Family Income and Child Cognitive and Non-Cognitive Development in Australia: Does Money Matter?

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Abstract

This paper investigates whether family income affects children's cognitive and non-cognitive development by exploiting comprehensive information from the Longitudinal Study of Australian Children. We include variables that represent parental investment, parental stress and neighbourhood characteristics to examine if these factors can mediate the effects of income. Using a dynamic panel data framework, we found that family income is significantly associated with child's cognitive skills but the relationship is insignificant for non-cognitive skills. Rather our research finds that mother's education, parent's physical and mental health, parenting styles, child's own health and presence of both biological parents are the most important factors for child's non-cognitive development. For cognitive development in addition to income, parents' education, child's birth weight and children book at home are found to be highly significant. We also find strong evidence to support the skill formation theory that previous cognitive and non-cognitive outcomes of a child are significantly related to current outcomes.

Key words: Family income, Child cognitive and non-cognitive development, Health inequalities, Panel data, Australia

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1. Introduction

Child poverty rates¹ are higher in Australia compared to many OECD countries. According to a UNICEF study, Australia ranked 13th out of 24 OECD nations for children's material well-being with about 11.6 percent of Australian children living in poverty (Bradshaw et al., 2007). The Luxembourg income study also reported that Australia's child poverty rate is 15 percent and that Australia ranks 21 out of 30 upper-income nations in child poverty (Gornick & Jantti 2010). The literature indicates that children born into families with limited financial resources were at greater risk of having poor cognitive, behavioural and health outcomes than their wealthier counterparts (Brooks-Gunn & Duncan 1997; Case et al. 2002; Currie et al. 2007; Currie & Stabile 2003; Dooley & Stewart 2007; Duncan et al. 2014; Khanam et al. 2009; Violato et al. 2010). The poorer outcomes of less wealthy children may cause an inter-generational transmission of poverty. Children who have worse cognitive and non-cognitive outcomes may be more likely to have less education and to have lower earnings as adults; hence they are more likely to raise their children in poor environments. Thus, the policies and programs, which improve the outcomes of low-income children and break the poverty cycle between generations, are desirable.

However, it is not always clear whether the observed differences in outcomes between poor and non-poor children occur because of income itself or other correlates of income such as parental education, health and single parenthood. Among others, Duncan et al. (2014) presented evidence that an increase in family income can help the children to do better at schools. On the other hand, Heckman and Mosso (2014) argued that the role of income and credit constraints has been exaggerated in the literature. They found more support for the positive roles of mentoring, parenting and human interaction in shaping child outcomes. They reported that targeted cash transfer policies to families are unlikely to improve child outcome. Washbrook et al. (2014) examined the income gradient in cognitive, non-cognitive and health outcomes of children using a framework of ecological models of child development. They used a decomposition approach and found that income gradient is highest for cognitive development, followed by non-cognitive and health outcomes. A recent Australian study by Nghiem et al. (2015) examined the effects of school type on child's cognitive and non-cognitive development using LSAC data. They found that enrolling children in private or Catholic schools did not create significant effects on their cognitive outcomes.

¹ Child poverty rate is defined as the rate of children living in households with income lower than 50% of the country's household-size adjusted median.

Among economics studies on this issue, Blau (1999) and Mayer (1997) were the first to focus on the endogeneity of income. Using an instrumental variable (IV) approach, Mayer (1997) found that the effects of income on child outcome was largely spurious when using ordinary least square (OLS). Blau (1999) applied a fixed-effects estimator and found only minor effects of current income on child outcomes. Some recent studies (Aughinbaugh & Gittleman 2003; Khanam et al. 2009; Shea 2000; Khanam et al. 2013) also found smaller effects of income on child outcome by using fixed effects and instrumental variable estimators. By applying a fixed-effects instrumental variable estimator, Dahl & Lochner 2012) found that an increase in household income by \$1,000 was associated with the rise of mathematics and reading test scores by 2 percent and 3.6 percent of a standard deviation (SD) of the population, respectively.

The literature from developmental psychology, which focused on examining the extent and depth of poverty on child development, found that effects of income were much higher for a child's cognitive development compared to non-cognitive development (e.g., Duncan et al. 1998; Brooks-Gunn & Duncan 1997; Morris et al. 2004). The evidence on how income is translated into better childhood outcomes is rather scarce, particularly in the economics literature. The available evidence is mostly from developmental psychology (e.g., Guo & Harris 2000; Yeung et al. 2002), but they focus on the investment and family process perspectives.

This paper aims to investigate the routes through which family income may affect children's cognitive and non-cognitive development by exploiting comprehensive information from the Longitudinal Study of Australian Children (LSAC). It contributes to the literature in the following ways. Firstly, this study incorporates neighbourhood effects in the model of child development based on empirical evidence that social environment, including neighbourhood characteristics, has a strong influence on child development (Aaronson 1998; Case & Katz 1991; Ginther et al. 2000; Goetz 2010; Sampson et al. 2002; Solon et al. 2000; Oliver & Hayes 2005; Owens 2010). Secondly, we investigate the *dynamic nature* of children's human capital development; that is how current cognitive and non-cognitive outcomes are determined by the lagged outcomes. The concept of interdependence between lagged and current outcomes has rarely been investigated empirically in children's cognitive and behavioural development literature in particular. To the best of our knowledge, only Heckman and colleagues (e.g., Cunha & Heckman 2007) examined this dynamic nature of children's skill formation. This paper fills this gap in the *empirical literature* of children's

cognitive and non-cognitive development. Thirdly, this paper combines economists' and psychologists' views to model income and child outcomes. For example, economics literature on child development has not extensively investigated the factors such as parental stress, family functioning and neighbourhood effects. In particular, we include father's physical and mental health and father's parenting style in modelling income and child development, which has been ignored even in developmental psychology literature. Finally, we address the endogeneity and unobserved heterogeneity issues by a) using a comprehensive set of covariates and b) applying a general method of moment (GMM) approach. Thus, using appropriate econometric techniques and taking advantage of longitudinal data we can model the evolution process of child health and development from childhood to adolescence, which represents an important methodological refinement to the existing literature.

2. Theoretical Framework

The existing theoretical framework on the effects of income on child outcome is dominated by two complementary theories: Investment theory (Becker & Tomes 1986; Becker 1991), and Family stress theory (Smith & Brooks-Gunn 1997; Yeung et al. 2002). The investment theory postulates that parents have a concern about the future well-being of their children, so they invest material and time input in their children's human capital in a way that will maximise parents' utility. Family stress theory posits that income affects parenting ability because economic hardships affect parents' psychological well-being adversely. Psychologically stressed parents are less able to lead better family functioning and practice an effective parenting style that is conducive to child development (Smith & Brooks-Gunn 1997; Yamauchi 2010; Yeung et al. 2002).

We propose a model of child outcome that combines investment perspective (ability to invest in materials, services and a home environment), family stress theory (highlighting the role of stress, mental health and parenting practice) and neighbourhood perspective. This model provides us with some insights into why parental income, education, stress and neighbourhood conditions might affect child development. Investment theory posits that child outcome is a result of parental investment on material resources and time input. Parents from high socio-economic status (SES) can buy higher quality resources such as better housing, good food, better school, reputable childcare, and good books, which can stimulate cognitive development of their children. The framework also implies that parents with different wage

rates, which depend on parental education and health, have different time preferences. For example, a higher wage rate might reduce parental interaction with child, because higher value of time. However, this substitution effect might be offset by the income effects. The net effect will depend on the relative size of the two effects. Also parents in wealthier families are likely to be less stressed as a result of relaxed budget constraint, which in turns help them to practice good parenting that is conducive for child development. Why neighbourhood may matter for child development can be explained by “stress theory” (exposure to pollution and community violence), “social organisation theory” (the importance of role models and social values in the neighbourhood), institutional explanations (better school, parks, health facilities, police protection) and “epidemic theories” (power of peer influence) (Coulton 1996; Earls & Buka, 2000; Ginther et al. 2000; Jencks & Mayer 1990; Shonkoff 2003). Our model assumes that richer families can afford to live in neighbourhoods with less violence, better facilities (i.e., library, park, museum), and more educated and employed people. Empirical evidence has shown that children living in poor neighbourhoods perform worse at school, have lower skills, and have more behavioural and health problems, even after controlling for household characteristics (Contoyannis & Li 2011; Pebley & Sastry 2004).

We also include child's development outcome in the previous period ($Q_{i,t-1}$, lagged outcomes) in our model, which is consistent with the “self-productivity” and “dynamic complementary” theories of skill formations by Heckman (2007), Cunha and Heckman (2008) and Cunha et al. (2010). Heckman and colleagues stressed the dynamic nature of skill formation, particularly the way current outcome (Q_t) depends on the previous outcome (Q_{t-1}). For example, dynamic complementary and self-productivity state that investment in one period (e.g., t) is more productive, if there is a high level of capacity in the previous period ($t-1$).

3. Econometric Specification

To integrate the main contributions of this study, the empirical specification to estimate the relationship between child development and family income in this study is presented as:

$$Q_{it} = \alpha + \beta_1 Q_{i,t-1} + \beta_2 Y_{it} + \beta_3 PI_{it} + \beta_4 FS_{it} + \beta_5 NF_{it} + \beta_6 Z_{it} + (\mu_i + \varepsilon_{it}); \quad t=1,2,...,T \quad (1)$$

where Q_{it} and $Q_{i,t-1}$ are the outcomes of child i in period t and $t-1$ respectively; PI , FS and NF are the indicators for parental investment, family stress and neighbourhood effects respectively; Y_{it} is the inflation-adjusted family income; ε_{it} is the random error; and the β_s are parameters to be estimated. Other remaining factors that affect child development are represented by Z_{it} . The component μ_i captures a set of time-invariant individual unobserved characteristics (i.e., fixed effects) that affect both household income and child development outcomes. Thus, income is endogenous and hence applying standard regressions can produce biased results. In this study, we address the endogeneity issue by a) using a comprehensive set of covariates (Gregg et al. 2005), and b) applying a GMM approach by Blundell and Bond (1998).

We can minimise the effects of unobserved individual heterogeneity by controlling for a comprehensive set of observable characteristics that are available in LSAC data. The implicit assumption under this approach is that there is a high degree of correlation between observables and unobservables. However, we acknowledge that this approach cannot eliminate all sources of unobserved heterogeneity.

The parameter μ_i in Equation 1 can also be eliminated by applying first-difference but the difference of the lag dependent variable still correlates with the difference of the error term. Arellano and Bond (1991) proposed that using a second lag and higher as instrumental variables; one can estimate the first differenced transformation consistently using a GMM framework (i.e., “difference GMM”). However, the time-invariant observable covariates will be eliminated, and lags of level dependent variables are weak instruments. Blundell and Bond (1998) proposed a system GMM estimator that uses both level and lags of additional covariates instrumental variables for differenced endogenous variables (“system GMM”). Results of a Monte Carlo experiment by Blundell and Bond (1998, Table 2) show that the system GMM estimator provided a substantial improvement over results by the difference GMM estimator. A potential issue with this estimator is that too many instrumental variables are available, which can lead to over-identification problems (Roodman 2009). A Sargan test can be applied to identify the desirable number of instrumental variables (Bond 2002). Another issue with this estimator is that standard errors of the estimates can be biased downwards, and hence, we apply the finite sample correction proposed by Windmeijer (2005) in the analysis.

4. Data and Variable Selection

4.1 Data Sources

This study utilises data from the first five waves of the nationally representative Longitudinal Study of Australian Children (LSAC) survey. The LSAC has comprehensive information about children cognitive and non-cognitive development, health outcomes, demographics, parental health, parenting practices, financial status, lifestyle, housing and neighbourhood attributes. The LSAC sampling frame consists of all children born between March 2003 and February 2004 (B-Cohort, infants aged 0-1 years in 2004), and between March 1999 and February 2000 (K-Cohort, children aged 4-5 years in 2004). The LSAC sample consists of ten thousand children, approximately 5000 children from each cohort. It involves biennial follow-up of the enrolled households and will continue until at least 2018. In this study we focus on presenting the results for children of K-cohort because measures on child cognitive outcomes are more widely available for this cohort in all five waves of the survey. The sample for both cohorts consists of 10089 children in Wave 1 (conducted in 2004). The numbers of children surveyed in Wave 2 (2006), Wave 3 (2008), Wave 4 (2010) and Wave 5 (2012) are slightly lower at 9070, 8717, 8411 and 8041 respectively. The attrition rates are therefore 10.1, 3.9, 3.5 and 4.4 percent for Wave 2, Wave 3, Wave 4 and Wave 5, respectively.

4.2 Outcome Variables

4.2.1 Non-cognitive Skills

We use data from the Strengths and Difficulties Questionnaire (SDQ) to measure a child's behavioural development. The SDQ includes five measures: 1) Pro-social scale, (2) Hyperactivity scale, (3) Emotional problems scale, (4) Conduct problems scale and (5) Peer problems. These measures were calculated as the sum of responses to five 3-point questions (1=not true, 2=somewhat true, 3=certainly true) about feelings and behaviour of children (see, for example, Muris 2003, for more details)]. Higher SDQ scores indicate a negative outcome except for pro-social scale.

Despite the SDQ measures have clear advantages of being widely used in the literature, one may argue that SDQ measures reflect more behaviour outcomes rather than non-cognitive

outcomes. Therefore, we select some other indicators such as self-efficacy scale², bullying perpetrator³ and being bullying victim⁴ to provide additional measures of non-cognitive skills.⁵ Unfortunately, these variables are only available for Wave 5 (8-9 years old for B cohort and 12-13 years old for K cohort), and hence, we cannot apply panel data analysis for these three non-cognitive skills.

4.2.2 Cognitive Skills

Based on available data, we select the following measures of a child's cognitive development.

Matrix reasoning test (MR): Children from wave 2 to 5 completed the MR test from the Wechsler Intelligence Scale for Children, 4th Edition (WISC-IV). MR tests assessed a child's non-verbal intelligence by presenting them with an incomplete set of pictures, which they needed to complete by selecting a picture from 5 different options. The raw matrix reasoning score is presented as the number of correct answers. This indicator has been used widely to measure child development (see, for example, Fiorini 2010; Fuchs et al. 2008; 2010; Jaeggi et al. 2010; Mazzocco et al. 2011).

Peabody Picture Vocabulary Test (PPVT): The PPVT, which is only available in the first three waves of LSAC, was an interviewer-administered test that assessed a child's listening comprehension ability for spoken words in standard English. The PPVT test required a child to show the picture that best represented the meaning of a stimuli word spoken by the examiner (Dunn & Dunn 1997).

Literacy and Mathematical skills were answered by both parents and teachers. We selected the results by teachers, assuming they had more detailed knowledge of the child's academic performance. This variable consisted of the average of answers to a 5-point Likert scale questions, such as the child's contribution to classroom discussions, understanding and interpreting stories and reading and writing comprehension. Similarly, mathematical skills captured the average of a series of 5-point Likert scale questions on issues such as

² Measured as the mean of 5-points Likert scale (1=false, 5=true) about whether the child “Does important things”, “Has a lot to be proud of”, “Can do things as well as others” and “Lot about me is good”.

³ Measured by the means of 4-point Likert scale (1=never, 4=several times a week) questions such as “I hit or kicked someone”, “I grabbed or shoved someone”, “I threatened someone”, and “I said mean things to someone”.

⁴ Measured by the means of 4-point Likert scale (1=never, 4=several times a week) questions such as “Kids hit or kicked me”, “Kids grabbed or shoved me”, “Kids threatened me” and “Kids said mean things to me”.

⁵ We acknowledge an anonymous referee for suggesting us to include these measures.

understanding of places and values, organise data in graph, estimation of quantities and use of various strategies to solve mathematical problems. Literacy and mathematical scores have been used widely to measure child development (see, for example, Fiorini 2010; Harrison et al. 2009; Murray & Harrison 2011; Pasnak et al. 2009).

To make a relevant comparison among outcomes, all indicators of cognitive and non-cognitive skills for B and K cohorts were standardised. Figure 1 shows that the distribution of PPVT and matrix reasoning scores are symmetrical while the distribution of mathematical and literacy scores are more skewed to the left (Panel *a*). Figure 1a also reveals that no data were available for the literacy and mathematical scores in the B cohort. The distribution of non-cognitive outcomes shows a left-skew for pro-social skills and right skews for hyperactivity, emotional problem, conduct problem and peer problem, suggesting that most children have good behaviour, according to their SDQ responses. Also, the distribution of other non-cognitive indicators such as self-efficacy bullying perpetrator and bullying victim show that most children were not the bullying perpetrators nor the victims of bullying (Panel *b*).

Figure 1. Distribution of standardised cognitive and non-cognitive outcomes

4.3 Independent Variables

Based on the theories of parental investment, family stress and neighbourhood specified in the conceptual framework, we select three respective sets of covariates in addition to log of household income (which is our main variable of interest) and a basic set of control variables. The basic set of controls, which are selected based on previous studies (see, for example, Currie & Stabile 2003; Khanam et al. 2009; Khanam et al. 2013; Murasko 2008; and Nghiem et al. 2015) on child development, includes age, education, employment status of parents, characteristics of the child (dummies for gender, birth order, birth weight, and physical health status) and characteristics of the households (household size, presence of both biological parents at home, Aboriginal and Torres Strait Islander (ATSI) status and whether English is spoken at home). Based on the human capital theory (Becker 1981; Becker & Tomes 1986), we select two types of indicators for parental investment: materials and time. The material inputs include housing tenure, number of children's books at home and access to home computer. The time inputs reflect the time that parents spend (invest) with their children in stimulating activities that improve child outcome. In this study, the selected variables representing parental time input include an index for family bonding activities (e.g., frequency of someone engaging in activities such as going to cinema or sporting events). The family stress hypothesis (Guo & Harris 2000; Yeung et al. 2002) is conceptualised using indicators of parenting style and parental physical and mental health. Another addition of this study is the inclusion of father's physical and mental health and father's parenting style among the explanatory variables, which have been ignored in most of previous studies. Finally, variables representing neighbourhood effects include neighbourhood facility index (a proxy for availability, accessibility and quality of infrastructure), percentage of people with high school education and percentage of people speak English in the neighbourhood.

The choices of these variables were also made on the data availability and making the model parsimonious. For example, the data do not have information on parents' expenditure on toys, childcare and extra-curriculum activities. Thus, we could not include these variables to represent parental investment. Meanwhile, the data set has a wide range of variables to represent characteristics of the neighbourhood: percentage of Aboriginal and Torres Strait Islanders, percentage of households earn less than \$1000 per month, and remoteness index. But these variables were highly correlated with percentage of people speak English, percentage of high school graduate and infrastructure index, respectively.

The household income variable was constructed as the sum of mother's and father's reported weekly income from all sources⁶, which was multiplied by 52 weeks to obtain the annual household income. The effect of inflation was controlled for using the consumer price index; and the price index of Wave 1 (2004) was selected arbitrarily as the base. We take the logarithm of the inflation-adjusted household income to mitigate the well-known property of income that it is highly skewed (see, for example, Petrou et al. 2007; Calvo & Wellisz 1979). The main advantage of making income symmetrical by taking logarithm is that the mean is similar to that of the median. Therefore, parameters of regressions represent the relationship at median income, which is convenient to predict outcomes of interests (cognitive and non-cognitive skills) of children living under poverty, which is a measure of relative poverty (i.e. households with income lower than median income by 50 percent). We focus on relative income in this study because Australia is a high-income country with generous welfare and safety net system. Thus, absolute poverty measured by the international poverty line \$1.25/person/day is not relevant in Australia. Taking logarithm also makes the relationship between income and outcome of interests in this study non-linear and has relevant relationship between outcomes and parental investment. For example, the relationship between continuous measures (PPVT scores, mathematics and literature scores) and income follows a log-linear relationship, which also conveniently reflects some useful properties such as monotonicity (i.e., knowledge are accumulatively acquired) and diminishing returns (e.g., more parental investment lead to smaller incremental increase in child outcomes).

Table 1 shows that 79 percent children are first born and 65 percent of mothers have completed year 12 while the relative figure for fathers is only 49 percent, but the number of hours worked per week by fathers (47 hours) is about double that of mothers (26 hours). The controls for parental investment show that 89 percent of households have a computer at home and, on average, households have more than 30 children books at home. The variables for parental stress reveal that mothers show the warmer style of parenting compared to fathers. Among neighbourhood characteristics, we chose the percentage of people with Year 12 education level (45.6 percent), and percentage of people speak English (85.6 percent) in the postcode as the main indicators because other characteristics (e.g., rate of people employed and ATSI background) were highly correlated with the selected ones.

⁶ The weekly income data is collected from the response to the question "Before income tax is taken out, how much does . . . usually receive from all sources in total?"

Table 1. Descriptive statistics: Selected independent variables

Variables	Mean	Std.	Min	Max
Log of household income	11.03	0.75	2.13	14.55
Basic control variables				
Mother's age	36.89	6.37	14.00	82.00
Mother has year 12 education (1=yes)	0.65	0.48	0.00	1.00
Father has year 12 education (1=yes)	0.49	0.50	0.00	1.00
Mother's work hours per week	25.55	14.10	0.00	120.00
Father's work hours per week	46.53	12.95	0.00	168.00
Child age (months)	78.97	42.36	3.00	166.00
Gender of the child (1=male)	0.51	0.52	0.00	32.00
Is the child was first born (1=yes)	0.79	0.40	0.00	1.00
Aboriginal and Torres Straits Islander (1=yes)	0.21	0.41	0.00	1.00
English spoken at home (1=yes)	0.90	0.30	0.00	1.00
Household size	4.48	1.22	2.00	32.00
Both biological parents present at home (1=yes)	0.85	1.37	0.00	81.00
Low birth weight<2500gm	0.06	0.23	0.00	1.00
Parental investment				
Housing tenure (1=owned out right)	0.12	0.33	0.00	1.00
Out of home activities index ¹	2.61	1.20	0.00	5.00
Number of children's book at home ²	3.61	0.81	0.00	4.00
Has computer access at home (1=yes)	0.89	0.31	0.00	1.00
Family stress				
Mother is in excellent health (1=yes)	0.19	0.39	0.00	1.00
Father is in excellent health (1=yes)	0.18	0.39	0.00	1.00
Mother's parenting style ³	4.44	0.52	1.00	5.00
Father's parenting style	4.10	0.61	1.00	5.00
Depression scale of mother ⁴	4.45	0.59	0.00	5.00
Depression scale of father ⁴	4.51	0.53	0.00	5.00
Neighbourhood effects⁵				
Neighbourhood facilities ⁶	1.95	0.70	1.00	5.00
Percentage of people completed year 12 the neighbourhood	45.64	13.80	6.00	90.00
Percentage of people speak English in the neighbourhood	85.66	14.01	8.00	100.00

Notes:

1 Number of "yes" answers to questions about activities that the family do together such as go to cinema and sporting events.

2 Categorical variables: 1=1-10 books; 2=11-20 books; 3=21-30 books; 4=more than 30 books (recode to 4=1, zero otherwise).

3 mean of 5-point Liker scale questions (1=never, 5=always) about the frequency of showing affection (e.g, hug) children and express happiness to children.

4 Parental depression scale (mental health) is measured using six questions about the frequency of feeling: nervousness, hopeless, restless, sadness, worthless and lack of energy. In particular, the questions are "In the past 4 weeks about how often did you feel...": (1) nervous?; (2) hopeless?; (3) restless or fidgety?; (4) that everything was an effort?; (5) so sad that nothing could cheer you up?; (6) worthless? The responses are recoded in 5-point Likert scale: 1 = depressed all the time, 5 = not depressed at all. The final variable was constructed from the mean of responses to these questions, which takes values from 1 (highly depressed) to 5 (no depression).

5 Neighbourhood in this study refer to the neighbourhood of residence despite the primary sampling unit is the postcode, which is also the primary sampling unit of LSAC. Robust standard errors (Rogers, 1994), taking into account correlation of residuals within postcode, are used in the analyses where appropriate.

6 Average of 4-point Likert scale (1=strongly agree, 4=strongly disagree) questions about the ability to access affordable, regular public transport, basic shopping facilities, and services such as banks, medical clinics, etc. in the neighbourhood.

5. Results and Discussions

To investigate the effects of family income on child outcomes, we first use log of family income and a basic set of variables in Specification 1. Then we develop other three specifications to investigate the three mechanisms proposed in the theoretical section. We gradually include parental investment, family stress and neighbourhood characteristics in Specification 2, Specification 3 and Specification 4 respectively in addition to Specification 1. Finally, we estimate the most comprehensive model (Specification 5), which includes all variables from Specification 1 to Specification 4.

Table 2. Dynamic framework of skills formation (parameters of lagged outcomes)

Spec/ Est.	Non-cognitive outcomes					Cognitive outcomes			
	Pro-social scale	Hyperactive scale	Emotional problem	Conduct problem	Peer problem	PPVT	Matrix reasoning	Literacy score	Math score
<i>Specification 1</i>									
FE	***-.10	***-.05	***-.08	***-.05	***-.09	***-.32	*.04	***-.16	**.03
GMM	***.18	***.36	***.30	***.19	***.31	**.06	***.43	*.04	***.26
OLS	***.51	***.68	***.53	***.49	***.53	***.39	***.63	***.37	***.56
<i>Specification 2</i>									
FE	***-.10	***-.05	***-.08	***-.05	***-.09	***-.32	*.04	***-.16	**.04
GMM	***.19	***.37	***.30	***.19	***.32	***.08	***.46	**.05	***.29
OLS	***.51	***.67	***.53	***.49	***.52	***.37	***.63	***.36	***.55
<i>Specification 3</i>									
FE	***-.11	***-.07	***-.10	***-.05	***-.10	***-.30	**.07	***-.14	.03
GMM	***.20	***.34	***.31	***.18	***.30	**.06	***.41	**.05	***.30
OLS	***.48	***.66	***.50	***.45	***.51	***.38	***.64	***.35	***.54
<i>Specification 4</i>									
FE	***-.11	***-.07	***-.10	***-.05	***-.10	***-.32	-.01	***-.16	*.03
GMM	***.18	***.36	***.30	***.20	***.31	*.06	***.37	**.05	***.29
OLS	***.52	***.68	***.53	***.50	***.53	***.38	***.60	***.39	***.57
<i>Specification 5</i>									
FE	***-.11	***-.07	***-.10	***-.05	***-.11	***-.30	**.07	***-.14	*.03
GMM	***.20	***.34	***.31	***.18	***.30	**.08	***.44	***.07	***.33
OLS	***.48	***.65	***.50	***.44	***.51	***.37	***.63	***.35	***.54

Notes: Specification 1 includes log of household income, lagged outcome plus basic set of covariates: child's age, gender, birth weight, education and hours of work of parents, age of mother at child birth and household size, English speaking household and Aboriginal and Torres strait Islander.

Specification 2 includes Specification 1 plus indicators of parental investments: housing tenure, index of activities that the family does together such as go to cinema and sporting events, number of children's books at home and has a computer at home

Specification 3 Specification 1 plus indicators of family stress: parenting style, parental mental and physical health.

Specification 4 includes covariates in Specification 1 plus neighbourhood characteristics: neighbourhood facilities, percentage of people completed Year 12, percentage of people speak English in the neighbourhood

Specification 5 includes all covariates from Specifications 1- 4 .

*Other covariates are skipped in this Table for brevity. Significant levels are ***=1%, **=5% and *=10%.*

5.1 Dynamic Framework of Cognitive and Non-Cognitive Skill Formation

The results of OLS, Fixed effects and GMM show that outcome in the previous wave is the most significant determinant of the child's cognitive and non-cognitive skills (see Table 2). This result is consistent with the self-productivity and dynamic complementary theories of skill formation and empirical evidence by Heckman (2007), Cunha and Heckman (2008), Cunha et al. (2010) and Nghiem et al. (2015). The results also confirm Bond (2002)'s recommendation that the parameter of lag outcome was overestimated by the OLS estimator but underestimated by the fixed effects estimator, suggesting that the GMM results are reliable. We also find that not only the lag outcome parameters remain highly significant, but also their magnitudes are very stable across different specifications. Thus, we suspect that significant effects of income to child development outcome found in the literature could be overestimated due to specification bias (i.e., omitting the lag outcome). Since results from OLS are biased upwards and results of fixed-effects estimator are biased downwards, we focus on presenting the results of GMM estimator for rest of the paper. Table 2 reports the results of K cohort only but the results for B cohort are similar.

5.2 Family Income and Child Outcomes

Table 3 shows that household income has expected effects on child development outcome but the results are not consistent across outcomes and specifications. When only a basic set of covariates is controlled for (Specification 1) we found that children of wealthier households are less likely to have emotional and conduct problem. But when the most comprehensive set of covariates is used (Specification 5) we find that family income has no effect on non-cognitive outcomes except hyperactivity, which is significant at only 10% level. Family income is mainly associated with better cognitive outcomes. In particular, an increase of log family income by one SD is associated with an improvement of PPVT, MR, literacy and mathematical scores of children by about 0.29, 0.26, 0.23 and 0.24 SD, respectively. However, for non-cognitive skills, inclusion of the three mechanisms makes most of the income coefficients insignificant. An explanation for the different role of income in cognitive and non-cognitive skills could be due to the fact that cognitive outcomes are more directly affected by purchasable inputs such as private schooling, tutors and extracurricular activities while non-cognitive outcomes are more likely to be affected by non-purchasable inputs such as

personal traits (e.g., introverts vs extrovert), family environment (parenting skills, family functioning), neighbourhoods (peers effects, infrastructure) and social trends.

Table 3. Effects of household income on child outcomes (GMM estimator)

	Specification 1	Specification 2	Specification 3	Specification 4	Specification 5
Non-cognitive outcomes					
Pro-social	0.06	0.12	-0.12	0.12	-0.04
Hyperactive	0.02	-0.03	**0.15	0.08	*0.12
Emotional problem	** -0.19	** -0.18	* -0.16	-0.14	-0.09
Conduct problem	** -0.18	*** -0.22	-0.07	-0.10	-0.05
Peer problem	-0.11	-0.11	0.03	-0.04	0.08
Cognitive outcomes					
PPVT	-0.002	***0.11	-0.02	-0.05	***0.29
Matrix reasoning	*0.19	**0.22	*0.19	**0.23	***0.26
Literacy score	0.06	0.13	0.05	***0.28	***0.23
Mathematical score	0.003	***0.19	0.04	0.10	***0.24

Notes: The covariates in Specification 1 to Specification 5 are as Table 2

*Other covariates are skipped in this Table for brevity. Significant levels are: ***=1%, **=5% and *=10%.*

5.3 The Role of Parental Investment, Parental Stress and Neighbourhood

The effects of investment, parental stress and neighbourhood mechanisms can be investigated by comparing income parameters across 5 specifications in Table 3. It can be seen that parental investment (Specification 2) improves the level of significance and magnitude of income effects on most outcomes. The income effect becoming stronger and significant suggests that parental investment (i.e., time and material) is not a substitute for parental income. One explanation is that material inputs, which are often complimentary of income, play an important role in parental investment and hence make income effect stronger. However, when parenting style and physical and mental health of parents are controlled for in Specification 3, the effects of income on most outcomes are no longer significant, and the magnitude of the income coefficients also reduce. This result suggests that parental stress plays a significant role to mediate the effect of income on a child's outcomes. Similarly, when neighbourhood characteristics (Specification 4) are added in the covariates, family income has no significant effects on non-cognitive outcomes but its effect on cognitive outcomes becomes highly significant with the exception of mathematical score and PPVT. Overall, our

results suggest that investment theory seems to have little effects especially on non-cognitive development (i.e., there are little differences between parameters from Specifications 1 and 2), while neighbourhood plays a significant role, followed by parental stress in explaining the relationship between income and child non-cognitive development outcomes. Our findings are consistent with a recent study by Heckman and Mosso (2014) that reveals the importance of human interaction, mentoring and parenting compared to income.

5.4 Determinants of Child Cognitive and Non-Cognitive Development

5.4.1 Non-cognitive Outcomes

Table 4 shows that household income has no significant effect on non-cognitive outcomes of children. One exception is that children from high-income households may be more hyperactive but this result is only significant at 10 percent. Table 4 also reveals that gender, age and health status of the child are the most significant determinants of non-cognitive outcomes. As expected, boys have lower score in pro-social skills and face less emotional problem than girls; but they are more likely to be hyperactive and have conduct and peer problem than girls. For example, boys are less pro-social than girls by 0.3 SD while they are more likely to be hyperactive by the same magnitude. Pro-social skills improve and hyperactivity declines as the child grows but older children are also more likely to face an emotional problem. Another expected result is that children with excellent health status are significantly more likely to have good behaviour but the magnitude is small: they are more likely to be pro-social by 0.08 SD and less likely to have behaviour “problems”: by 0.1 SD for hyperactivity and conduct problem to 0.2 SD for peer and emotional problems. Children from a family with both biological parents and from large households are also less likely to be hyperactive (by 0.13 SD) and having problems with their peers (by 0.09 SD). Also, children from highly educated parents are less likely to have hyperactivity (lowered by 0.13 SD if mother completed Year 12 and by 0.1 SD if father completed Year 12).

Most of the variables representing parental investment are either insignificant or significant at 5% or 10% with modest effect. Among the variables representing parental stress and neighbourhood characteristics, most of the variables significantly affect non-cognitive outcomes of children. In particular, children from parents with better physical and mental health are less likely to have behaviour problem and more likely to have good pro-social skills. In particular, one SD reduction in mother's depression scale is associated with an

improvement of about 0.1 SD in pro-social skills and about 0.1 SD reduction in hyperactivity, conduct, emotional and peer problems.

Table 4. Details results of the GMM estimator for non-cognitive outcomes - Specification 5

Variables	Pro-social		Hyperactivity		Emotional Scale		Conduct problem		Peer problem	
	Coef.	SE	Coef.	SE	Coef.	SE	Coef.	SE	Coef.	SE
Lagged outcome	***.20	.02	***.35	.02	***.31	.02	***.18	.02	***.31	.02
Log of family income	-.04	.07	*.12	.07	-.09	.08	-.05	.06	.08	.08
Child's gender (male=1)	***-.30	.02	***.28	.02	***-.09	.02	***.12	.02	***.07	.02
Low birthweight	.01	.06	-.00	.05	.02	.05	-.03	.05	-.003	.05
ATSI status	***-.10	.03	**-.05	.03	.01	.03	***-.15	.02	.01	.03
English spoken at home	-.01	.05	*.08	.04	.05	.04	.05	.04	-.03	.04
Mother complete Year 12	-.01	.03	***-.13	.03	-.01	.03	*-.05	.03	*-.05	.03
Father complete Year 12	.03	.03	***-.10	.03	-.01	.03	-.04	.03	***-.06	.03
The child was first born	-.01	.03	*-.06	.03	***.11	.03	.04	.03	.01	.03
Mother's age	.02	.02	**-.04	.02	-.01	.02	**-.04	.02	***-.06	.02
Mother's working hours	**-.03	.01	-.001	.01	*-.02	.01	.01	.01	.01	.01
Father's working hours	.01	.01	***-.03	.01	.001	.01	-.01	.01	-.002	.01
Child's age (months)	***.14	.02	***-.07	.02	***.07	.02	-.02	.02	-.02	.02
The child has excellent health	***.08	.02	***-.10	.02	***-.22	.02	***-.09	.02	***-.18	.02
Household size	.01	.02	***-.08	.01	***-.07	.01	.01	.01	***-.06	.01
Both parents at home	.08	.06	**-.13	.05	-.001	.05	.001	.05	*-.09	.06
Parental Investment										
House tenure	*-.05	.03	-.01	.03	*-.05	.03	-.01	.02	-.01	.03
Out of home activities index	***.03	.01	**-.02	.01	-.02	.01	*-.02	.01	*-.02	.01
Has computer at home	.01	.06	.04	.05	-.02	.06	*-.08	.04	*-.11	.06
No. children's books in home	*.02	.01	**-.02	.01	-.001	.01	.001	.01	-.003	.01
Parental Stress										
Mother has excellent health	.02	.02	-.02	.02	.01	.03	.002	.02	**-.05	.02
Father has excellent health	**-.05	.02	***-.06	.02	-.01	.02	*-.03	.02	***-.05	.02
Mother's parenting style	***.17	.01	***-.07	.01	-.01	.01	***-.09	.01	***-.03	.01
Father's parenting style	***.03	.01	***-.04	.01	*-.02	.01	***-.04	.01	***-.04	.01
Mother's depression scale	***.08	.01	***-.11	.01	***-.14	.02	***-.11	.01	***-.09	.01
Father's depression scale	.01	.01	**-.02	.01	***-.04	.01	**-.02	.01	***-.04	.01
Neighbourhood										
Neighbourhood facilities	***-.03	.01	*.02	.01	.01	.01	.01	.01	***.03	.01
% people completed year 12	-.03	.02	*-.04	.02	.001	.02	-.01	.02	-.02	.02
% English speaking people	.01	.02	***-.04	.01	**-.03	.01	*-.03	.01	-.02	.01
Constant	.12	.10	.001	.08	.09	.09	-.09	.08	***.28	.09
Observations	7380		7380		7380		7380		7378	
Sargan test p-value	0.00		0.00		0.00		0.00		0.00	
Number of instrument	121		121		121		121		121	

Positive parenting significantly reduces the probability of hyperactivity and conduct problem and mother's parenting style has more positive effects than that of father's. Good neighbourhood characteristics (i.e. more facilities and higher percentage of English speaking population in the neighbourhood) are also associated with fewer behaviour problems, but their magnitudes are small and significant levels are modest. For example, one SD increase in the English speaking population in the neighbourhood is associated with reduction in hyperactivity, emotional and conduct problems by 0.04, 0.03 and 0.03 SD, respectively. Also, children in neighbourhoods with poor infrastructure have lower pro-social skills and higher chance of having behaviour problem: one SD decrease in infrastructure (note that lower score means better infrastructure for this variable) is associated with a reduction of prosocial skills by 0.03 SD. In particular, we find that parental stress and neighbourhood characteristics along with other factors such as child's age, gender, health and parental education and presence of both biological parents at home play a significant role to mediate the effect of income on child's non-cognitive development.

For children in the B cohort, we found that the physical health of a child is the most significant determinants of child behaviour and non-cognitive skills. For example, children with excellent health have pro-social skills higher by 0.06 SD, while their scores for behaviour problems reduces from 0.08 SD in hyperactivity to 0.12 SD in bullying perpetrators. The depression and parenting style of mother also have similar effects: a reduction in depression scale and an increase in warm parenting style activities (e.g. frequency of kiss or hug children) of mothers are associated with better non-cognitive outcomes of their children. But we did not find significant effects of father's depression scale and parenting style.

We also examine the effects of income on other non-cognitive outcomes, including self-efficacy, bullying perpetrator and bullying victim using ordinary least squares (OLS) estimator as these outcome is available for only one wave. Table 5 shows that income has positive effects on self-efficacy (only significant at 10%) while it creates no effects on bullying. Gender and age are the most significant factors contributing to these non-cognitive measures. In particular, girls have lower score about overall self-efficacy by 0.22 SD. As expected, boys have higher scores for both bullying perpetrator (by 0.27 SD) and bullying victim (by 0.19 SD). The age has mixed effects: older children have lower score on self-efficacy and bullying victim but they also have a higher score on bullying perpetrator. Parents' education also has expected effects: children from a mother with Year 12 education

have a higher self-efficacy score by 0.11 SD and lower score for bullying victim by the same amount. Children of a father with Year 12 education also received the same effects, but the magnitude is only 0.06 SD for both higher self-efficacy and lower bullying victim scores.

Table 5. Details results of the OLS estimator for additional non-cognitive outcomes

Variables	Self-efficacy		Bullying perpetrator		Bullying victim	
	Coef.	SE	Coef.	SE	Coef.	SE
Log of family income	*0.03	0.02	-0.004	0.02	-0.01	0.02
Child's gender (male=1)	***-0.22	0.02	***0.27	0.03	***0.19	0.03
Low birthweight	0.03	0.06	-0.03	0.06	-0.06	0.06
English spoken at home	-0.03	0.03	0.01	0.06	***0.16	0.06
Mother complete Year 12	***0.11	0.03	-0.01	0.04	***-0.11	0.04
Father complete Year 12	**0.06	0.03	-0.04	0.03	*-0.06	0.03
The child was first born	0.05	0.04	-0.03	0.04	0.05	0.05
Mother's age	***-0.06	0.02	0.02	0.02	-0.02	0.02
Mother's working hours	-0.01	0.01	-0.001	0.02	0.02	0.02
Father's working hours	-0.02	0.01	0.02	0.02	0.01	0.02
Child's age (months)	***-0.34	0.05	**0.05	0.03	***-0.23	0.03
The child has excellent health	***0.10	0.03	-0.03	0.03	** -0.07	0.03
Household size	-0.01	0.02	-0.00	0.02	-0.02	0.02
Both parents at home	***0.19	0.06	*-0.14	0.08	-0.12	0.07
<i>Parental Investment</i>						
House tenure	-0.01	0.03	-0.06	0.04	***-0.12	0.04
Out of home activities index	**0.03	0.01	-0.01	0.01	-0.02	0.02
Has computer at home	-0.06	0.07	-0.09	0.10	*-0.18	0.10
No. children's books in home	-0.02	0.02	0.01	0.02	*0.03	0.02
<i>Parental Stress</i>						
Mother has excellent health	0.002	0.03	-0.004	0.03	0.02	0.04
Father has excellent health	-0.01	0.03	*0.07	0.04	0.02	0.04
Mother's parenting style	***0.07	0.01	-0.01	0.01	-0.02	0.02
Father's parenting style	***0.07	0.01	** -0.03	0.01	-0.02	0.02
Mother's depression scale	**0.04	0.02	*-0.03	0.02	***-0.06	0.02
Father's depression scale	0.02	0.01	-0.01	0.02	-0.02	0.02
<i>Neighbourhood</i>						
Neighbourhood facilities	0.01	0.01	0.005	0.01	0.01	0.02
% people completed year 12	0.001	0.02	*-0.03	0.02	-0.03	0.02
% English speaking people	**0.04	0.02	** -0.04	0.02	-0.01	0.02
Constant	**0.25	0.11	-0.06	0.13	***0.45	0.14

5.4.2 Cognitive Outcomes

Table 6 shows that income significantly affects child's cognitive development. On average, one SD increase in log of household income is associated with 0.29, 0.26, 0.23 and 0.24 SD increase in PPVT, MR and literacy and mathematical scores, respectively. This result is consistent with a recent study by (Washbrook et al. 2014) that found that income has the highest effect on child cognitive development compared to other indicators of child development, such as non-cognitive development and health. Characteristics of households and child are also significant determinants of child's cognitive development. It is surprising that gender still plays a significant role in determining cognitive outcomes: boys achieve higher PPVT and mathematical scores than girls by 0.05 SD while their MR and literacy scores are lower than that of girls by 0.07 and 0.19 SD, respectively. Low stock of initial health status seems to create long-lasting effects on child development: children with low birthweight achieve significantly lower cognitive scores by about 0.1 SD in all four measures of cognitive outcomes. Children from Aboriginal and Torres Strait Islander families are more likely to have lower MR (by 0.13 SD), literacy scores (by 0.3 SD) and mathematical scores (by 0.1 SD) but their results in PPVT do not significantly differ from that of other children. Another surprising result is that children from English-speaking households perform worse in MR, literacy and mathematics by a considerable amount of 0.2 SD. One possible explanation is that migrant families from some cultural groups (e.g., Asian “tiger moms”) pay more attention to scholarly development of children. Parental education also affects children's cognitive outcomes strongly. Children from a family with father or mother having completed Year 12 have cognitive tests higher by about 0.1 SD.

Variables in parental investment become more influential for cognitive outcomes compared to non-cognitive outcomes. Among the variables proxied for parental investment, computers and books play the most significant role in improving cognitive outcomes of children but the magnitude of computer is larger: students with a computer at home achieve higher score in MR and mathematics by 0.15 and 0.13 SD, respectively. Housing tenure, proxied by the dummy variable on whether the family owns a house outright, is also associated with higher literacy and mathematical scores by 0.07 SD. The indicators of parental stress either provide unexpected or insignificant results for cognitive skills, while among the neighbourhood characteristics, only the percentage of English speaking people in the areas is significantly associated with increased probability of having better PPVT with the marginal effect of 0.05 SD.

Table 6. Details results of the GMM estimator for cognitive outcomes-Specification 5

Variables	PPVT		Matrix reasoning		Literacy score		Mathematical score	
	Coef.	SE	Coef.	SE	Coef.	SE	Coef.	SE
Lagged outcome	** .08	.03	*** .45	.03	*** .25	.02	*** .28	.02
Log of family income	*** .29	.08	*** .26	.09	*** .29	.03	*** .24	.07
Child's gender (male=1)	** .05	.02	*** -.07	.02	*** -.24	.03	** .05	.02
Low birthweight	*** -.14	.04	*** -.13	.05	* -.10	.06	* -.09	.05
Aboriginal and Torres Strait Islanders	.01	.07	* -.13	.08	*** -.30	.11	*** -.10	.02
English spoken at home	.06	.05	*** -.18	.05	*** -.15	.05	*** -.23	.04
Mother complete Year 12	.04	.03	.05	.03	*** .10	.04	*** .11	.03
Father complete Year 12	* .04	.03	** .06	.03	*** .13	.03	*** .08	.03
The child was first born	.05	.03	-.02	.04	* .07	.04	.05	.03
Mother's age	.02	.02	.01	.02	.02	.02	.02	.02
Mother's average hours worked per week	*** -.04	.01	*** -.04	.02	** -.03	.01	* -.03	.01
Father's average hours worked per week	-.02	.01	-.02	.01	** -.03	.01	-.01	.01
Child's age (months)	*** .84	.07	.03	.02	*** .26	.02	*** .11	.03
The child has excellent health	.01	.02	.01	.02	* .04	.02	** .05	.02
Household size	*** -.04	.01	.003	.02	.002	.02	* .03	.01
Both biological parents at home	.03	.05	-.06	.06	-.02	.07	.01	.06
Parental investment								
Housing tenure	.03	.03	.02	.03	** .07	.03	** .07	.03
Out of home activities index	.003	.01	-.0004	.01	** .02	.01	-.01	.01
Has computer at home	-.01	.05	** .15	.06	* .11	.06	* .13	.08
No. children's books in home	*** .07	.02	.02	.02	*** .05	.02	* .01	.01
Parental stress								
Mother has excellent health	* -.04	.02	-.003	.03	-.02	.03	.02	.03
Father has excellent health	-.003	.02	-.02	.03	* -.05	.03	* -.05	.03
Mother has warm parenting style	-.01	.01	-.02	.01	* .02	.01	.004	.01
Father has warm parenting style	-.001	.01	-.01	.01	-.003	.01	-.01	.01
Mother's depression scale	* -.02	.01	*** -.07	.02	.01	.01	-.01	.01
Father's depression scale	* -.02	.01	-.01	.01	.004	.01	-.01	.01
Neighbourhood								
Neighbourhood facilities	.004	.01	.01	.01	-.01	.01	-.01	.01
% people completed year 12	.01	.02	-.01	.03	* -.05	.03	* -.04	.02
% English speaking people in linked area	*** .05	.02	-.0005	.02	-.02	.02	-.01	.02
Constant	-.002	.10	-.002	.10	-.06	.11	-.14	.10
Observations	3545		5687		5171		5368	
Sargan test p-value	0.00		0.00		0.00		0.00	
Number of instrument	81		110		121		121	

In summary, our results indicate that parental stress and neighbourhood characteristics are important for child's non-cognitive development while parental investment is important for child's cognitive development. Child's age and gender, mother's education, parents' physical and mental health, positive parenting, child's own health and presence of both biological

parents at home are the most important factors for child non-cognitive development. For cognitive development, in addition to family income, parents' education, having computers and children books (which is a proxy for cognitively stimulating environment) are important factors.

6. Conclusions

This paper examines the association between household income and child outcomes using a system GMM method to account for the potential endogeneity of income and unobserved individual heterogeneity. It investigates whether the relationship between child outcomes and income can be mediated by 'parental investment', 'parental stress' and 'neighbourhood characteristics'. One of the unique additions of this paper is the inclusion of previous outcomes in the model of child development, which is ignored by most of the previous empirical studies of child cognitive and non-cognitive development. Because of this dynamic specification (i.e., inclusion of lagged outcome among the covariates), our results are less likely to suffer from upward bias which could be the case for most of the previous studies that used a static specification. Our results find that the parameters of previous outcomes are highly significant, providing strong support for the skill formation theory of Heckman (2007) and Cunha et al. (2010).

Results from different estimates confirm that family income has a significant positive effect on most of child's cognitive outcomes but effects of income on non-cognitive or behavioural development are mostly non-significant. **We find that parental stress has a significant role to mediate the effect of income on non-cognitive development. Also,** parental physical and mental health, parenting style, along with other characteristics of the child (age, gender and health) and the household (presence of both biological parents at home, parents' education) are the important determinants of child non-cognitive development. Other factors such as child's gender, age, birthweights, parental education, computers and number of children's book at home are the most important factors for child cognitive development. Overall, we found support for 'parental investment' theory to some extent and 'parental stress' and neighbourhood theories with great extent on non-cognitive outcomes but a reverse story (supports parental investment to a greater extent) was found for cognitive outcomes.

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