		(0.0996)	(0.101)	(0.0774)	(0.0968)	(0.101)	(0.107)	(0.0776)	(0.0998)
Birth order		-0.205***	-0.0726	-0.131**	-0.0793	-0.202***	-0.111	-0.136***	-0.109
		(0.0681)	(0.131)	(0.0517)	(0.119)	(0.0701)	(0.130)	(0.0518)	(0.118)
Adolescent in 2007		0.0997	1.868	0.245***	0.657	0.119	2.880*	0.282***	1.218
		(0.103)	(1.452)	(0.0777)	(0.995)	(0.102)	(1.669)	(0.0777)	(1.232)
Constant		-3.592	14.95	5.648	10.48	-0.474	25.65*	7.195*	17.15
		(5.371)	(12.50)	(4.118)	(8.915)	(5.476)	(14.49)	(4.318)	(11.16)
Observations		386	386	386	386	386	386	386	386
R-squared		0.176	0.097	0.510	0.278	0.209	0.151	0.534	0.333

Number of sibling groups	193	193	193	193

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

D2 OLS Regressions Including Children without Siblings in the CDS

Table D2.1
Child Cognitive Skill Production Functions – OLS Regressions Including Children without Siblings in the CDS

			Letter-Word Identification	Passage Comprehe-nsion	Applied Problems
CHILD TIME INVESTMENT	**Educational**	*Extensive*	0.0903	0.158*	0.0755
			(0.0857)	(0.0829)	(0.0881)
		Intensive	0.0244**	0.0197*	0.0169
			(0.0113)	(0.0111)	(0.0125)
	Structured	*Extensive*	0.100	0.0856	0.152
			(0.103)	(0.103)	(0.110)
		Intensive	-0.00575	0.00562	-0.0248
			(0.0247)	(0.0264)	(0.0253)
	Unstructured	*Extensive*	-0.0144	0.00477	0.0800
			(0.0855)	(0.0781)	(0.0829)
		Intensive	-0.00684	-0.00917*	-0.00578
			(0.00503)	(0.00526)	(0.00568)
MATERNAL TIME INVESTMENT	**Educational**	*Extensive*	0.00896	0.0571	-0.0370
			(0.0962)	(0.0907)	(0.0938)
		Intensive	-0.0161	-0.0241	-0.0134
			(0.0168)	(0.0150)	(0.0158)
	Structured	*Extensive*	-0.0102	-0.0399	0.140
			(0.1000)	(0.0960)	(0.0974)
		Intensive	0.0134	0.00685	-0.00514
			(0.0158)	(0.0157)	(0.0162)
	Unstructured	*Extensive*	0.100	0.0845	0.0154
			(0.0868)	(0.0781)	(0.0805)
		Intensive	-0.0226***	-0.0244***	-0.0143*
			(0.00848)	(0.00880)	(0.00829)
	Controls				
	Child's age		0.147	1.314***	1.043***
			(0.316)	(0.307)	(0.306)
	(Child's age)^2		-0.0117	-0.0883***	-0.0649***
			(0.0196)	(0.0189)	(0.0191)
	Mother's age		0.0882	0.0843	0.116*
			(0.0631)	(0.0632)	(0.0620)
	(Mother's age)^2		-0.000729	-0.000609	-0.000885
			(0.000859)	(0.000853)	(0.000844)
	Male		-0.196***	-0.250***	0.124**
			(0.0628)	(0.0609)	(0.0613)
	Birth order		-0.213***	-0.225***	-0.180***
			(0.0404)	(0.0395)	(0.0375)
	Child in 2002		0.0415	0.155**	-0.155**
			(0.0688)	(0.0637)	(0.0672)
	Child in 2007		-0.00533	-0.220*	-0.0496
			(0.125)	(0.121)	(0.121)
	Constant		-2.189	-6.447***	-6.795***
			(1.640)	(1.652)	(1.630)
	Observations		941	941	941
	R-squared		0.098	0.170	0.128

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table D2.2
Adolescent Cognitive Skill Production Function: Letter-Word Identification – OLS Regressions Including Children without Siblings in the CDS

			Model 1	Model 2	Model 3	Model 4
CHILD TIME INVESTMENT	**Educational**	*Extensive*	-0.0885	-0.109	-0.132	-0.139*
			(0.101)	(0.0809)	(0.100)	(0.0805)
		Intensive	0.0152**	0.00880	0.0189**	0.0116*
			(0.00766)	(0.00595)	(0.00770)	(0.00606)
	Structured	*Extensive*	0.140	0.0408	0.0716	-0.00814
			(0.125)	(0.101)	(0.118)	(0.0974)
		Intensive	0.0256	0.0228	0.0281	0.0274
			(0.0259)	(0.0210)	(0.0240)	(0.0207)
	Unstructured	*Extensive*	0.144	0.0561	0.105	0.0312
			(0.112)	(0.0856)	(0.111)	(0.0834)
		Intensive	0.00171	0.00269	0.00287	0.00284
			(0.00429)	(0.00311)	(0.00437)	(0.00315)
MATERNAL TIME INVESTMENT	**Educational**	*Extensive*	0.0404	0.152	0.0762	0.159
			(0.156)	(0.134)	(0.164)	(0.134)
		Intensive	-0.0147	-0.0356	-0.0201	-0.0364
			(0.0250)	(0.0234)	(0.0255)	(0.0230)
	Structured	*Extensive*	-0.0656	-0.00269	-0.110	-0.0504
			(0.106)	(0.0915)	(0.106)	(0.0926)
		Intensive	0.0147	0.0155	0.0160	0.0178
			(0.0161)	(0.0136)	(0.0157)	(0.0135)
	Unstructured	*Extensive*	0.114	0.0104	0.0909	0.00289
			(0.0920)	(0.0730)	(0.0922)	(0.0733)
		Intensive	-0.0152	-0.00555	-0.0127	-0.00611
			(0.00994)	(0.00696)	(0.0102)	(0.00709)
LAG	**Educational**	*Extensive*			0.0716	-0.0146

(CHILD TIME INVESTMENT)					(0.105)	(0.0815)
		Intensive			0.000184	-0.00912
					(0.0145)	(0.0113)
	Structured	*Extensive*			0.346**	0.233**
					(0.138)	(0.107)
		Intensive			-0.0275	-0.0170
					(0.0324)	(0.0230)
	Unstructured	*Extensive*			0.0386	0.0310
					(0.0933)	(0.0753)
		Intensive			-0.000941	0.000884
					(0.00635)	(0.00500)
LAG (MATERNAL TIME INVESTMENT)	**Educational**	*Extensive*			-0.0310	-0.0425
					(0.107)	(0.0913)
		Intensive			-0.0123	-0.00419
					(0.0176)	(0.0158)
	Structured	*Extensive*			-0.0283	0.0187
					(0.116)	(0.0932)
		Intensive			0.0377*	0.0255
					(0.0218)	(0.0181)
	Unstructured	*Extensive*			0.0134	0.0148
					(0.0934)	(0.0721)
		Intensive			-0.0208**	-0.00653
					(0.00985)	(0.00763)
	Lagged Score			0.594***		0.584***
				(0.0387)		(0.0390)
	Controls					
	Child's age		-0.553	-0.740	-0.565	-0.724
			(0.569)	(0.472)	(0.577)	(0.470)

(Child's age)^2	0.0184	0.0264	0.0186	0.0258
	(0.0217)	(0.0179)	(0.0221)	(0.0178)
Mother's age	0.0547	-0.0337	0.0481	-0.0421
	(0.116)	(0.0801)	(0.109)	(0.0780)
(Mother's age)^2	-0.000182	0.000679	-0.000177	0.000744
	(0.00141)	(0.000955)	(0.00132)	(0.000932)
Male	-0.211***	-0.0891	-0.203***	-0.0901
	(0.0747)	(0.0609)	(0.0759)	(0.0616)
Birth order	-0.231***	-0.0830**	-0.221***	-0.0830**
	(0.0508)	(0.0400)	(0.0492)	(0.0386)
Adolescent in 2007	-0.0175	-0.0497	0.0293	-0.0237
	(0.0793)	(0.0631)	(0.0775)	(0.0623)
Constant	2.418	5.462	2.741	5.558
	(4.702)	(3.636)	(4.641)	(3.599)
Observations	684	684	684	684
R-squared	0.104	0.419	0.142	0.434

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table D2.3
Adolescent Cognitive Skill Production Function: Passage Comprehension – OLS Regressions Including Children without Siblings in the CDS

			Passage Comprehension			
			Model 1	**Model 2**	**Model 3**	**Model 4**
CHILD	**Educational**	*Extensive*	-0.0212	-0.0536	-0.0555	-0.0824
TIME			(0.0991)	(0.0853)	(0.0977)	(0.0850)
INVESTMENT		*Intensive*	0.0187**	0.0117*	0.0215***	0.0141**
			(0.00733)	(0.00641)	(0.00718)	(0.00635)
	Structured	*Extensive*	0.177	0.148	0.123	0.102
			(0.112)	(0.0973)	(0.113)	(0.0998)

		Intensive	0.00841	0.00192	0.00844	0.00502
			(0.0198)	(0.0145)	(0.0197)	(0.0157)
	Unstructured	*Extensive*	0.186*	0.127	0.163	0.110
			(0.101)	(0.0907)	(0.103)	(0.0915)
		Intensive	-0.00122	-0.00118	0.00102	-9.50e-05
			(0.00422)	(0.00337)	(0.00425)	(0.00342)
MATERNAL TIME INVESTMENT	**Educational**	*Extensive*	-0.1000	-0.159	-0.0664	-0.152
			(0.141)	(0.131)	(0.148)	(0.137)
		Intensive	0.00586	0.0160	0.00123	0.0151
			(0.0302)	(0.0251)	(0.0312)	(0.0266)
	Structured	*Extensive*	0.0421	0.112	-0.0101	0.0472
			(0.115)	(0.0952)	(0.117)	(0.0985)
		Intensive	-0.00331	-0.00891	-0.000743	-0.00500
			(0.0147)	(0.0122)	(0.0148)	(0.0125)
	Unstructured	*Extensive*	0.282***	0.240***	0.244***	0.219***
			(0.0857)	(0.0709)	(0.0841)	(0.0708)
		Intensive	-0.0154*	-0.0102	-0.0111	-0.00898
			(0.00915)	(0.00666)	(0.00920)	(0.00681)
LAG (CHILD TIME INVESTMENT)	**Educational**	*Extensive*			0.305***	0.216***
					(0.0964)	(0.0782)
		Intensive			-0.0160	-0.0258**
					(0.0144)	(0.0118)
	Structured	*Extensive*			0.340**	0.268**
					(0.133)	(0.108)
		Intensive			-0.0408	-0.0334
					(0.0318)	(0.0225)
	Unstructured	*Extensive*			-0.000902	0.0164
					(0.0911)	(0.0777)
		Intensive			-0.00665	-0.00310
					(0.00587)	(0.00519)

LAG (MATERNAL TIME INVESTMENT)	**Educational**	*Extensive*			-0.0459	-0.0446
					(0.108)	(0.0940)
		Intensive			-0.00680	-0.00247
					(0.0201)	(0.0172)
	Structured	*Extensive*			0.0278	0.0775
					(0.105)	(0.0902)
		Intensive			0.0294	0.0228
					(0.0184)	(0.0157)
	Unstructured	*Extensive*			-0.000174	-0.0284
					(0.0881)	(0.0746)
		Intensive			-0.00460	0.00926
					(0.00987)	(0.00812)
	Lagged Score			0.511***		0.504***
				(0.0361)		(0.0364)
	Controls					
	Child's age		-0.0181	-1.045**	-0.127	-1.099**
			(0.541)	(0.471)	(0.528)	(0.456)
	(Child's age)^2		-0.00102	0.0405**	0.00256	0.0422**
			(0.0207)	(0.0179)	(0.0202)	(0.0174)
	Mother's age		0.279***	0.251***	0.269***	0.238***
			(0.0938)	(0.0698)	(0.0883)	(0.0675)
	(Mother's age)^2		-0.00283**	-0.00272***	-0.00276***	-0.00259***
			(0.00113)	(0.000838)	(0.00106)	(0.000808)
	Male		-0.155**	0.00411	-0.111	0.0364
			(0.0778)	(0.0689)	(0.0772)	(0.0672)
	Birth order		-0.239***	-0.109**	-0.235***	-0.114***
			(0.0531)	(0.0466)	(0.0508)	(0.0437)
	Adolescent in 2007		-0.0948	-0.156**	-0.0731	-0.148**

			(0.0775)	(0.0663)	(0.0756)	(0.0657)
	Constant		-6.027	1.021	-5.095	1.611
			(3.845)	(3.259)	(3.726)	(3.130)
	Observations		684	684	684	684
	R-squared		0.144	0.365	0.186	0.391

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table D2.4
Adolescent Cognitive Skill Production Function: Applied Problems – OLS Regressions Including Children without Siblings in the CDS

			Model 1	**Model 2**	**Model 3**	**Model 4**
CHILD TIME INVESTMENT	**Educational**	*Extensive*	-0.0700	-0.0856	-0.0943	-0.0977
			(0.0920)	(0.0722)	(0.0927)	(0.0729)
		Intensive	0.0249***	0.0165***	0.0273***	0.0182***
			(0.00651)	(0.00577)	(0.00640)	(0.00572)
	Structured	*Extensive*	0.173	0.0847	0.136	0.0535
			(0.114)	(0.100)	(0.115)	(0.0988)
		Intensive	-0.00611	-0.00705	-0.00506	-0.00289
			(0.0200)	(0.0171)	(0.0191)	(0.0163)
	Unstructured	*Extensive*	0.250**	0.118	0.234**	0.115
			(0.108)	(0.0879)	(0.110)	(0.0872)
		Intensive	-0.00407	-0.000280	-0.00270	-4.39e-06
			(0.00430)	(0.00309)	(0.00445)	(0.00330)
MATERNAL TIME INVESTMENT	**Educational**	*Extensive*	-0.242	-0.170	-0.175	-0.121
			(0.169)	(0.129)	(0.171)	(0.129)
		Intensive	0.00934	0.00343	-0.000112	-0.00255
			(0.0359)	(0.0288)	(0.0354)	(0.0287)
	Structured	*Extensive*	-0.0547	0.00653	-0.0799	-0.0286

			(0.116)	(0.0901)	(0.116)	(0.0915)
		Intensive	0.00992	0.00880	0.0115	0.0107
			(0.0159)	(0.0118)	(0.0162)	(0.0119)
	Unstructured	*Extensive*	0.169*	0.130*	0.134	0.112
			(0.0868)	(0.0701)	(0.0874)	(0.0704)
		Intensive	-0.0176**	-0.0137**	-0.0139*	-0.0123**
			(0.00746)	(0.00536)	(0.00746)	(0.00537)
LAG (CHILD TIME INVESTMENT)	**Educational**	*Extensive*			0.153	0.0672
					(0.0996)	(0.0733)
		Intensive			-0.0102	-0.0161*
					(0.0144)	(0.00939)
	Structured	*Extensive*			0.194	0.178*
					(0.139)	(0.0986)
		Intensive			-0.0241	-0.0239
					(0.0362)	(0.0224)
	Unstructured	*Extensive*			-0.00518	-0.0315
					(0.0920)	(0.0725)
		Intensive			-0.00964*	-0.00626
					(0.00560)	(0.00441)
LAG (MATERNAL TIME INVESTMENT)	**Educational**	*Extensive*			0.0111	0.113
					(0.102)	(0.0807)
		Intensive			-0.0325*	-0.0391***
					(0.0166)	(0.0136)
	Structured	*Extensive*			0.0385	-0.0138
					(0.121)	(0.0883)
		Intensive			0.00284	0.00419
					(0.0192)	(0.0143)
	Unstructured	*Extensive*			0.0703	0.0643
					(0.0944)	(0.0725)
		Intensive			-0.0190**	-0.00877

			(0.00956)	(0.00810)
Lagged Score		0.615***		0.612***
		(0.0312)		(0.0312)
Controls				
Child's age	-0.661	-1.520***	-0.764	-1.555***
	(0.535)	(0.438)	(0.546)	(0.448)
(Child's age)^2	0.0222	0.0548***	0.0260	0.0565***
	(0.0205)	(0.0168)	(0.0210)	(0.0172)
Mother's age	0.190**	0.0940	0.179**	0.0875
	(0.0886)	(0.0662)	(0.0858)	(0.0666)
(Mother's age)^2	-0.00170	-0.000914	-0.00160	-0.000836
	(0.00107)	(0.000798)	(0.00103)	(0.000801)
Male	0.138*	0.0518	0.166**	0.0664
	(0.0739)	(0.0600)	(0.0731)	(0.0601)
Birth order	-0.217***	-0.107***	-0.210***	-0.103***
	(0.0480)	(0.0385)	(0.0488)	(0.0387)
Adolescent in 2007	0.0901	0.193***	0.118	0.213***
	(0.0756)	(0.0583)	(0.0753)	(0.0587)
Constant	-0.0846	8.024***	0.837	8.340***
	(3.898)	(3.086)	(3.908)	(3.159)
Observations	684	684	684	684
R-squared	0.139	0.466	0.164	0.480

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

D3 Non-Linear Functional Form

Table D3.1
Child Cognitive Production Functions – Non-linear Functional Form

			Letter-Word Identification		Passage Comprehension		Applied Problems	
			OLS	Family FE	OLS	Family FE	OLS	Family FE
CHILD TIME INVESTMENT	**Educational**	*Extensive*	0.130	0.348*	0.406**	0.536***	0.213	0.302*
			(0.167)	(0.190)	(0.161)	(0.186)	(0.173)	(0.165)
		Intensive	0.0403	-0.0383	-0.0240	-0.103**	-0.00717	-0.0483
			(0.0385)	(0.0450)	(0.0360)	(0.0418)	(0.0387)	(0.0473)
	Structured	*Extensive*	-0.0706	-0.354	-0.270	-0.567***	-0.122	-0.373*
			(0.177)	(0.222)	(0.166)	(0.208)	(0.184)	(0.212)
		Intensive	0.0884	0.195**	0.159**	0.249***	0.106*	0.143*
			(0.0730)	(0.0934)	(0.0674)	(0.0841)	(0.0620)	(0.0789)
	Unstructured	*Extensive*	-0.0113	0.0462	-0.0931	-0.220	0.0393	-0.0352
			(0.127)	(0.172)	(0.120)	(0.180)	(0.125)	(0.163)
		Intensive	-0.00900	0.00957	-0.000804	0.0282	0.00533	0.0314**
			(0.0133)	(0.0164)	(0.0128)	(0.0178)	(0.0130)	(0.0158)
MATERNAL TIME INVESTMENT	**Educational**	*Extensive*	0.0179	-0.181	0.0229	-0.391*	-0.0763	-0.453**
			(0.173)	(0.222)	(0.149)	(0.214)	(0.174)	(0.218)
		Intensive	-0.0288	0.0160	-0.0500	0.0419	0.00277	0.108*
			(0.0445)	(0.0609)	(0.0385)	(0.0584)	(0.0430)	(0.0580)
	Structured	*Extensive*	0.150	-0.0558	0.125	-0.113	0.0229	0.254
			(0.183)	(0.255)	(0.175)	(0.234)	(0.188)	(0.257)
		Intensive	-0.0488	-0.00735	-0.0719	-0.0209	0.0248	0.00346
			(0.0499)	(0.0612)	(0.0519)	(0.0609)	(0.0534)	(0.0665)
	Unstructured	*Extensive*	0.235*	-0.0293	0.227*	-0.0605	0.112	-0.0346
			(0.142)	(0.194)	(0.132)	(0.199)	(0.137)	(0.194)

	Intensive	-0.0579***	-0.0167	-0.0562**	-0.0200	-0.0351*	0.00187
		(0.0210)	(0.0280)	(0.0232)	(0.0340)	(0.0212)	(0.0297)
Controls							
Child's age		0.377	1.181***	1.098***	1.663***	0.772*	1.527***
		(0.424)	(0.409)	(0.415)	(0.436)	(0.423)	(0.438)
(Child's age)^2		-0.0265	-0.0743***	-0.0766***	-0.110***	-0.0478*	-0.0903***
		(0.0264)	(0.0259)	(0.0258)	(0.0272)	(0.0263)	(0.0276)
Mother's age		0.203**	0.343	0.260***	0.510***	0.213**	0.344
		(0.0822)	(0.221)	(0.0847)	(0.182)	(0.0936)	(0.219)
(Mother's age)^2		-0.00237**	0.000531	-0.00300***	-0.00271	-0.00208*	0.00101
		(0.00110)	(0.00185)	(0.00112)	(0.00207)	(0.00126)	(0.00187)
Male		-0.189**	-0.0728	-0.232***	-0.282***	0.222***	0.222**
		(0.0848)	(0.0901)	(0.0818)	(0.0950)	(0.0817)	(0.0900)
Birth order		-0.245***	-0.0400	-0.264***	-0.0703	-0.117*	0.122
		(0.0659)	(0.144)	(0.0645)	(0.144)	(0.0602)	(0.128)
Child in 2002		0.0229	-2.074**	0.168*	-1.407*	-0.239**	-2.420**
		(0.101)	(0.882)	(0.0933)	(0.782)	(0.0990)	(1.052)
Child in 2007		0.219	-3.901**	-0.0488	-3.092**	-0.307	-4.757**
		(0.198)	(1.747)	(0.214)	(1.529)	(0.228)	(2.097)
Constant		-4.971**	-16.68***	-8.577***	-19.78***	-7.828***	-19.42***
		(2.181)	(6.359)	(2.161)	(5.088)	(2.421)	(7.074)
Observations		510	510	510	510	510	510
R-squared		0.144	0.119	0.210	0.207	0.177	0.186
Number of sibling groups			255		255		255

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table D3.2
Adolescent Cognitive Production Function: Letter-Word Identification – Non-linear Functional Form

			Model 1		Model 2		Model 3		Model 4	
			OLS	Family FE	OLS	Family FE	OLS	Family FE	OLS	Family FE
CHILD TIME INVESTMENT	**Educational**	*Extensive*	0.0248	-0.159	0.0416	-0.127	-0.0290	-0.256	-0.0242	-0.206
			(0.156)	(0.178)	(0.128)	(0.160)	(0.150)	(0.190)	(0.125)	(0.176)
		Intensive	0.0125	0.0129	-0.000860	0.00620	0.0138	0.0255	0.00541	0.0169
			(0.0181)	(0.0178)	(0.0144)	(0.0163)	(0.0179)	(0.0186)	(0.0145)	(0.0172)
	Structured	*Extensive*	0.326	-0.0710	0.101	-0.124	0.271	0.0320	0.0412	-0.0427
			(0.204)	(0.206)	(0.184)	(0.198)	(0.190)	(0.221)	(0.172)	(0.213)
		Intensive	-0.0320	0.0487	-0.0205	0.0765	-0.0425	-0.0235	-0.0193	0.0111
			(0.0803)	(0.0851)	(0.0718)	(0.0761)	(0.0778)	(0.0941)	(0.0707)	(0.0860)
	Unstructured	*Extensive*	0.0972	0.149	0.0272	0.150	0.0611	0.0443	0.0225	0.0688
			(0.157)	(0.145)	(0.126)	(0.135)	(0.158)	(0.157)	(0.127)	(0.147)
		Intensive	-0.00624	-0.000902	-0.00490	-0.00178	-0.00783	0.00243	-0.00748	0.00110
			(0.00797)	(0.00986)	(0.00637)	(0.00944)	(0.00827)	(0.00967)	(0.00654)	(0.00939)
MATERNAL TIME INVESTMENT	**Educational**	*Extensive*	0.370	-0.173	0.489	0.228	0.327	-0.202	0.400	0.0859
			(0.345)	(0.420)	(0.307)	(0.416)	(0.384)	(0.482)	(0.319)	(0.490)
		Intensive	-0.149	0.0387	-0.158	-0.162	-0.137	0.0705	-0.129	-0.0753
			(0.143)	(0.199)	(0.121)	(0.183)	(0.158)	(0.222)	(0.128)	(0.215)
	Structured	*Extensive*	-0.274	0.0313	-0.144	-0.0743	-0.253	-0.0978	-0.120	-0.168
			(0.196)	(0.237)	(0.170)	(0.234)	(0.202)	(0.229)	(0.176)	(0.234)
		Intensive	0.0708	-0.0856	0.0481	-0.0440	0.0537	-0.0229	0.0268	0.0110
			(0.0600)	(0.0685)	(0.0507)	(0.0617)	(0.0587)	(0.0708)	(0.0495)	(0.0653)
	Unstructured	*Extensive*	0.0747	0.209	0.0687	0.157	0.0250	0.155	0.0325	0.0997
			(0.146)	(0.155)	(0.119)	(0.137)	(0.143)	(0.157)	(0.116)	(0.140)
		Intensive	-0.0160	-0.0339	-0.0175	-0.0293	-0.00948	-0.0219	-0.0125	-0.0184
			(0.0202)	(0.0242)	(0.0160)	(0.0197)	(0.0204)	(0.0254)	(0.0159)	(0.0216)

LAG (CHILD TIME INVESTMENT)	**Educational**	*Extensive*					0.0460	0.274	-0.0739	0.150
							(0.191)	(0.181)	(0.161)	(0.172)
		Intensive					0.0359	-0.0119	0.0205	0.0136
							(0.0448)	(0.0441)	(0.0386)	(0.0434)
	Structured	*Extensive*					0.338	-0.0178	0.183	-0.0175
							(0.263)	(0.274)	(0.217)	(0.260)
		Intensive					-0.0325	0.0807	0.0133	0.0693
							(0.108)	(0.107)	(0.0897)	(0.0982)
	Unstructured	*Extensive*					-0.0379	-0.00568	-0.0247	-0.0360
							(0.134)	(0.150)	(0.107)	(0.136)
		Intensive					0.000175	0.0355*	0.00968	0.0335*
							(0.0168)	(0.0204)	(0.0144)	(0.0189)
LAG (MATERNAL TIME INVESTMENT)	**Educational**	*Extensive*					0.0400	-0.0974	0.0686	-0.0316
							(0.181)	(0.226)	(0.164)	(0.221)
		Intensive					-0.0407	0.00842	-0.0447	-0.000565
							(0.0511)	(0.0670)	(0.0478)	(0.0669)
	Structured	*Extensive*					0.0308	-0.218	-0.0530	-0.212
							(0.208)	(0.287)	(0.170)	(0.301)
		Intensive					0.0498	0.0851	0.0723*	0.0894
							(0.0537)	(0.0762)	(0.0423)	(0.0781)
	Unstructured	*Extensive*					0.184	-0.247	0.104	-0.261
							(0.150)	(0.180)	(0.120)	(0.168)
		Intensive					-0.0470*	0.00477	-0.0220	0.0119
							(0.0253)	(0.0314)	(0.0215)	(0.0308)
	Lagged Score				0.538***	0.330***			0.535***	0.303***
					(0.0513)	(0.0572)			(0.0528)	(0.0596)
	Controls									
	Child's age		0.251	-0.726	-0.347	-0.891*	0.0739	-0.604	-0.491	-0.795

	(0.739)	(0.611)	(0.621)	(0.533)	(0.788)	(0.743)	(0.647)	(0.647)
(Child's age)^2	-0.0134	0.0269	0.0105	0.0326	-0.00650	0.0217	0.0164	0.0286
	(0.0282)	(0.0232)	(0.0236)	(0.0202)	(0.0301)	(0.0285)	(0.0246)	(0.0248)
Mother's age	0.278*	-0.225	0.120	-0.143	0.201	-0.281	0.0790	-0.194
	(0.142)	(0.332)	(0.108)	(0.343)	(0.145)	(0.326)	(0.113)	(0.322)
(Mother's age)^2	-0.00288*	-0.00292	-0.00113	-0.00308	-0.00207	-0.00180	-0.000711	-0.00192
	(0.00172)	(0.00281)	(0.00129)	(0.00272)	(0.00174)	(0.00252)	(0.00134)	(0.00248)
Male	-0.228**	-0.150	-0.0947	-0.147	-0.216**	-0.200*	-0.0864	-0.190*
	(0.0929)	(0.113)	(0.0798)	(0.103)	(0.0990)	(0.104)	(0.0870)	(0.0968)
Birth order	-0.235***	-0.0739	-0.0977	-0.0664	-0.219**	-0.0593	-0.0851	-0.0530
	(0.0863)	(0.136)	(0.0616)	(0.122)	(0.0846)	(0.129)	(0.0585)	(0.119)
Adolescent in 2007	0.0187	2.225	-0.00828	1.958	0.0479	2.017	-0.00385	1.705
	(0.123)	(1.435)	(0.0929)	(1.569)	(0.125)	(1.520)	(0.0951)	(1.550)
Constant	-7.080	18.46	-0.106	16.65	-4.262	18.17	1.680	16.18
	(5.481)	(11.57)	(4.499)	(12.37)	(5.686)	(12.54)	(4.579)	(12.33)
Observations	386	386	386	386	386	386	386	386
R-squared	0.164	0.165	0.426	0.277	0.214	0.252	0.454	0.341
Number of sibling groups		193		193		193		193

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table D3.3
Adolescent Cognitive Production Function: Passage Comprehension – Non-linear Functional Form

			Model 1		**Model 2**		**Model 3**		**Model 4**	
			OLS	Family FE	OLS	Family FE	OLS	Family FE	OLS	Family FE
CHILD	**Educational**	*Extensive*	-0.113	-0.210	-0.0585	-0.204	-0.212	-0.401*	-0.171	-0.368*
TIME			(0.169)	(0.212)	(0.142)	(0.198)	(0.165)	(0.221)	(0.136)	(0.207)
INVESTMENT		*Intensive*	0.0430**	0.0219	0.0221	0.0187	0.0525***	0.0355	0.0377**	0.0312

			(0.0193)	(0.0258)	(0.0172)	(0.0242)	(0.0194)	(0.0280)	(0.0166)	(0.0259)
	Structured	*Extensive*	0.237	-0.0838	0.0941	-0.170	0.214	-0.0570	0.0500	-0.165
			(0.189)	(0.241)	(0.184)	(0.220)	(0.195)	(0.249)	(0.185)	(0.220)
		Intensive	-0.000603	0.00716	0.0382	0.0669	-0.0105	-0.0138	0.0374	0.0414
			(0.0707)	(0.0970)	(0.0719)	(0.0890)	(0.0744)	(0.106)	(0.0703)	(0.0943)
	Unstructured	*Extensive*	0.208	0.144	0.123	0.142	0.221	0.0377	0.154	0.0647
			(0.163)	(0.185)	(0.138)	(0.164)	(0.168)	(0.207)	(0.141)	(0.176)
		Intensive	-0.00434	0.00182	-0.00585	-0.00274	-0.00637	0.00910	-0.00954	0.00265
			(0.00878)	(0.0107)	(0.00703)	(0.00985)	(0.00913)	(0.0103)	(0.00699)	(0.00948)
MATERNAL TIME INVESTMENT	**Educational**	*Extensive*	0.0639	-0.823**	-0.0814	-0.642*	0.109	-0.831*	-0.0741	-0.808*
			(0.272)	(0.387)	(0.221)	(0.367)	(0.291)	(0.429)	(0.229)	(0.419)
		Intensive	-0.132	0.397**	-0.0359	0.245	-0.150	0.347*	-0.0435	0.278
			(0.137)	(0.193)	(0.104)	(0.177)	(0.138)	(0.209)	(0.102)	(0.191)
	Structured	*Extensive*	-0.0213	0.356	0.0835	0.248	-0.0356	0.257	0.0724	0.208
			(0.223)	(0.264)	(0.167)	(0.245)	(0.245)	(0.231)	(0.193)	(0.229)
		Intensive	0.0355	-0.135	0.0386	-0.0589	0.0335	-0.0957	0.0300	-0.0310
			(0.0628)	(0.0878)	(0.0492)	(0.0816)	(0.0673)	(0.0803)	(0.0540)	(0.0789)
	Unstructured	*Extensive*	0.153	0.187	0.240**	0.310**	0.0784	0.114	0.171	0.235
			(0.143)	(0.176)	(0.116)	(0.154)	(0.141)	(0.176)	(0.115)	(0.150)
		Intensive	-0.000446	0.00107	-0.0119	-0.0188	0.00483	0.0135	-0.00858	-0.00821
			(0.0215)	(0.0253)	(0.0171)	(0.0218)	(0.0211)	(0.0263)	(0.0167)	(0.0228)
LAG (CHILD TIME INVESTMENT)	**Educational**	*Extensive*					0.564***	0.477**	0.311**	0.249
							(0.188)	(0.202)	(0.152)	(0.204)
		Intensive					-0.0980**	-0.125**	-0.0795**	-0.0731
							(0.0456)	(0.0496)	(0.0381)	(0.0500)
	Structured	*Extensive*					0.607**	0.501*	0.641***	0.646**
							(0.272)	(0.286)	(0.213)	(0.251)
		Intensive					-0.217*	-0.138	-0.241***	-0.202*
							(0.113)	(0.126)	(0.0893)	(0.109)
	Unstructured	*Extensive*					0.0269	-0.0483	0.103	-0.0181

							(0.130)	(0.191)	(0.113)	(0.172)
		Intensive					-0.0197	0.0329	-0.0139	0.0232
							(0.0144)	(0.0225)	(0.0125)	(0.0206)
LAG (MATERNAL TIME INVESTMENT)	**Educational**	*Extensive*					-0.107	0.0103	-0.0876	0.170
							(0.173)	(0.249)	(0.153)	(0.237)
		Intensive					-0.00563	-0.0802	0.00208	-0.0977*
							(0.0473)	(0.0622)	(0.0419)	(0.0591)
	Structured	*Extensive*					0.120	-0.280	0.0165	-0.277
							(0.196)	(0.265)	(0.165)	(0.245)
		Intensive					0.0347	0.0789	0.0668*	0.110
							(0.0517)	(0.0742)	(0.0405)	(0.0700)
	Unstructured	*Extensive*					0.000943	-0.422**	-0.104	-0.346**
							(0.142)	(0.177)	(0.119)	(0.165)
		Intensive					0.00311	0.0470	0.0305	0.0387
							(0.0248)	(0.0370)	(0.0202)	(0.0365)
	Lagged Score				0.557***	0.356***			0.559***	0.346***
					(0.0503)	(0.0645)			(0.0512)	(0.0714)
	Controls									
	Child's age		0.805	0.0327	-0.340	-0.660	0.532	-0.316	-0.575	-0.865
			(0.693)	(0.761)	(0.565)	(0.723)	(0.706)	(0.762)	(0.558)	(0.706)
	(Child's age)^2		-0.0346	-0.00127	0.0127	0.0261	-0.0242	0.0108	0.0221	0.0331
			(0.0266)	(0.0293)	(0.0217)	(0.0279)	(0.0271)	(0.0293)	(0.0214)	(0.0271)
	Mother's age		0.463***	0.447	0.301***	0.366	0.376***	0.0565	0.245***	-0.0332
			(0.128)	(0.308)	(0.104)	(0.315)	(0.118)	(0.335)	(0.0939)	(0.323)
	(Mother's age)^2		-0.00497***	-0.00403	-0.00327**	-0.00328	-0.00400***	-0.00359	-0.00264**	-0.00215
			(0.00155)	(0.00271)	(0.00126)	(0.00281)	(0.00142)	(0.00245)	(0.00113)	(0.00256)
	Male		0.00169	-0.0180	0.166*	0.101	0.0423	-0.103	0.192**	0.0352
			(0.101)	(0.121)	(0.0868)	(0.113)	(0.103)	(0.115)	(0.0875)	(0.112)

Birth order	-0.263***	-0.0731	-0.143**	-0.0710	-0.247***	-0.130	-0.128**	-0.125
	(0.0834)	(0.156)	(0.0635)	(0.144)	(0.0807)	(0.152)	(0.0615)	(0.142)
Adolescent in 2007	-0.0309	-0.621	-0.112	-0.549	-0.0501	1.200	-0.157	1.049
	(0.127)	(1.248)	(0.0999)	(1.134)	(0.128)	(1.588)	(0.103)	(1.423)
Constant	-14.94***	-11.38	-4.551	-5.102	-11.41**	5.960	-1.949	10.44
	(4.613)	(10.16)	(4.069)	(10.09)	(4.557)	(12.60)	(3.788)	(11.66)
Observations	386	386	386	386	386	386	386	386
R-squared	0.194	0.103	0.440	0.229	0.267	0.224	0.497	0.330
Number of sibling groups		193		193		193		193

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table D3.4
Adolescent Cognitive Production Function: Applied Problems – Non-linear Functional Form

			Model 1		**Model 2**		**Model 3**		**Model 4**	
			OLS	Family FE	OLS	Family FE	OLS	Family FE	OLS	Family FE
CHILD	**Educational**	*Extensive*	-0.174	-0.195	0.0266	-0.0343	-0.210	-0.275	0.00523	-0.0659
TIME			(0.162)	(0.170)	(0.123)	(0.155)	(0.164)	(0.181)	(0.124)	(0.164)
INVESTMENT		*Intensive*	0.0327*	0.0217	0.00762	0.0114	0.0320	0.0293	0.00731	0.0149
			(0.0191)	(0.0189)	(0.0149)	(0.0162)	(0.0197)	(0.0206)	(0.0154)	(0.0174)
	Structured	*Extensive*	0.426*	0.164	0.166	0.00541	0.413*	0.159	0.151	0.00433
			(0.220)	(0.218)	(0.206)	(0.196)	(0.219)	(0.226)	(0.209)	(0.198)
		Intensive	-0.0727	0.0438	0.0166	0.111	-0.0790	0.0466	0.0104	0.0986
			(0.0771)	(0.0792)	(0.0753)	(0.0696)	(0.0796)	(0.0923)	(0.0767)	(0.0789)
	Unstructured	*Extensive*	0.309*	0.0933	0.129	0.144	0.322*	0.0350	0.143	0.0699
			(0.161)	(0.175)	(0.132)	(0.161)	(0.163)	(0.192)	(0.133)	(0.170)
		Intensive	-0.00666	0.00409	-0.00307	0.00167	-0.00872	0.00849	-0.00607	0.00460
			(0.00947)	(0.0110)	(0.00681)	(0.00951)	(0.00993)	(0.0112)	(0.00723)	(0.00959)

MATERNAL TIME INVESTMENT	**Educational**	*Extensive*	0.317	-0.739*	0.145	-0.343	0.317	-0.593	0.105	-0.285
			(0.320)	(0.446)	(0.195)	(0.354)	(0.320)	(0.463)	(0.189)	(0.374)
		Intensive	-0.261*	0.273	-0.140**	0.0844	-0.250*	0.199	-0.113	0.0692
			(0.134)	(0.238)	(0.0677)	(0.194)	(0.135)	(0.242)	(0.0703)	(0.193)
	Structured	*Extensive*	-0.292	-0.292	-0.0780	-0.158	-0.333	-0.395	-0.109	-0.200
			(0.194)	(0.206)	(0.155)	(0.179)	(0.205)	(0.244)	(0.178)	(0.221)
		Intensive	0.103*	0.0764	0.0555	0.0808	0.110*	0.119	0.0534	0.110
			(0.0566)	(0.0678)	(0.0461)	(0.0588)	(0.0594)	(0.0771)	(0.0506)	(0.0725)
	Unstructured	*Extensive*	0.207	0.251	0.250**	0.353**	0.163	0.246	0.239**	0.340**
			(0.145)	(0.167)	(0.111)	(0.147)	(0.149)	(0.188)	(0.117)	(0.163)
		Intensive	-0.0276	-0.00353	-0.0283**	-0.0122	-0.0208	-0.00219	-0.0244	-0.0143
			(0.0200)	(0.0267)	(0.0143)	(0.0224)	(0.0204)	(0.0295)	(0.0151)	(0.0242)
LAG (CHILD TIME INVESTMENT)	**Educational**	*Extensive*					0.409**	0.437**	0.136	0.182
							(0.191)	(0.202)	(0.137)	(0.180)
		Intensive					-0.0562	-0.0868*	-0.0214	-0.0219
							(0.0493)	(0.0449)	(0.0351)	(0.0408)
	Structured	*Extensive*					0.334	0.0765	0.398**	0.267
							(0.268)	(0.283)	(0.199)	(0.256)
		Intensive					-0.0694	-0.0518	-0.0830	-0.126
							(0.116)	(0.136)	(0.0928)	(0.115)
	Unstructured	*Extensive*					-0.0309	-0.0700	0.00895	-0.0561
							(0.138)	(0.174)	(0.119)	(0.170)
		Intensive					-0.0107	0.0224	-0.00737	0.0162
							(0.0166)	(0.0222)	(0.0155)	(0.0205)
LAG (MATERNAL TIME INVESTMENT)	**Educational**	*Extensive*					0.0970	-0.0741	0.206	0.170
							(0.172)	(0.241)	(0.143)	(0.200)
		Intensive					-0.0643	-0.0502	-0.0919**	-0.0823
							(0.0457)	(0.0605)	(0.0408)	(0.0538)
	Structured	*Extensive*					0.0377	-0.221	-0.0795	-0.363

						(0.205)	(0.306)	(0.170)	(0.269)
	Intensive					0.0101	0.0188	0.0105	0.0412
						(0.0538)	(0.0782)	(0.0440)	(0.0672)
Unstructured	*Extensive*					0.124	-0.0888	0.0408	-0.0939
						(0.155)	(0.188)	(0.113)	(0.166)
	Intensive					-0.0317	-0.0180	-0.0126	-0.0282
						(0.0249)	(0.0343)	(0.0191)	(0.0343)
Lagged Score				0.636***	0.420***			0.637***	0.438***
				(0.0407)	(0.0634)			(0.0409)	(0.0643)
Controls									
Child's age		-0.254	-0.863	-0.944*	-1.438**	-0.483	-1.145	-1.104*	-1.612**
		(0.718)	(0.661)	(0.563)	(0.599)	(0.776)	(0.714)	(0.607)	(0.675)
(Child's age)^2		0.00511	0.0323	0.0320	0.0543**	0.0138	0.0419	0.0382	0.0601**
		(0.0274)	(0.0257)	(0.0215)	(0.0231)	(0.0296)	(0.0277)	(0.0233)	(0.0260)
Mother's age		0.301**	-0.131	0.0913	0.0338	0.227*	-0.290	0.0541	-0.0873
		(0.124)	(0.312)	(0.0917)	(0.267)	(0.127)	(0.382)	(0.0987)	(0.324)
(Mother's age)^2		-0.00294*	-0.00281	-0.000899	-0.00259	-0.00211	-0.00342	-0.000491	-0.00242
		(0.00152)	(0.00224)	(0.00112)	(0.00216)	(0.00155)	(0.00242)	(0.00119)	(0.00224)
Male		0.223**	0.138	0.0971	0.0646	0.271***	0.0952	0.123	0.0264
		(0.0999)	(0.106)	(0.0829)	(0.0985)	(0.0998)	(0.117)	(0.0843)	(0.105)
Birth order		-0.220***	-0.0523	-0.146***	-0.0361	-0.211***	-0.0940	-0.145***	-0.0707
		(0.0773)	(0.134)	(0.0529)	(0.124)	(0.0787)	(0.137)	(0.0535)	(0.128)
Adolescent in 2007		0.0973	1.901	0.247***	0.966	0.138	3.017*	0.292***	1.616
		(0.125)	(1.332)	(0.0864)	(1.055)	(0.126)	(1.683)	(0.0892)	(1.336)
Constant		-4.904	15.11	4.495	11.87	-1.869	24.56*	6.351	17.89
		(5.257)	(11.60)	(4.007)	(9.344)	(5.533)	(14.47)	(4.316)	(11.92)
Observations		386	386	386	386	386	386	386	386
R-squared		0.194	0.117	0.519	0.303	0.233	0.184	0.546	0.365

Number of sibling groups			193	193	193	193	193	193

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

D4 Paternal Time Investments

Table D4.1
Child Cognitive Skill Production Functions Including Paternal Time Investments

			Letter-Word Identification		Passage Comprehension		Applied Problems	
			OLS	Family FE	OLS	Family FE	OLS	Family FE
CHILD TIME INVESTMENT	**Educational**	*Extensive*	0.178	0.138	0.334***	0.235	0.142	0.126
			(0.124)	(0.144)	(0.123)	(0.162)	(0.128)	(0.129)
		Intensive	0.0253	0.0299	0.000774	0.00487	0.0125	0.0292
			(0.0194)	(0.0218)	(0.0186)	(0.0299)	(0.0184)	(0.0227)
	Structured	*Extensive*	0.0450	0.0472	-0.0431	-0.120	0.113	-0.0628
			(0.145)	(0.163)	(0.152)	(0.190)	(0.151)	(0.170)
		Intensive	0.0173	0.0102	0.0250	0.0343	-0.0316	-0.00910
			(0.0383)	(0.0375)	(0.0429)	(0.0511)	(0.0348)	(0.0361)
	Unstructured	*Extensive*	-0.0534	0.0494	-0.110	-0.149	0.0222	-0.00457
			(0.112)	(0.151)	(0.101)	(0.159)	(0.115)	(0.151)
		Intensive	-0.000745	0.00656	0.00262	0.0140	0.00641	0.0182**
			(0.00642)	(0.00894)	(0.00704)	(0.00999)	(0.00893)	(0.00845)
MATERNAL TIME INVESTMENT	**Educational**	*Extensive*	-0.0130	-0.00549	-0.0772	-0.237	-0.133	-0.263
			(0.131)	(0.166)	(0.119)	(0.174)	(0.132)	(0.167)
		Intensive	-0.00840	-0.0151	-0.00239	0.0283	0.0213	0.0675**
			(0.0201)	(0.0279)	(0.0182)	(0.0307)	(0.0196)	(0.0292)
	Structured	*Extensive*	0.0545	0.0107	0.0799	0.0319	0.204	0.427**

			(0.145)	(0.205)	(0.131)	(0.218)	(0.153)	(0.210)
		Intensive	-0.0249	-0.0134	-0.0641***	-0.0594*	-0.0441	-0.0568*
			(0.0243)	(0.0273)	(0.0205)	(0.0326)	(0.0270)	(0.0325)
	Unstructured	*Extensive*	0.0920	-0.0836	0.0953	-0.111	-0.0948	-0.110
			(0.126)	(0.176)	(0.114)	(0.179)	(0.116)	(0.172)
		Intensive	-0.0311**	-0.00465	-0.0322*	0.00585	-0.000671	0.0251
			(0.0140)	(0.0259)	(0.0169)	(0.0279)	(0.0141)	(0.0213)
PATERNAL TIME INVESTMENT	**Educational**	*Extensive*	0.100	-0.234	0.297*	0.214	0.316	0.247
			(0.223)	(0.288)	(0.175)	(0.240)	(0.250)	(0.261)
		Intensive	-0.0686	-0.00864	-0.0744*	-0.0300	-0.109	-0.0591
			(0.0440)	(0.0634)	(0.0386)	(0.0635)	(0.0682)	(0.0658)
	Structured	*Extensive*	-0.0749	-0.116	-0.219	-0.278	-0.148	-0.0508
			(0.164)	(0.218)	(0.146)	(0.195)	(0.165)	(0.212)
		Intensive	0.0474**	0.0389	0.0897***	0.0967***	0.0551**	0.0298
			(0.0213)	(0.0291)	(0.0199)	(0.0344)	(0.0221)	(0.0289)
	Unstructured	*Extensive*	0.158	-0.0494	0.103	-0.162	0.308**	0.217
			(0.134)	(0.200)	(0.122)	(0.172)	(0.126)	(0.180)
		Intensive	-0.0186	0.00159	-0.00434	0.00228	-0.0278*	-0.0383*
			(0.0138)	(0.0228)	(0.0146)	(0.0221)	(0.0164)	(0.0200)
	Controls							
	Child's age		0.618	1.275***	1.377***	1.803***	0.953**	1.567***
			(0.409)	(0.413)	(0.401)	(0.431)	(0.404)	(0.423)
	(Child's age)^2		-0.0419	-0.0807***	-0.0942***	-0.120***	-0.0593**	-0.0922***
			(0.0256)	(0.0260)	(0.0248)	(0.0268)	(0.0252)	(0.0268)
	Mother's age		-0.225***	-0.109	-0.307***	-0.359***	0.155*	0.206**
			(0.0824)	(0.0937)	(0.0799)	(0.0917)	(0.0831)	(0.0937)
	(Mother's age)^2		0.179**	0.356	0.246***	0.584***	0.173*	0.246
			(0.0846)	(0.224)	(0.0868)	(0.180)	(0.0982)	(0.213)
	Male		-0.00205*	0.000467	-0.00282**	-0.00285	-0.00154	0.000644

	(0.00114)	(0.00191)	(0.00115)	(0.00197)	(0.00132)	(0.00182)
Birth order	-0.234***	-0.0594	-0.249***	-0.138	-0.118*	0.130
	(0.0653)	(0.149)	(0.0651)	(0.145)	(0.0602)	(0.128)
Child in 2002	0.0374	-2.104**	0.177*	-1.668**	-0.239**	-1.864*
	(0.103)	(0.867)	(0.0921)	(0.743)	(0.0982)	(1.075)
Child in 2007	0.279	-4.011**	-0.000584	-3.578**	-0.254	-3.604*
	(0.197)	(1.690)	(0.200)	(1.448)	(0.222)	(2.124)
Constant	-5.485**	-17.32***	-9.437***	-22.54***	-7.790***	-15.93**
	(2.161)	(6.320)	(2.182)	(5.128)	(2.421)	(7.197)
Observations	510	510	510	510	510	510
R-squared	0.153	0.098	0.228	0.186	0.193	0.176
Number of sibling groups		255		255		255

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Appendix E: Time Diary Activities

E1 Activity Codes for 1997 Time Diary

Type of Investment	PSID Time Diary Activity	Activity Code in Coding Manual
(1) Educational activities	Using Computer for Homework/Research	504
	Library Functions (using computer/internet to acquire specialised information)	511
	Homework (non-computer related), studying, research, related to classes or profession, except for current job; "went to the library", homework non-computer	549
	Puzzles/Word or Educational Games	874
	Reading or looking at book; looking at books (even if R cannot read)	939
	Reading magazines, reviews, pamphlets	941
	Reading newspapers	959
	Reading, NA what; or other	942
	Being read to, listening to a story	943
(2) Structured Activities	Classes/Lessons for Leisure Activity: -Lessons in dance -Lessons in sports activities such as swimming, golf, tennis, skating, roller skating -Lessons in music, singing, instruments -Other lessons, not listed above	881, 885, 886, 887, 888
	Competitive Sports – Other Educational Activities: -Organised meets, games, practices for team sports; track meets and practices, gymnastic meets and practices	883
	Active Leisure Activities: -Meets, practices for individual sports	884
	Active Sports: -Football, basketball, baseball, volleyball, hockey, soccer, field hockey -Tennis, squash, racquetball, paddleball -Golf, miniature golf -Swimming, waterskin -Skiing, ice skating, sledding, roller skating -Bowling; pool, ping-pong, pinball -Frisbee, catch -Exercises, yoga -Judo, boxing, wrestling -Weight lifting -Gymnastics	801, 802, 803, 804, 805, 806, 807, 808, 809, 810, 865
	Other Out of Doors: -Hunting -Fishing -Boating, sailing, canoeing -Camping, at the beach -Snowmobiling, dune-buggies -Gliding, ballooning, leaping off high buildings, flying -Excursions, pleasure drives (no destination), rides with the family -Picnicking	811, 812, 813, 814, 815, 816, 817, 818, 824, 825, 826

	Walking: -Walking for pleasure, crawling (for babies) -Hiking -Jogging, running -Bicycling -Motorcycling -Horseback riding	821, 822, 823, 824, 825, 826
	Hobbies: -Photography -Working on cars – not necessary to their running; customising, painting -Working on or repairing leisure time equipment (repairing the boat, sorting out fishing tackle) -Collections, scrapbooks -Carpentry and woodworking (as a hobby)	831, 832, 833, 834, 835
	Domestic Crafts: -Preserving foodstuffs (canning, pickling) -Knitting, needle-work, weaving, crocheting (including classes), crewel, embroidery, quilting, quilling, macramé	841, 842, 843, 844
	Art and Literature: -Sculpture, painting, potting, drawing, colouring -Literature, poetry, writing (not letters), writing a diary	851, 852
	Music/Theatre/Dance: -Playing a musical instrument (include practicing), whistling -Singing -Acting in/rehearsing for a play	861, 862, 863, 864
	Volunteer, Helping Organisations	631, 632, 633, 634, 635
	Religious Practice	651, 652
	Religious Groups	641, 642, 643, 644
	Professional/Union Organisations	601, 602
	Child/Youth/Family Organisations	671,672
	Fraternal Organisations	661, 662
	Political Party and Civic Participation	621, 622
	Special Interest/Identity Organisations	611, 612
	Other Miscellaneous Organisations	689
	Lessons in Computers (Learning how to use computer)	501
(3) Unstructured Activities	Playing Computer Games	502
	Other Recreational Computer Activities: surfing the net, non-games	503
	Unspecified play outdoors	876
	Unspecified play indoors; getting into stuff, making a mess	877
	Unspecified playing games, “played a game”	878
	Electronic Video games (Nintendo, Sony, Game Boy, Sega)	879
	Radio	909
	TV	919
	Record, tapes, “listening to music”, listening to others playing a musical instrument	929
	Relaxing	981

	Thinking, planning; reflecting	982
	"Doing nothing", "sat", "wasted time"	983
	Other passive leisure: smoking, pestering, teasing, joking around, messing around, laughing, sucking thumb, laying in sun, listening to birds, looking at slides/pictures/home movies, stopped at excavating place, girl watching/boy watching, watching boats, tickled	989

E2 Activity Codes for 2002 Time Diary

Type of Investment	**PSID Time Diary Activity**	**Activity Code in Coding Manual**
(1) Educational activities	Using Computer for Homework/Research	5040
	Library Functions (using computer/internet to acquire specialised information)	5110
	General category for homework/studying-specific activity NA	5490
	Homework, non-computer related	5491
	Studying, research, reading, related to classes or profession, except for current job, college applications, working on school project	5492
	"Went to the library"	5493
	Reviewing homework with parent/caregiver* (new in 2002)	5494
	Puzzles/word or educational games or trivia games	8740
	Reading or looking at books (even if R can't read)	9390
	Reading magazines, reviews, pamphlets	9410
	Reading newspapers	9590
	Reading, not coded elsewhere, material unspecified	9420
	Being read to, listening to a story, listening to a book on tape	9430
(2) Structured Activities	Classes/Lessons for Leisure Activity -Lessons in dance -Lessons in sports activities, sport unspecified -Swim lessons -Golf lessons -Tennis lessons -Skating lessons -Lessons in gymnastics/fitness activity, unspecified -Gymnastics lessons -Yoga lessons -Martial Arts (Judo, Karate, Tae Kwan Do) lessons -Body movement lessons -Aerobics/Kick Boxing/Pilates class -Music lessons, unspecified -Voice lessons -Lessons in musical instruments -Other lessons, not listed above	8810, 8850, 8851, 8852, 8853, 8854, 8860, 8861, 8862, 8863, 8864, 8865, 8870, 8871, 8872, 8880
	Meets, Games, and Practices for Team-Based Sports	8830, 8831, 8832, 8833, 8834, 8835,

	-Organised meets, games, practices for team sports, sport unspecified or sport other than those listed, such as a cheerleading meet -Organised meets, games, practices for the following sports: football, baseball/softball, basketball, volleyball, soccer, hockey, field hockey, swimming, track or cross-country running, gymnastics or dance	8836, 8837, 8838, 8839
	<u>Meets and Practices for Individual Sports</u> -Meets and practices for individual sports, sport unspecified, or sport other than one listed -Meets and practices for the following: tennis, squash or racquetball, golf, ice skating, martial arts, boxing and wrestling, bowling	8840, 8841, 8842, 8843, 8844, 8845, 8846, 8847
	<u>Active Leisure, Sports and Exercise:</u> -Traditional team-based sports (football, basketball, volleyball, hockey, soccer, field hockey, cheerleading), sport unspecified -Football, basketball, baseball, volleyball, hockey, soccer, field hockey -Sports using racquets (tennis, squash, racquetball, paddleball), sport unspecified -Tennis, squash, racquetball, paddleball, golf, water-based sports (swimming, water-skiing), sport unspecified -Swimming, water-skiing -Seasonal sports (skiing, sledding, ice skating, roller skating), sport unspecified -Skiing, sledding, snow boarding, ice skating, roller skating/roller blading, skateboarding -Recreational sports, unspecified. Includes kickball, street hockey, rock climbing and trampoline -Bowling, pool, miniature golf -Frisbee, catch -Exercises, yoga, “at gym”, exercise unspecified -Judo, boxing, wrestling, Judo/Martial Arts, Boxing/Wrestling, Weight lifting, Gymnastics	8010, 8011, 8012, 8013, 8014, 8015, 8016, 8017, 8020, 8021, 8022, 8023, 8024, 8030, 8040, 8041, 8042, 8050, 8051, 8052, 8053, 8054, 8055, 8060, 8061, 8062, 8032, 8070, 8080, 8090, 8091, 8092, 8100, 8650
	<u>Other Out of Doors:</u> -Hunting; skeet shooting -Fishing -Boating, sailing, canoeing -Camping, at the beach -Snowmobiling, dune-buggies -Extreme Sports – Gliding, ballooning, leaping off high buildings, flying -Excursions, pleasure drives (no destination), rides with the family, “driving around”, “out for a ride” -Playground activities – swings, slides, monkey bars; tree climbing; picnicking -Bicycling, mountain biking, riding a scooter -Tricycling or big wheels -“Off-roading” using ATVs or dune buggies	8110, 8120, 8130, 8140, 8150, 8160, 8170, 8180, 8240, 8241, 8242, 8250, 8260

	-Motorcycling -Horseback riding	
	Walking -Walking for pleasure, crawling (for babies) -Hiking -Jogging, running	8210, 8220, 8230
	Hobbies: -Photography -Working on cars – not necessary to their running; customising, painting -Working on/repairing leisure time equipment (repairing boat, "sorting out fishing tackle") -Collections, scrapbooks, model cars, airplanes, ships & boats -Carpentry and woodworking (as a hobby)	8310, 8320, 8330, 8340, 8350
	Domestic Crafts: -Preserving food (canning, pickling, freeing) -Needlework, including classes (knitting, crocheting, beading, embroidery, cross-stich, weaving, quilting, macramé) -Sewing -Care of animals/livestock when R is not a farmer	8410, 8420, 8430, 8440
	Art and Literature: -Arts, arts and crafts, art unspecified -Pottery, ceramics -Painting -Drawing, colouring -Sculpture -Literature, literature unspecified -Writing (not letters; not homework) -Poetry -Writing in a diary	8510, 8511, 8512, 8513, 8514, 8520, 8521, 8522, 8523
	Music/Theatre/Dance -Playing a musical instrument (include practicing), whistling – NA which activity -Playing/practicing a musical instrument -Whistling -Singing for fun, special event, or competition, karaoke -Acting in/rehearsing for a play -Non-social dancing; ballet, modern dance, body movement	8610, 8611,8612, 8620, 8630, 8640
	Volunteer, Helping Organisations	6310, 6311, 6312, 6313, 6320, 6321, 6322, 6323, 6330, 6331, 6332, 6333, 6340, 6341, 6342, 6343, 6350, 6351, 6352, 6353
	Religious Practice	6510, 6520
	Religious Groups	6410, 6420, 6430, 6440
	Professional/Union Organisations	6010, 6020
	Child/Youth/Family Organisations	6710, 6720
	Fraternal Organisations	6610, 6620
	Political Party and Civic Participation	6210, 6220
	Special Interest/Identity Organisations	6110, 6120

	Before/After School Clubs	6130, 6131, 6132, 6133, 6134, 6135, 6136, 6137, 6138, 6890
	Lessons in computers (Learning how to use computer)	5010
(3) Unstructured Activities	Playing computer games including solitaire	5020
	Other recreational computer activities: "surfing the net"; downloading pictures, music, movies, burning CDs; watching DVDs on computer; creating/programming; other non-specific computer activities that are not computer games	5030
	Unspecified play outdoors	8760
	Unspecified play indoors; getting into stuff, making a mess, wrestling in the context of playing	8770
	Unspecified Play games, "played a game"	8780
	Electronic Video games (Nintendo, Sony, Game Boy, Sega)	8790
	Radio	9090
	TV	9190
	Records/Tapes/CDS/Listening to music	9290
	Relaxing; "soaking in hot tub"; "taking a break"	9810
	Thinking, Planning; Reflecting	9820
	"Doing nothing", "sat"; "wasted time"	9830
	Other passive leisure: smoking, pestering, teasing, joking around/messing around, laughing, girl watching/boy watching, laying in sun, listening to birds, looking at slides/pictures/home movies, stopped at excavating place, thumbsucking, tickled, watching boats, getting pictures taken, going thru your candy	9890

E3 Activity Codes for 2007 Time Diary

Type of Investment	**PSID Time Diary Activity**	**Activity Code in Coding Manual**
(1) Educational activities	Using the computer for homework, studying, research, reading related to classes or profession, except for current job	5040
	Library Functions (using computer/internet to acquire specialised information)	5110
	Library functions (using cell phone/internet to acquire specialised information)* (new in 2007)	5111
	General category for homework/studying-specific activity NA	5490
	Homework, non-computer related	5491
	Studying, research, reading, related to classes or profession, except for current job	5492
	"Went to library"	5493
	Reviewing homework with parent/caregiver	5494
	Puzzles/word or educational Games	8740
	Reading or looking at books (even if R cannot read)	9390
	Reading magazines, reviews, pamphlets	9410

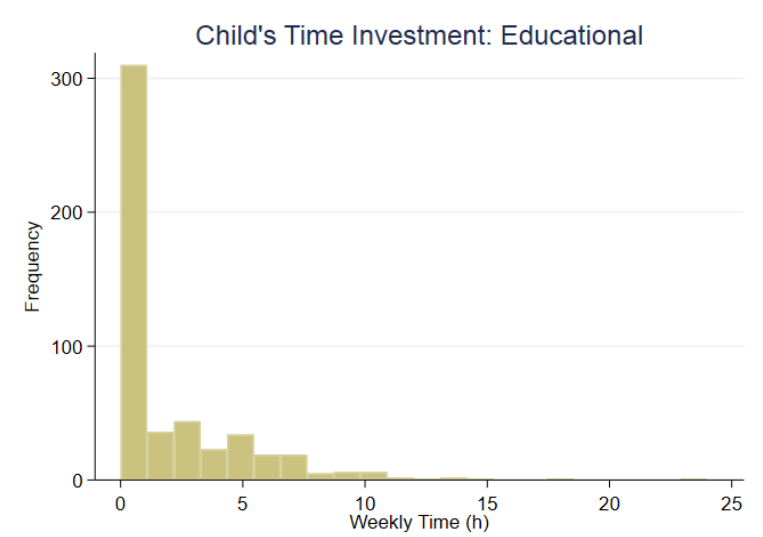
	Reading newspapers	9590
	Reading, not coded elsewhere, material unspecified	9420
	Being read to, listening to a story	9430
(2) Structured Activities	Classes/Lessons for Leisure Activity -Lessons in dance -Lessons in sports activities, sport unspecified -Swim lessons -Golf lessons -Tennis lessons -Skating lessons -Lessons in gymnastics/fitness activity, unspecified -Gymnastics lessons -Yoga lessons -Martial Arts (Judo, Karate, Tae Kwan Do) lessons -Body movement lessons -Aerobics/Kick Boxing/Pilates lessons -Music lessons, unspecified -Voice lessons -Lessons in musical instruments -Other lessons, not listed above	8810, 8850, 8851, 8852, 8853, 8854, 8860, 8861, 8862, 8863, 8864, 8865, 8870, 8871, 8872, 8880
	Competitive Sports – Other Educational Activities -Organise meets, games, practices for team sports, cheerleading, sport unspecified or sport other than those listed -Organised meets, games, practices for: football, baseball/softball, basketball, volleyball, soccer, hockey, field hockey, swimming, cross-country running, gymnastics or dance	8830, 8831, 8832, 8833, 8834, 8835, 8836, 8837, 8838, 8839
	Active Leisure Activities: -Meets, practices for individual sports, sport unspecified, or sport other than one listed -Meets, practices for: tennis, squash or racquetball, golf, ice skating, martial arts, boxing and wrestling, bowling	8840, 8841, 8842, 8843, 8844, 8845, 8846, 8847
	Active Sports: -Traditional team-based sports (football, basketball, volleyball, hockey, soccer, field hockey), sport unspecified -Football, basketball, baseball, volleyball, hockey, soccer, field hockey -Sports using racquets, sport unspecified -Tennis, squash, racquetball, paddleball, golf, miniature golf -Water-based sports, sport unspecified -Swimming, water-skiing -Seasonal Sports, sport unspecified -Skiing, sledding, snow boarding, ice skating, roller skating/Roller blading, skateboarding -Recreational sports, unspecified -Bowling, pool, frisbee, catch -Exercises, yoga “at gym”, exercise unspecified	8010, 8011, 8012, 8013, 8014, 8015, 8016, 8017, 8020, 8021, 8022, 8023, 8024, 8030, 8032, 8040, 8041, 8042, 8050, 8051, 8052, 8053, 8054, 8055, 8060, 8061, 8062, 8070, 8080, 8090, 8091, 8092, 8100, 8650

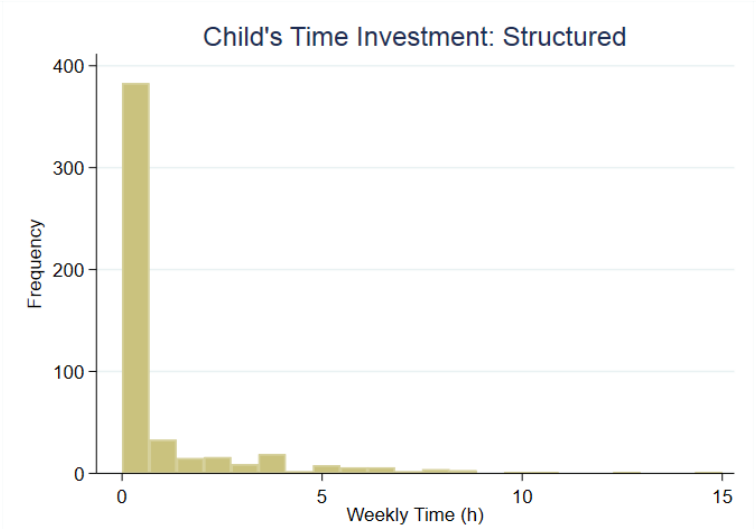
	-Judo, boxing, wrestling, Judo/Martial Arts, Boxing/Wrestling, Weight lifting, Gymnastics	
	Other Out of Doors: -Hunting -Fishing -Boating, sailing, canoeing -Camping, at the beach -Extreme Sports – gliding, ballooning, leaping off high buildings, flying -Excursions, pleasure drives (no destination), rides with the family; "Driving around", "Out for a ride" -Picnicking	8110, 8120, 8130, 8140, 8160, 8170, 8180
	Walking -Walking for pleasure, crawling (for babies) -Hiking -Jogging, running -Bicycling, mountain biking -Tricycling or big wheels -Off-roading using ATVs or dune buggies, snowmobiles -Motorcycling -Horseback riding	8210, 8220, 8230, 8240, 8241, 8242, 8250, 8260
	Hobbies -Photography -Working on cars – not necessary to their running; customising, painting -Working on or repairing leisure time equipment (repairing the boat, "sorting out fishing tackle") -Collections, scrapbooks -Carpentry and woodworking (as a hobby)	8310, 8320, 8330, 8340, 8350
	Domestic Crafts -Preserving foodstuffs (canning, pickling, freezing) -Needle-work including classes (Knitting, crocheting, beading, embroidery, cross-stich, weaving, quilting, macramé) -Sewing -Care of animals/livestock when R is not a farmer	8410, 8420, 8430, 8440
	Art and Literature -Arts, arts unspecified -Pottery, ceramics -Painting -Drawing -Sculpture -Literature, literature unspecified -Writing (not letters; not homework) -Poetry -Writing in a diary	8510, 8511, 8512, 8513, 8514, 8520, 8521, 8522, 8523
	Music/Theatre/Dance -Playing a musical instrument (including practicing), whistling – NA which activity -Playing/Practicing a musical instrument -Whistling -Singing for fun, special event, or competition -Acting in/rehearsing for a play	8610, 8611, 8612, 8620, 8630, 8640

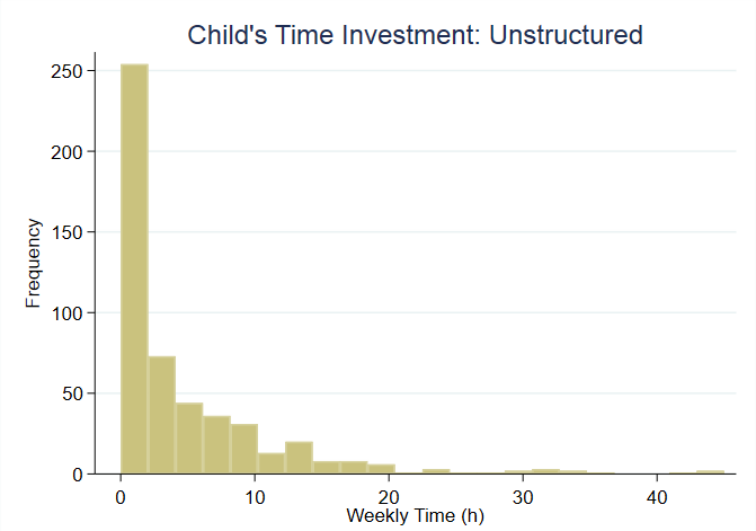
	-Non-social dancing, ballet, modern dance, body movement	
	Volunteer, helping organisations	6310, 6311, 6312, 6313, 6320, 6321, 6322, 6323, 6330, 6331, 6332, 6333, 6340, 6341, 6342, 6343, 6350, 6351, 6352, 6353
	Religious Practice	6510, 6520
	Religious Groups	6410, 6420, 6430, 6440
	Professional/Union Organisations	6010, 6020
	Child/Youth/Family Organisations	6710, 6711, 6712, 6720, 6721, 6722
	Fraternal Organisations	6610, 6620
	Political Party and Civic Participation	6210, 6220
	Special Interest/Identity Organisations	6110, 6120, 6130, 6131, 6132, 6133, 6134, 6135, 6136, 6137, 6138
	Other Miscellaneous Organisations	6890
	Lessons in computers (Learning how to use computer)	5010
(3) Unstructured Activities	Playing Computer Games	5020
	Playing games on a cell phone* (new in 2007)	5021
	Other Recreational Computer Activities: "surfing the net"; downloading pictures, music, movies; watching DVDs on computer; other non-specific computer activities that are not computer games	5030
	Other recreational cell phone activities, "surfing the net"; downloading/watching pictures, music, movies; other non-specific cell phone activities that are not games* (new in 2007)	5031
	Unspecified play outdoors	8760
	Unspecified play indoors; getting into stuff, making a mess	8770
	Unspecified playing games, "played a game"	8780
	Electronic Video games (Nintendo, Sony, Game Boy, Sega)	8790
	Radio	9090
	TV	9190
	Records, tapes, CDs, "listening to music", listening to others playing a musical instrument	9290
	Relaxing	9810
	Thinking, Planning; Reflecting	9820
	"Doing nothing", "sat"; "wasted time"	9830
	Other passive leisure: smoking, pestering, teasing, joking around, messing around, sucking thumb, laying in sun, listening to birds, looking at slides/pictures/home movies, stopped at excavating place, girl watching/boy watching, watching boats, tickled	9890

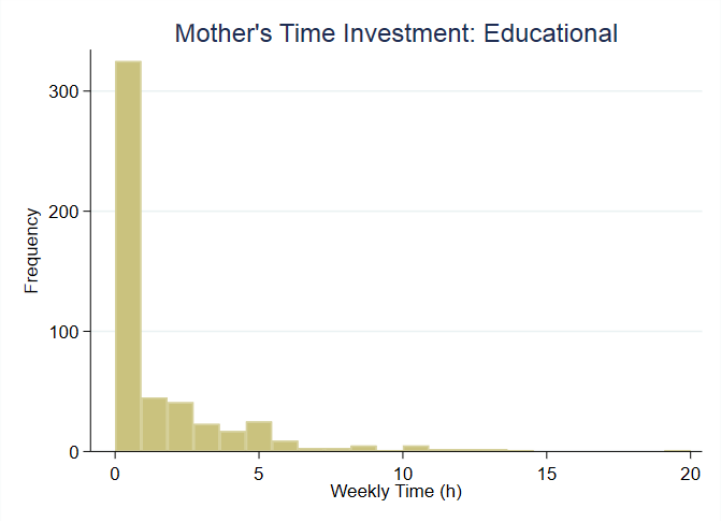
Appendix F: Histograms of Time Investments

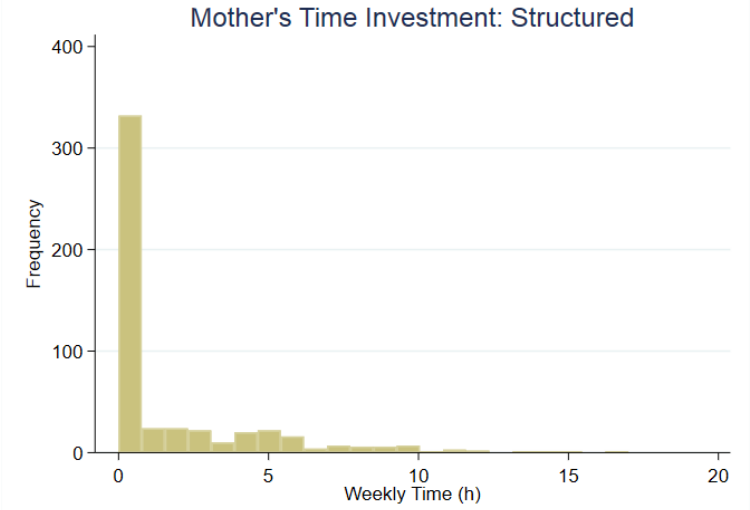
F1 Child Sample (6 to 10 years)

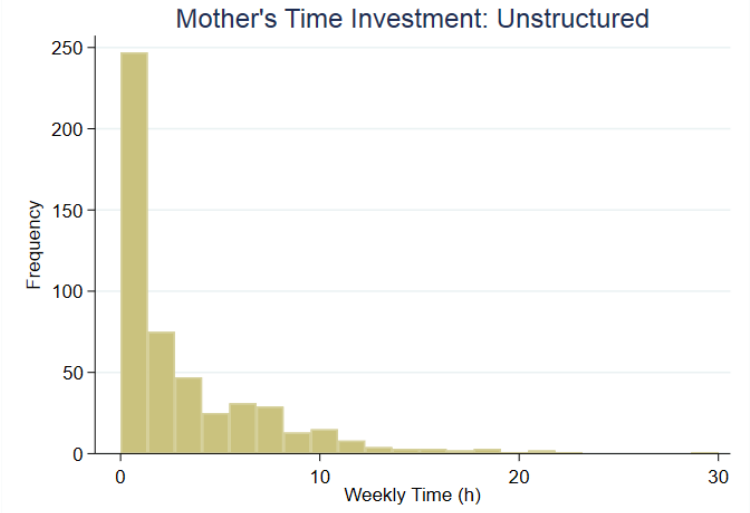




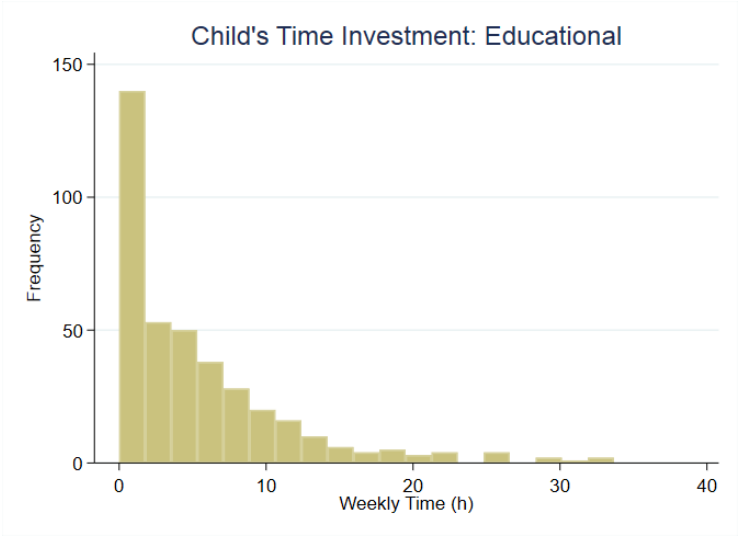


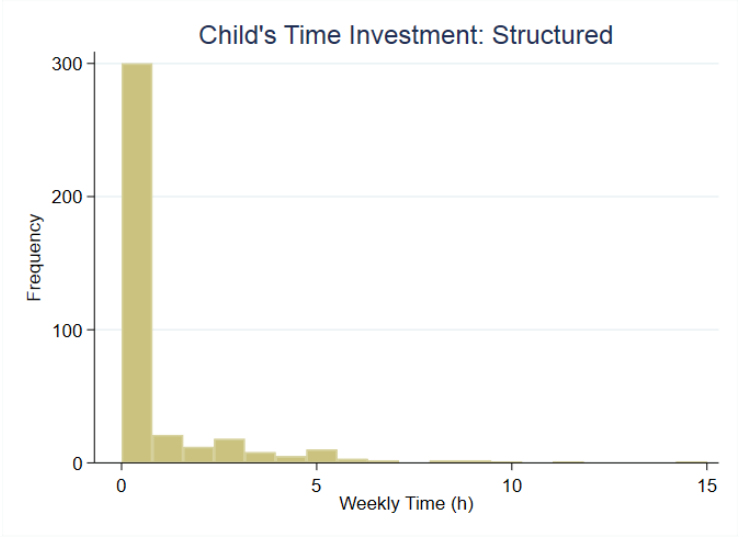

Mother's Time Investment: Educational
Frequency
0
100
200
300
0
5
10
15
20
Weekly Time (h)

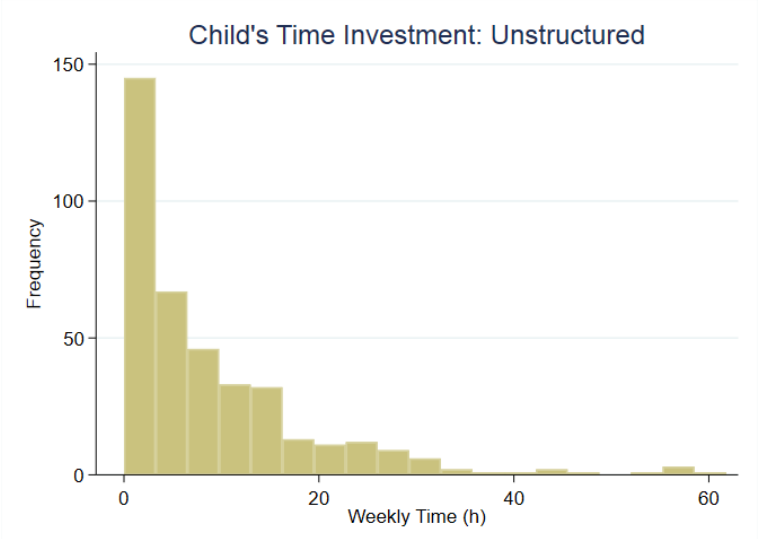

Mother's Time Investment: Structured
Frequency
0
100
200
300
400
0
5
10
15
20
Weekly Time (h)

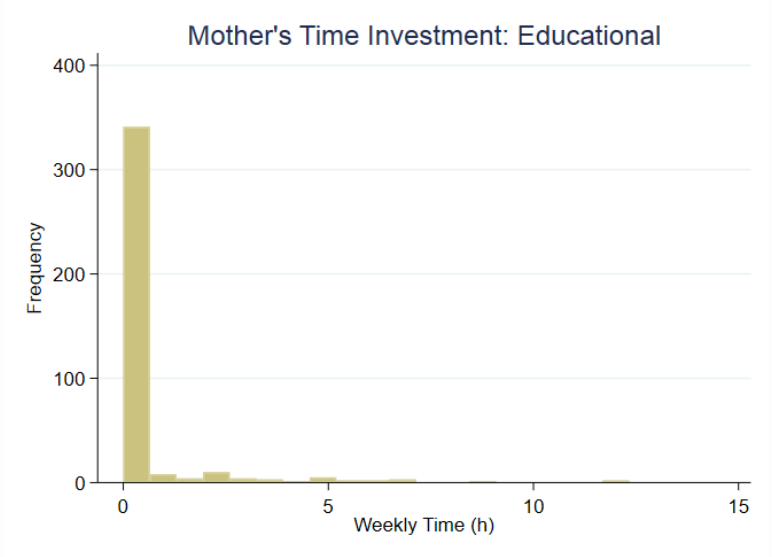

Mother's Time Investment: Unstructured
Frequency
0
50
100
150
200
250
0
10
20
30
Weekly Time (h)

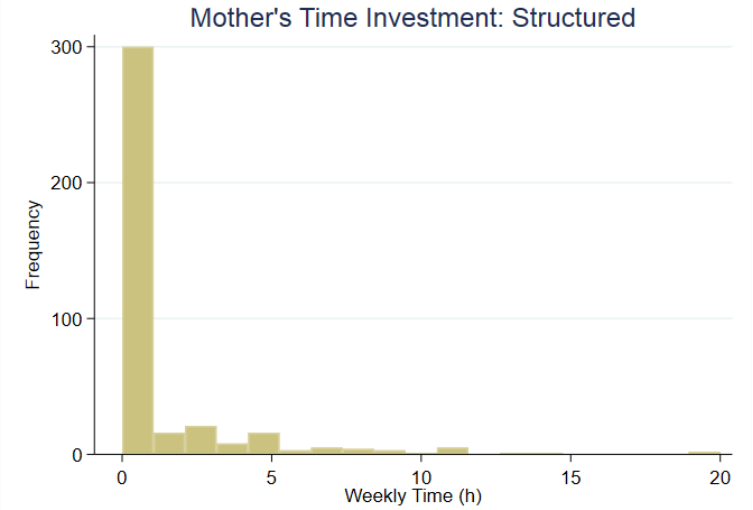
F2 Adolescent Sample (11 to 15 years)

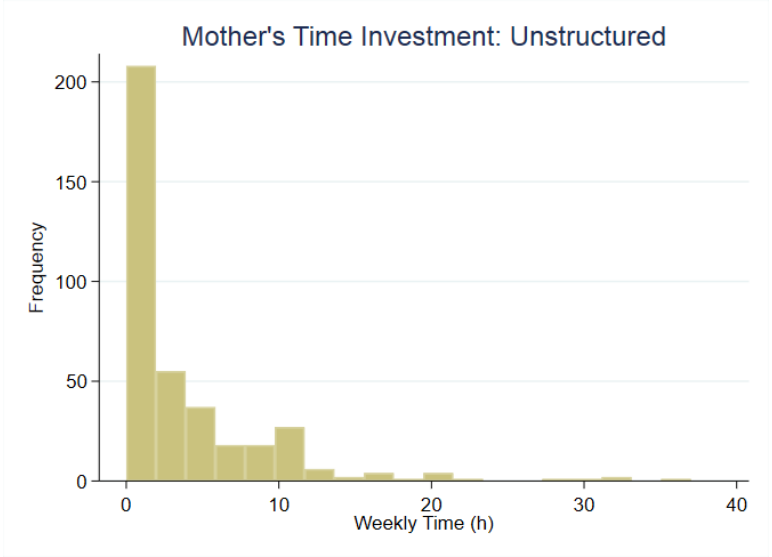


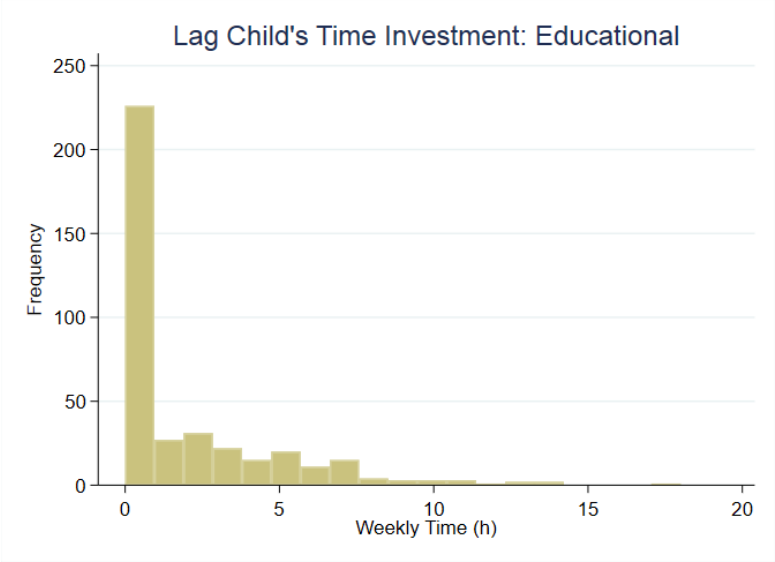


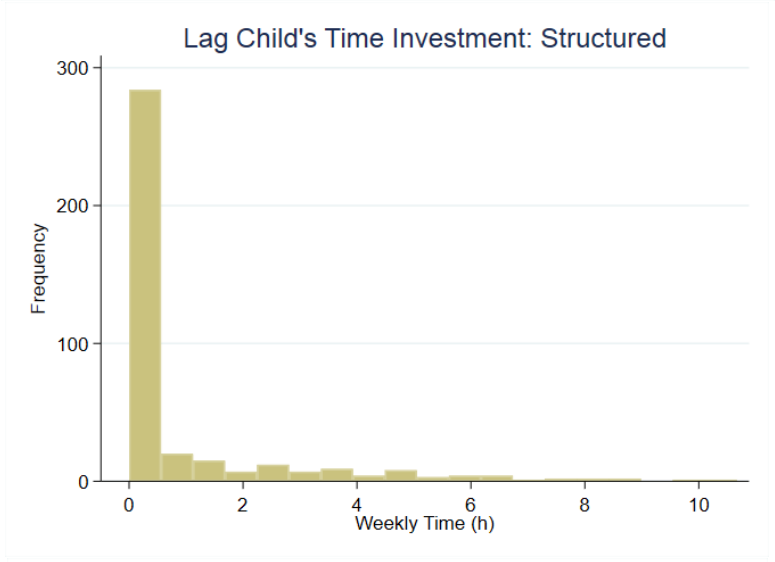


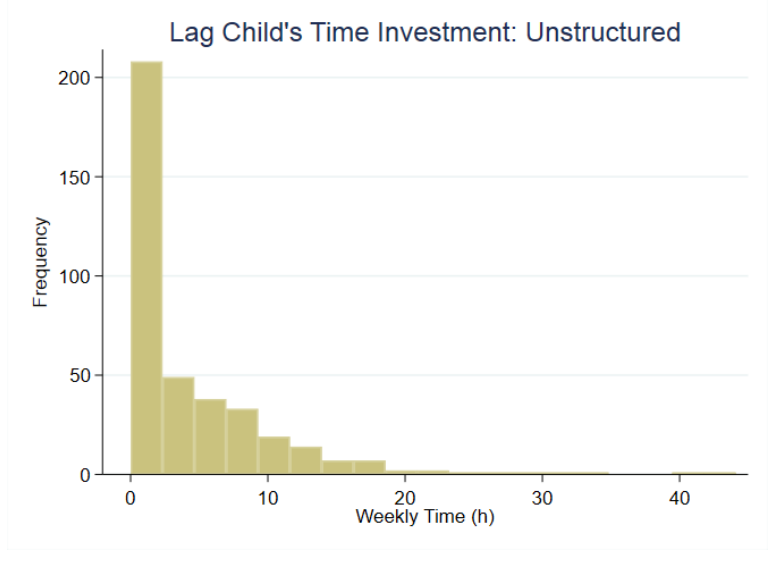

Mother's Time Investment: Educational
Frequency
400
300
200
100
0
0
5
10
15
Weekly Time (h)

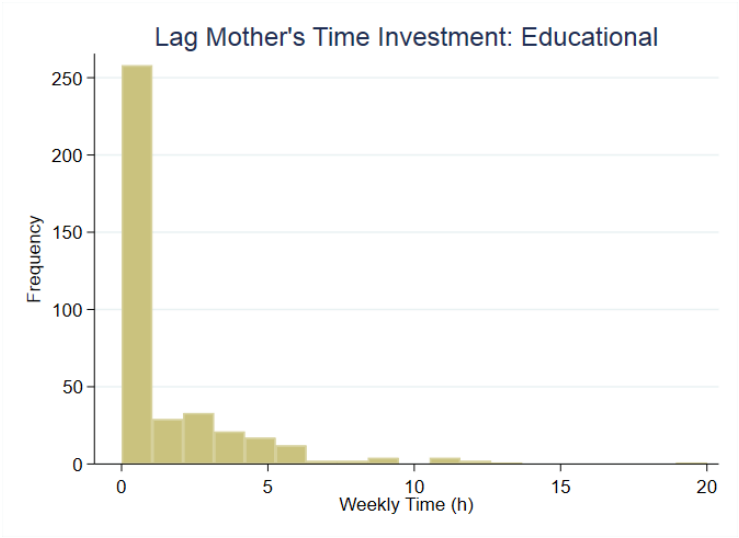

Mother's Time Investment: Structured
Frequency
300
200
100
0
0
5
10
15
20
Weekly Time (h)

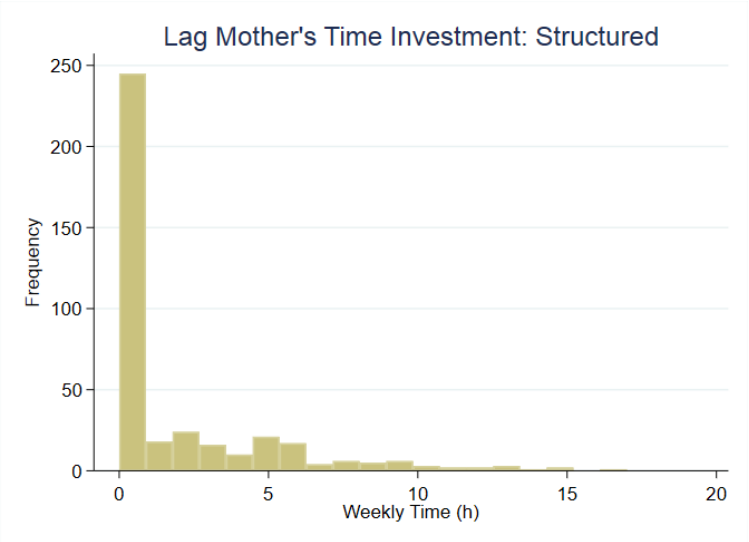

Mother's Time Investment: Unstructured
Frequency
200
150
100
50
0
0
10
20
30
40
Weekly Time (h)

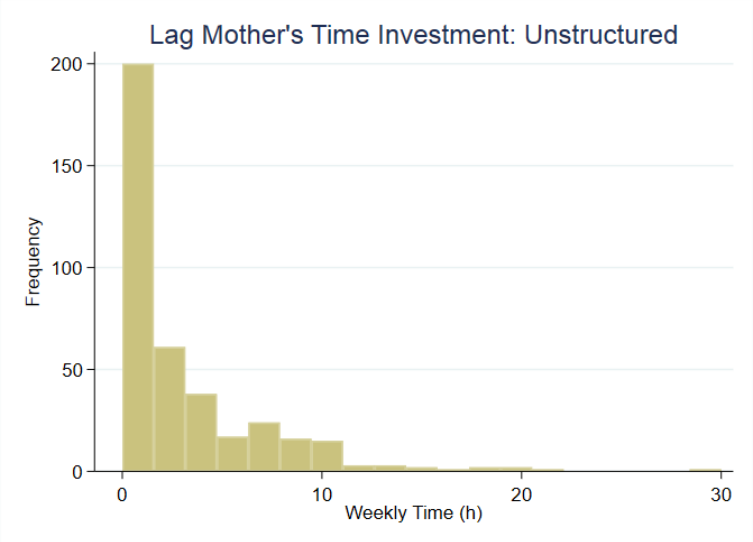

Lag Child's Time Investment: Educational
Frequency
250
200
150
100
50
0
0
5
10
15
20
Weekly Time (h)


Lag Child's Time Investment: Structured
Frequency
300
200
100
0
0
2
4
6
8
10
Weekly Time (h)


Lag Child's Time Investment: Unstructured
Frequency
200
150
100
50
0
0
10
20
30
40
Weekly Time (h)


Lag Mother's Time Investment: Educational
Frequency
0
50
100
150
200
250
0
5
10
15
20
Weekly Time (h)


Lag Mother's Time Investment: Structured
Frequency
0
50
100
150
200
250
0
5
10
15
20
Weekly Time (h)


Lag Mother's Time Investment: Unstructured
Frequency
0
50
100
150
200
0
10
20
30
Weekly Time (h)

Appendix G: Indexes

G1 Behaviour Problems Index (BPI)

The BPI was calculated from responses by the child's primary caregiver to survey questions on whether the child displayed certain problem behaviours and the frequency of the behaviours. From wave 2 of the CDS, the BPI provided by the Panel Study of Income Dynamics (PSID) incorporates two additional survey items. For the sake of consistency, a new version of the BPI using only the survey items present in all waves of the CDS (see below) was constructed and used for this study. The BPI was calculated as follows. In each survey question, primary caregivers of the child were asked to rate their child's behaviour as "Not true", "Sometimes true" or "Often true". Each of these responses were coded as "1", "2" and "3" respectively. Before computing the BPI, scores of "1" were recoded to "0" and scores of "2" or "3" were recoded to "2". Following this, the recoded scores of all survey items were added to give the total BPI score, which is a summed score. Higher scores imply greater problem behaviours.

Survey Items in the Behaviour Problems Index (Modified)

For the next set of statements, decide whether they are not true, sometimes true, or often true, of (CHILD)'s behavior.
a. (He/She) has sudden changes in mood or feeling.
b. (He/She) feels or complains that no one loves him/her.
c. (He/She) is rather high strung and nervous.
d. (He/She) cheats or tells lies.
e. (He/She) is too fearful or anxious
f. (He/She) argues too much
g. (He/She) has difficulty concentrating, cannot pay attention for long
h. (He/She) is easily confused, seems to be in a fog
i. (He/She) bullies or is cruel or mean to others.
j. (He/She) is disobedient
k. (He/She) does not seem to feel sorry after (he/she) misbehaves
l. (He/She) has trouble getting along with other children
m. (He/She) is impulsive, or acts without thinking.
n. (He/She) feels worthless or inferior.
o. (He/She) is not liked by other children
p. (He/She) has difficulty getting (his/her) mind off certain thoughts.
q. (He/She) is restless or overly active, cannot sit still
r. (He/She) is stubborn, sullen, or irritable.
s. (He/She) has a very strong temper and loses it easily.
t. (He/She) is unhappy, sad or depressed.
u. (He/She) is withdrawn, does not get involved with others
v. (He/She) breaks things on purpose or deliberately destroys things
w. (He/She) clings to adults.
x. (He/She) cries too much
y. (He/She) demands a lot of attention
z. (He/She) is too dependent on others.
aa. (He/She) feels others are out to get (him/her).
bb. (He/She) hangs out with kids who get into trouble.
cc. (He/She) is secretive, keeps things to (himself/herself)

dd. (He/She) worries too much.

Source: PSID User Guide Supplement for CDS-I

G2 Positive Behaviour Scale (PBS)

This scale measures the emotional/social abilities of the child. Survey items contributing to the scale were obtained from the primary caregiver child interviews (see below). They remained the same over the three waves of the Child Development Supplement (CDS).

Survey Items for Positive Behaviour Scale

Please tell me how much each statement applies to (CHILD) on a scale from 1-5, where one means “not at all like your child,” and five means “totally like your child”, and two, three and four are somewhere in between.
a. Is cheerful, happy.
b. Waits (his/her) turn in games and other activities.
c. Does neat, careful work.
d. Is curious and exploring, likes new experiences.
e. Thinks before (he/she) acts, is not impulsive.
f. Gets along well with other people (his/her) age.
g. Usually does what you tell (him/her) to do.
h. Can get over being upset quickly.
i. Is admired and well-liked by other people (his/her) age.
j. Tries to do things for (himself/herself), is self-reliant.

Source: PSID CDS User Guide Supplement for CDS-I