The effect of home and school inputs on learning achievement in Vietnam: A fixed-effect approach

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Contents

Abstract

Given the recent tremendous expansion of the public educational system in Vietnam with remarkable performance such as nearly universal primary school enrolment and high scores in international standardized tests, this paper concerns the learning gaps between children from more and less advantaged backgrounds and the unequal distribution of education in Vietnam. This analysis provides the overall picture of the factors behind the achievement differences by exploiting within-child variation in longitudinal Young Live study data. The rich information of family and school input enables many estimation specifications that accommodate the presence of unobserved endowments and input choices that are endogenous concerning endowed mental capacity. In general, the paper finds that caregivers' ability, improvement of access to services, and investing in learning supporting devices at home and school positively impact the achievement of unprivileged students. The paper further discusses other constraints for the country's education - most of which were identified decades ago but have not been appropriately tackled- such as dropout rate in secondary level and private tutoring.

Keywords: Educational Production Function, Learning Achievement, Cognitive Development, Within-child Fixed-effects

Chapter 1

Introduction

The motivation of this paper comes from the theoretical and empirical relationship between a good education and high income together with greater economic growth. It is well-documented in many recent studies (Hanushek and Kimko [2000], Murnane et al. [2000]) that high cognitive achievement significantly impacts labor-market returns. However, the benefit does not stop at the pecuniary gain only. Take Perry preschool program[1] as an example. Even the program failed to boost the permanent IQ of the treatment group in the long run. It is shown in the work of Heckman et al. [2013] that there are significant gains in life outcomes of treated children compared to their untreated peers such as employment, health, cognitive and socio-emotional skills, and a substantial decrease in incarceration. In that regard, Warren [2017] find evidence that children who experienced poverty at some time in their childhood are likely to have poorer cognitive and social outcomes, are more likely to be obese and are also likely to have lower levels of general health. Consequently, there are good reasons to bring students together to eradicate poverty and the waste of talent that inequality brings. In this analysis, I use a simple economic model of the education production function to examine the forms of inequality from many angles by exploiting within-child variation in the longitudinal data from Young Lives.

In Todd and Wolpin [2003], the authors distinguish two large bodies of recent skill formation research: the early childhood development (ECD) and the education production function (EPF). When the early childhood development research shed light on understanding "the role of parental characteristics and the early home environment in producing cognitive skills". The education production function has focused on identifying the relationship between education investment from both family and schooling system with child's achievement in school-age development phase. However, the empirical evaluation is challenging because of these two problems: first, the econometric challenge in dealing with unobserved latent cognitive abilities; second, data sets on inputs are usually half-completed (i.e., lack of some input histories or suffer from systematical missing values). For these problems, one approach in the ordinary least square model is that researchers explicitly impose the orthogonality assumption between the included variables and omitted variables and unobserved traits. This approach, however, is inconsistent with the

[1] As described in Heckman [2017]: "The Perry Preschool Project, carried out from 1962 to 1967, provided high-quality preschool education to three- and four-year-old African-American children living in poverty. Heckman and his team applied an econometric model to 46 cognitive and character measures sorted into three categories: cognition (IQ); academic motivation (engagement, initiative, persistence); and negative externalizing behavior (lying and cheating, aggression, classroom disruption). The long-term effects on adult outcomes were analyzed using numerous measures, including the California Achievement Test, special education enrollment, earnings, employment, health behaviors, marriage duration and crime rates. The 35-year-and-counting duration of the Perry study makes it a living laboratory for determining adult outcomes and their causes."

behavior model of parents and children's cognitive development. Another approach assumes that the missing variables are time-invariant and removed by within-unit estimators. In this essay, I implement two alternative specifications of the cognitive production function, focusing on understanding the impact of home and school inputs on learning disparities. Confronting with the classic problems of omitted variables bias and endogeneity, I adopt within-child fixed-effects to account for the assumption of time-invariant abilities. The caveat of this approach is that it required the assumption of time-invariant production function technology across ages, which is not in line with many recent works of literature of multistage technology of human capital accumulation, which has been documented in Cunha et al. [2005, 2010], Heckman and Mosso [2014]).

Overall, the estimation results show that caregivers' education and household assets' improvement are substantive determinants of children's learning achievement. I combine the Young Lives Survey (YLS) and the Young Lives School Survey (YLSS)[2] in Viet Nam for home and school inputs in the educational production function. This paper contributes to the studying of child's cognitive accumulation in developing countries in two ways : (i) I extend the definition of investment for a child to time investment. (ii) In contrast with other papers using class size or teacher salary as a proxy for school input, I construct the school inputs at a comparable level with home inputs and use within-child variation to distinguish the effect of family and schooling system on child's test outcomes.

The paper continues as follows; to continue in this chapter, I revisit the concept of Educational Production Function and show the current debates with policy implications. In the next chapter, I describe the Young Lives (YL) longitudinal survey in Vietnam, highlighting important characteristics captured in my sample. Then, I present the conceptual framework of the production function of skill formation in Chapter 3, detail my estimation equations, and address the assumptions under each specification. Finally, I report my results and conclude with a short discussion.

The education production function and the policy debate

The EPF literature has a long history focusing primarily on constructing the equation of skill formation. The analogous structure between the technology of EPF and the firm's production function provides guidance for the choice of variables and a better understanding of the mechanisms and the interpretation of the treatment effects. The researchers have adopted this framework to measure various types of cognitive and non-cognitive skills. In Cunha and Heckman [2007] (see also Cunha and Heckman [2008], Cunha et al. [2010], Heckman and Mosso [2014]), the researchers emphasize on the dynamic production function of skills with many production-based terms such as *dynamic complementarities*, *cross-productivity* and *self-productivity* [3] in order to

[2] https://www.younglives.org.uk/

[3] As noted in Cunha and Heckman [2007]: Self-productivity means skill produced at one stage augment the skills attained at later stages. Cross-productivity means cognitive skills may affect the accumulation of non-cognitive skills and vice versa. Dynamic complementarity is skills produced at one stage raise the productivity of investment at subsequent stages.

explain how capabilities gaps emerge at early childhood and persist or widen over the life cycle. The inequality in education appears in all forms, such as gender disparity, region disparity, and socio-economic disparities. After recognizing the initial differences of human capital formation, there are considerable debates surrounding the contributions of home background and school quality to children's development and learning outcomes and how to mitigate the gaps.

A large body of research (Coleman [1968], Rouse and Barrow [2006], Kim [2008], Hung et al. [2020]) finds that students' socio-economic status, family environment, and parent's educational support strongly influence a child's achievement. Some studies even suggested that the decreased role of schools and characteristics of classrooms are not closely related to student performance. In that regard, the work of Todd and Wolpin [2007] uses the National Longitudinal Surveys of Labor Market Experience - Children Sample to examine the impact of school inputs, family inputs, and mother's ability on children's test outcomes. The conclusion is that nearly half of the black-white and Hispanic-white test score gaps in reading and math are due to the differences in mothers' Armed Forces Qualification Test scores (AFQT)[4]. Likewise, Fernald et al. [2013] finds that the conversation of children at age three from highly-educated parents' families contains 50% more vocabularies than children from working-class families and over doubles the number of words used by children from welfare families. In addition,Grantham-McGregor et al. [2007] find that early stuntedness due to inadequate food and poor sanitation and hygiene conditions impede child development. The authors show that early childhood disadvantages can affect a child's potential development in two ways: fewer years of schooling and lower learning achievement in school. Mitchell et al. [2020] use Young Lives (YL) longitudinal survey in Peru with a dynamic latent factor model of household investment to examine socio-emotional skills. The paper provides evidence that family resources and parents' socio-emotional skills are the main determinants for parental investment. Noticeably, the results show that the children's revealed capacity does not affect parental investment, and family wealth is the primary determinant of investment choice. Conversely, Fan and Porter [2020] shows that parents attempt weakly to provide a remedy for disadvantaged children by increasing cognitive investment. This controversy will be discussed in Chapter 3 on the assumption that there is no reinforcing or compensating behavior between family investment and past child's achievement.

Meanwhile, the work of Heyneman and Loxley [1982], Hanushek [1997], Gibbons and McNally [2013] show that school characteristics do matter apart from the family background. In Cunha and Heckman [2007], Malamud et al. [2016], the authors also suggest a reinforcing and interacting relationship between home input and school inputs through dynamic complementarities mechanism. In that regard, Fan and Porter [2020] provides evidence on compensating behavior of well-educated mothers, small household size, and high wealth families. Also, Strand [2014, 2016] emphasize that gaps already appear substantial before children start school, and the conclusion that schools do not play a part in narrowing the gap can be a misreading of the evidence. The work of Hanushek [2003] also suggests that the over-generalization of resource policies without "no good description of when and where" can make a lousy bias and offset the true effects. In addition, the authors also highlight the usually omitted heterogeneity "variations in teacher

[4]AFQT test is a screening test developed in 1950 by the Department of Defense to determine a person's eligibility for acceptance into U.S. military service by assessing his or her mental ability qualification.

quality that are not systematically related to school resources".

Vietnam education, poverty, and equity

Vietnam's education system has experienced an impressive increase in enrolment rate at both the primary and secondary levels (Dang and Glewwe [2017]) over the past decades. The literacy of the population more or equal ten years old is high (96% for Kinh - the majority and 78% for the minority). Strikingly, Vietnamese students' performance in the Program for International Student Assessment (PISA)[5] was exceptional despite the country's low education budget. In PISA 2012 assessment, the country's 15-year-old students rank 8^{th} in science among 65 participating nations countries, which is seen as the evidence for a successful education system providing students with strong basic cognitive skills such as reading literacy and numeracy.

However, these far-reaching achievements in the last decade raise more questions than the answers. Many researchers (see Jairo et al. [2014], Dornan and Portela [2014], Nguyen [2019], Dejaeghere et al. [2021]) express their concern about hidden inequality — educational inequality in Vietnam. The achievement could be representative of a small and better-off population as "rapid expansion of education might have come at the expense of egalitarian goals" in Holsinger [2005]. According to recent studies on education of Viet Nam(Le and Nguyen [2016], Rolleston and Krutikova [2014], Dejaeghere et al. [2021]), there are many sources of the inequality in cognitive achievement between the groups of children, including access to schools, materials, classroom practice, teachers' qualifications, teaching pedagogy and low teachers' beliefs for students in socio-economically underdeveloped areas. In order to design an efficient instrument that cracks the problem of skill gaps and achieves accessible and equitable quality education, policymakers must understand the contribution of the family and schooling system in child development.

Concerned with the disadvantages of the minorities, DeJaeghere et al. point out that most teachers in disadvantaged regions have a common belief in minority ethnic students' low learning capacity. Instead of embracing the difference between minority students and Kinh students, the didactic teaching method hinders students' thinking creatively and critically. As presented in DeJaeghere et al. [2021]:

> The beliefs about the superiority of Kinh students manifested in in activities teachers designed for students...In a majority Kinh student classroom, teachers not only asked questions about content knowledge in textbooks, but they also asked questions to serve various purposes, such as to check if students understand particular learned knowledge, connect old and new knowledge, or identify new knowledge...However, the teachers did not give ethnic minority students an opportunity to use their understanding, but rather interrupted or did not wait for a response and rather finished their own question by providing them the definitions (p.21-22)

[5]PISA is the OECD's Program for International Student Assessment. PISA measures 15-year-old' ability to use their reading, mathematics, and science

Despite those overall high enrollment rates, there are persisting gaps even more expansive in the upper secondary level among ethnic groups. To be more specific, in the report of Kataoka et al. [2020], the enrollment rate of Khmer and H'Mong was 29.5% and 20.4 % , respectively, but about 78% for Kinh[6] in 2016. According to Tam et al. [2013], dropout probability is sensitive to family's poverty and direct cost of schooling. Many students are caught in a classic trap – lack of education kept them from prosperity. Then, low starting points and lack of development opportunities loom in their future and the next generation.

[6] Kinh is the largest ethnic group in Vietnam

Chapter 2

Data and Preliminary Evidence

This paper employs Viet Nam Young Lives Survey (YLS) and the Viet Nam Young Lives School Survey (YLSS) in 20 sentinel sites in five provinces in all three parts of the country (Lao Cai - Northen Mountainous region, Hung Yen - Red River Delta, Da Nang - Central Urban, Phu Yen - South Central Coast, Ben Tre - Mekong Delta, see figure 2.1). The study of the YLS

Figure 2.1: Young Lives study sites in Vietnam

younger cohort has collected rich information of 2000 children who were born in 2001–2002 on their family background and the individual information, the living communities, and children's cognitive measures in five rounds of surveys, which were carried out in 2002, 2006, 2009, 2013 and 2016. The re-interview rate was high as 98.5% of students in the second wave and still at 96.9% in the fifth round. In the YLSS, the primary and secondary school survey data were collected in 2011-2012 and 2016-2017, respectively. The dataset contains school, principal, and teacher characteristics from a random sample of schools attended by the Younger Cohort of children followed by Young Lives. The primary school sample contains 3284 Grade 5 students, of which 1138 are Young Lives children from 176 classes and 92 school sites. At the secondary level, if there is no secondary school located in the commune in which students live, then they then travels to the nearest upper secondary school in the district. The secondary school survey results cover 14 districts in which the 20 Young Lives sites with 7429 students in 52 schools (with 385 Young Lives children). Nguyen [2008] criticizes the YLS as lacking representativeness because the survey was designed to focus on poor children and was based on non-random sampling. The sampling process of YLS and YLSS is pro-poor, with two-thirds of the sample from rural or poor areas.

In this analysis, I use the information of children from Round 2 (aged 5) to Round 5 (aged 15), combining family backgrounds, child achievement test scores from the YLS, and school characteristics from the YLSS. Due to data limitations, there was no school survey for junior high school (corresponding to 12-year-old students in Round 4). I restricted the sample in Round 3 and 5 to construct balanced panel data. To obtain the largest sample size as much as possible, I include children who did not enroll in Round 3 and 5. Those children who are dropouts have the contemporaneous school input default at zero.

Next, I present some stylized facts and features of the Young Lives data used in this paper. These stylized facts show how gaps form and persist under many disadvantaged backgrounds.

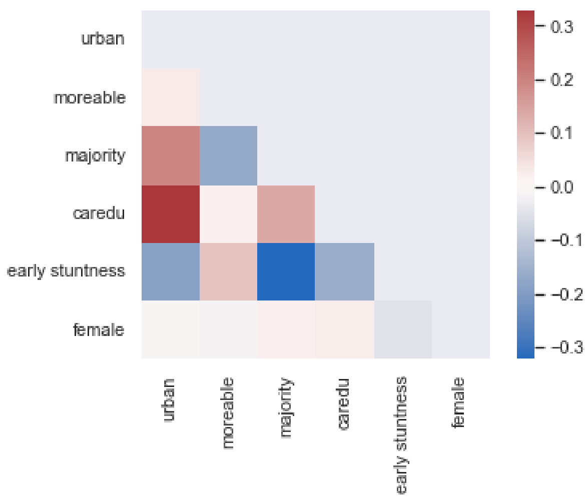


Figure 2.2: Correlation among advantage backgrounds

2.1 Cognitive skill measures

Many test scores measure cognitive abilities in Young Lives data to assess children's verbal and quantitative abilities, namely Peabody Picture of Vocabulary Test (PPVT), Early Grade Reading Assessment (EGRA), the Cognitive Developmental Assessment (CDA), and a mathematics test. Young Lives Study used two principal methodologies to construct these tests: Classical Test Theory (CTT)[1] and Item Response Theory (IRT)[2]. The panel was also assessed for gender bias, urban-rural bias, and finally, majority-minority bias. Some tests were only conducted in

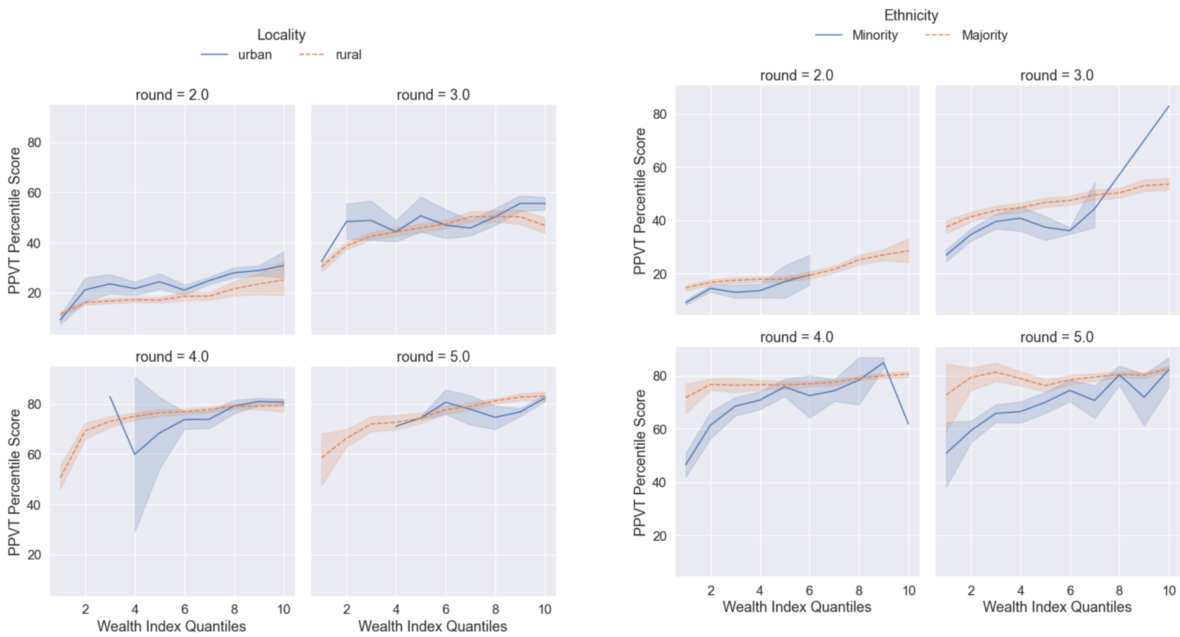
[1]Classical Test Theory is a body of related psychometric theory that predicts outcomes of psychological testing such as the difficulty of items or the ability of test-takers. It is a theory of testing based on the idea that the observed or obtained score on a test is the sum of an actual score and an error score

[2]Item Response Theory is a model that attempts to explain the relationship between latent traits and their manifestations (observed outcomes or performance)

a specific period. For example, the CDA for the younger cohort was tested only in Round 2 with the reason that "it would be too easy for most children in primary school by the time of testing" as reported in Cueto et al. [2012]. The CDA is considered as a good predictor of innate cognitive skills for the young child and used as a replacement for unobserved abilities of the child in Glewwe et al. [2017]. In this analysis, I use the top decile of the CDA test as a criterion for more-able 5-year-old children.

There are only two tests implemented across rounds: the Peabody Picture Vocabulary Test (PPVT) and Math test. However, Maths tests align with the curriculum and fit with age-specific education level, so I cannot directly use the average scores from the tests to assess the development over time. Considering the reliability, validity, and comparability over time, I use the PPVT as the dependent variable, representing cognitive development. According Leon and Singh [2017], PPVT tests are constructed based on the three parameters model, which considers the item's difficulty, discrimination, and pseudo-guessing to estimate the individual's ability. All the children took PPVT in Vietnamese. However, if an ethnic minority child requests, they can be assisted by a local translator.

According to León et al. [2015], using the raw score or percentage score to evaluate child ability could be biased. However, the analysis results in Cueto et al. [2009, 2012] show a high correlation (0.99) between raw and Rasch scores (IRT). In addition, according to these Technical Note of Young Lives Study, the PPVT tests were constructed by the principle of "on average, children in higher grades of school should get higher results than children in lower grades or out of school". Consequently, I consider using PPVT percentage score appropriate for this paper. Next, I present longitudinal evidence for skill gaps in children's PPVT test scores from Round 2 to 5, considering many types of advantages and disadvantages between many groups of children.

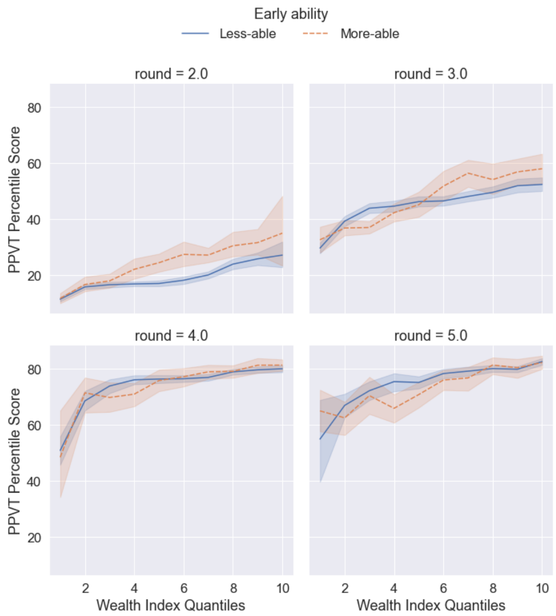


(a) By locality

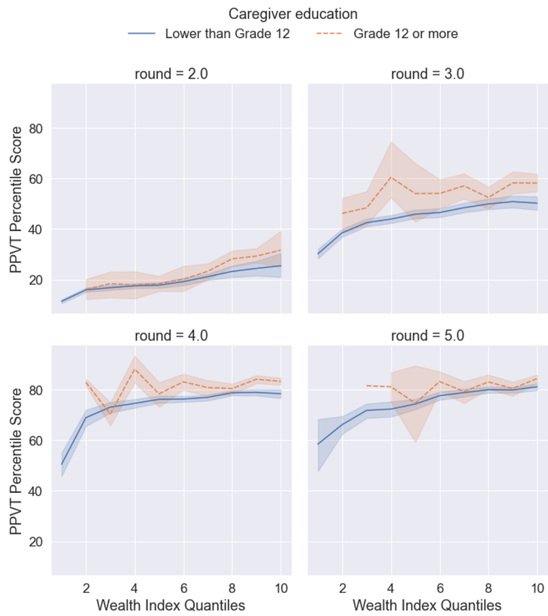
(b) By ethnicity

Figure 2.3: PPVT Percentage score by locality and ethnicity

Note that the learning gap problem is multi-dimensional. I explore the gap from many angles: urban-rural, majority-minority, more-able children (top quintile of CDA in Round 2), child with mother having at least 12 years of education, child early stuntedness (being stunting in the first 5 years of childhood). The correlation heatmap between these categories is shown in the figure 2.2. Urban and majority students are more likely to have well-educated caregivers and less likely to be stunted early. Being a girl or being more-able is not correlated with any other group. In other words, there is no specific advantage or disadvantage for female students, and the initial mental capacity is almost randomly distributed. By preliminary mean comparison, the analysis finds that the locality, being the majority and having a well-educated caregiver make relatively large gaps in child development, while being more-able or stunt at a young age shows less apparent gaps.



(a) Being moreable



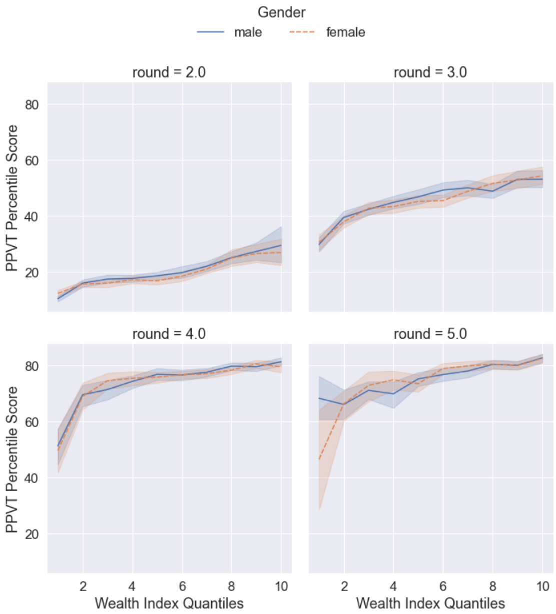
(b) By Caregiver's education

Figure 2.4: PPVT Percentage score by Caregiver's education

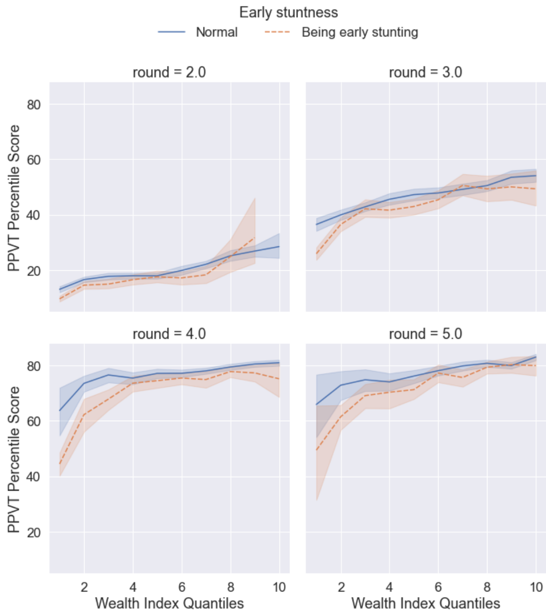
Figures 2.3a presents evidence for gaps in cognitive development emerging between urban and rural students before children enter school (children from Round 2 at age 5) and exhibit variation as they grow older and progress into primary schools. On the opposite, the difference due to difference in caregiver's education (Figure 2.4b) is minor when the child is at a young age, but the gap opens and widens in primary and junior secondary school then narrow somewhat by Round 5. Minimal differences are observed in gender difference and being more-able or being stunting at an early age (see Figure 2.5a and 2.4a)

2.2 Home Inputs and Time Use

The positive relationship between family investment and a child's mean years of schooling or achievement is well documented in many pieces of literature. The inputs from parents are the purchased goods and parental time investment. In this paper, to take the novel perspective of



(a) By gender



(b) Being stunting at early age

Figure 2.5: PPVT Percentage score by gender and early stuntness

family investments, two types of resources are examined: facilities inputs (or goods input) and time inputs. As the YLS study was not designed to examine a child's learning achievement, *per se*, but many other family characteristics and living conditions, detailed materials that directly impact a child's learning are hard to identify. In that regard, I use the family wealth index as in Briones [2017] to represent the general parent investment in the child. In some senses, families with better financial conditions can provide more and better inputs for their children. In addition, instead of using merely wealth index as the primary input of family for the child, I use its three components: housing conditions[3], access to services[4], and durable goods[5]. The decomposition of the wealth index is as follows:

$$\text{Wealth Index} = \frac{\text{Housing Quality} + \text{Access to Service} + \text{Consumer Durables}}{3}$$

The range of each sub-indices is between 0 and 1. As a result, the value of the wealth index produces an index between 0 and 1, where a higher wealth index indicates a higher socio-economic status. With the same constructing method of wealth index and sub-indices (Briones [2017]), I construct a studying materials index based on the availability of studying materials supplied for the child, including basic learning materials (studying desk, lamp, dictionary, bag, ruler, textbooks) and other supporting learning devices (calculator, computer, internet). Each instrument equals to 1 if the child possess the item, 0 otherwise. All items having equal weighting in the index.

From table 2.2.1, it can be seen that children growing up in rural areas or being a minority or

[3]Housing quality: rooms per person, floor and roof quality

[4]Access-to-service: electricity, piped water into dwelling/yard, access to own pit latrine/flush toilet, cooking fuel is electricity, gas, or kerosene

[5]Household durables: radio, bicycle, TV, car/truck, motorbike/scooter, land-line telephone, bed/table

Table 2.2.1: Descriptive Sample Statistics of Home Inputs

	Urban	Rural	Minority	Majority	Caregiver	Caregiver edu	Less-able	More-able	Not stunting	Early stunting
8-year-old child										
Housing quality index	0.87	0.75	0.55	0.79	0.77	0.89	0.77	0.77	0.78	0.74
	(0.06)	(0.19)	(0.17)	(0.16)	(0.18)	(0.08)	(0.17)	(0.20)	(0.18)	(0.19)
Access to services index	0.89	0.52	0.41	0.61	0.58	0.83	0.58	0.62	0.60	0.52
	(0.15)	(0.19)	(0.19)	(0.23)	(0.23)	(0.20)	(0.23)	(0.27)	(0.24)	(0.21)
Consumer durables index	0.67	0.56	0.44	0.60	0.58	0.74	0.58	0.59	0.60	0.52
	(0.15)	(0.16)	(0.17)	(0.15)	(0.16)	(0.09)	(0.16)	(0.17)	(0.16)	(0.18)
Basic studying stationary	0.91	0.83	0.75	0.86	0.84	0.95	0.85	0.85	0.85	0.81
	(0.08)	(0.13)	(0.17)	(0.12)	(0.13)	(0.07)	(0.12)	(0.14)	(0.12)	(0.13)
Other home devices	0.36	0.09	0.04	0.16	0.13	0.53	0.13	0.21	0.16	0.08
	(0.33)	(0.18)	(0.10)	(0.25)	(0.23)	(0.29)	(0.23)	(0.29)	(0.25)	(0.15)
Household size	5.02	4.38	4.87	4.47	4.50	4.69	4.47	4.64	4.51	4.45
	(1.59)	(1.08)	(1.65)	(1.17)	(1.22)	(1.29)	(1.16)	(1.44)	(1.20)	(1.34)
Total male siblings	1.22	0.91	1.30	0.94	0.97	1.12	0.95	1.06	0.98	0.91
	(1.20)	(0.91)	(1.03)	(0.97)	(0.98)	(1.03)	(0.95)	(1.10)	(1.01)	(0.83)
15-year-old child										
Housing quality index	0.88	0.85	0.67	0.86	0.85	0.91	0.85	0.89	0.85	0.88
	(0.05)	(0.15)	(0.18)	(0.14)	(0.14)	(0.05)	(0.15)	(0.05)	(0.14)	(0.12)
Access to services index	0.98	0.68	0.42	0.74	0.73	0.84	0.73	0.76	0.75	0.68
	(0.06)	(0.20)	(0.14)	(0.21)	(0.22)	(0.15)	(0.22)	(0.21)	(0.21)	(0.24)
Consumer durables index	0.67	0.66	0.63	0.66	0.66	0.74	0.66	0.67	0.66	0.67
	(0.08)	(0.09)	(0.06)	(0.09)	(0.08)	(0.12)	(0.09)	(0.06)	(0.08)	(0.09)
Basic studying stationary	0.87	0.88	0.81	0.88	0.88	0.88	0.88	0.87	0.89	0.82
	(0.14)	(0.13)	(0.08)	(0.14)	(0.14)	(0.09)	(0.14)	(0.12)	(0.13)	(0.18)
Other home devices	0.79	0.59	0.42	0.63	0.61	0.80	0.62	0.66	0.63	0.62
	(0.27)	(0.26)	(0.14)	(0.28)	(0.27)	(0.25)	(0.28)	(0.26)	(0.27)	(0.30)
Household size	4.57	4.08	5.00	4.16	4.16	4.31	4.17	4.20	4.16	4.27
	(1.33)	(1.10)	(1.00)	(1.16)	(1.16)	(1.30)	(1.19)	(1.05)	(1.15)	(1.28)
Total male siblings	1.15	0.87	1.67	0.92	0.93	0.94	0.84	1.40	0.94	0.87
	(1.07)	(0.82)	(1.15)	(0.88)	(0.90)	(0.68)	(0.76)	(1.31)	(0.91)	(0.63)

having a mother with low education (disadvantaged groups) possess fewer facilities and goods at home than their peers in the respectively opposite groups. However, the home facilities do not significantly differ for two other categories of being more/less-able (measured by the top score in CDA Round 2) and early stunting/normal. Besides, observing the time trend from Round 3 to Round 5, there is a slight improvement in advantaged groups but significant progress in disadvantaged ones in all three sub-indices, namely housing quality, access to service, and consumer durables index.

In Todd and Wolpin [2003], the authors specifically discuss the inclusion of family income as a proxy for missing data of family investment together with other purchased inputs such as books and studying materials. This proxy is considered "problematic" under *ceteris paribus* - holding other inputs constant. If the number of studying materials increases while family income holds still, it means reducing other goods such as food or services. Considering this problem, I refrain from including household income as a proxy for other possible unobserved inputs.

Preferably, the time data should provide information on how much time parents use with children or interact, talk, and read for children. However, the YLS only provides time inputs on a broad scale, such as hours spent for schooling, hours spent studying outside schools, and hours of a child playing with no indication of the interaction with whom. The quality of the activities cannot be detected directly. The advantage of these time records is that they are on a daily basis (except for extra classes hours per week). As documented in Felfe et al. [2016], Cardoso et al. [2010], leisure activities with positive interaction, such as reading and studying, report a good impact on human capital accumulation.

Besides, I also include the number of hours spent in extra classes as the time inputs from family. Although there has been much public debate about the high cost and inequality of supplementary classes in Vietnam, the problem has not been appropriately tackled. As can be seen from table 2.2.2, the primary student spends 10 hours per week on average in extra classes, equivalent to half of the official hours in school. Private tutoring - referred to as *the shadow of Vietnam's education system* - is also a significant concern for policy purposes. On the one hand, it is considered the imbalance of demand and supply in education. In Dang [2013], three popular reasons for taking these supplementary classes are (i) keeping up with the class, (ii) studying for the examinations, and (iii) poor understanding of the lessons. Not to mention, supplementary tutoring imposes a heavy burden on households. The average cost for the private tutor of the wealthiest quintile can be 14 times more than that of the poorest quintile. The fees also increase sharply with education level, which is worrisome for many families.

On the other hand, the problem is closely related to inequality in education as the high-cost private tutor only favors the wealthier. The bias toward the privileged population could widen the gap and lower the probabilities of moving up the economic ladder. However, the impact of private tutoring is ambiguous. The mixed results vary from study to study. For example, Ha and Harpham [2005] finds that attending extra classes is not significantly related to improvement in writing and numeracy for 8-year-old children. The evidence only suggests that extra classes increase the probability of reading correctly. At the same time, Dang and Rogers [2008] reports a positive relationship between private tutoring and academic performance under certain assumptions.

Finally, using the quadratic term is ubiquitous in economic models to present the concavi ty and non-linear relationship over the distribution of arguments. Yet, according to Mcintosh and Schlenker [2006], the simple square term in the fixed-effect model is unable to measure "within-unit variation" as expected. The mis-specified model is biased. Consequently, the authors propose a 'hybrid estimator' as a cure. To maintain the model parsimony, I refrain from using square terms; hence, I assume that the marginal effects of the covariates remain the same across all the distribution of time-use.

2.3 School inputs

While there is a bulk of classroom quality research in industrialized countries, little is known about the developing country context. This section presents the overall schooling system in Vietnam and how the school inputs are constructed using the Young Lives School Survey.

Throughout most consideration of which measure suitable as the representative of school resources, the empirical researchers have focused mainly on the expenditure per student or the teacher's salary and the reduction of class-size or teacher/student ratios, based on the theory of class size Lazear [1999] and sometimes severe data limitations. Undoubtedly, considering the costs and benefits of change, policymakers are always concerned about how much should be invested. Nevertheless, there is a controversy of the determinants of school quality as raised in

Table 2.2.2: Descriptive Sample Statistics of Time use

	Urban	Rural	Minority	Majority	Caregiver l.edu	Caregiver h.edu	Less-able	More-able	Not stunting	Early Stunting
8-year-old child										
Hours/day studying outside school	3.20	3.68	3.27	3.62	3.57	4.08	3.61	3.53	3.61	3.50
	(1.21)	(1.38)	(0.94)	(1.39)	(1.36)	(1.29)	(1.36)	(1.38)	(1.34)	(1.49)
Hours/day spent sleeping	9.75	9.46	9.32	9.53	9.52	9.42	9.48	9.64	9.51	9.52
	(0.88)	(1.04)	(0.62)	(1.04)	(1.02)	(0.81)	(1.00)	(1.06)	(1.02)	(1.00)
Hours/day spent in leisure activities	5.09	5.29	5.08	5.27	5.27	4.81	5.28	5.14	5.20	5.55
	(1.63)	(1.44)	(1.44)	(1.48)	(1.47)	(1.58)	(1.47)	(1.49)	(1.49)	(1.36)
Hours/Week attended in extra classes	10.55	10.01	8.81	10.23	10.07	11.46	9.90	10.99	10.10	10.17
	(4.94)	(4.49)	(3.61)	(4.64)	(4.58)	(4.41)	(4.60)	(4.40)	(4.61)	(4.41)
Hours/day spent at school	5.81	4.68	4.75	4.91	4.90	5.06	4.91	4.86	4.92	4.82
	(1.76)	(0.82)	(0.75)	(1.18)	(1.14)	(1.55)	(1.16)	(1.15)	(1.19)	(0.94)
Travel time to school (in minutes)	8.36	14.83	18.30	13.18	13.75	8.43	13.41	14.33	13.28	15.21
	(5.05)	(10.98)	(10.05)	(10.36)	(10.50)	(5.53)	(9.96)	(12.23)	(9.79)	(13.26)
Hours/day hh chores	0.24	0.63	0.89	0.49	0.57	0.39	0.54	0.57	0.55	0.55
	(0.44)	(0.69)	(0.92)	(0.60)	(0.67)	(0.56)	(0.66)	(0.69)	(0.66)	(0.69)
Hours/day in domestic - farming business	0.00	0.12	0.51	0.03	0.11	0.00	0.09	0.14	0.07	0.24
	(0.00)	(0.60)	(1.24)	(0.25)	(0.57)	(0.00)	(0.53)	(0.59)	(0.45)	(0.88)
15-yeal-old child										
Hours/day spent studying outside school	4.51	3.16	2.50	3.44	3.36	4.25	3.43	3.39	3.55	2.60
	(1.07)	(1.26)	(0.87)	(1.34)	(1.30)	(1.53)	(1.30)	(1.53)	(1.33)	(1.04)
Hours/day spent sleeping	8.50	8.29	8.50	8.33	8.32	8.47	8.34	8.31	8.30	8.58
	(1.18)	(0.97)	(0.50)	(1.02)	(1.03)	(0.78)	(1.04)	(0.88)	(0.95)	(1.35)
Hours/day spent in leisure activities	4.20	3.63	4.00	3.74	3.73	3.91	3.74	3.75	3.72	3.90
	(1.40)	(1.75)	(1.00)	(1.71)	(1.70)	(1.75)	(1.72)	(1.63)	(1.71)	(1.68)
Hours/Week attended in extra classes	10.11	7.56	9.33	8.05	8.06	8.13	8.29	6.77	8.17	7.33
	(5.23)	(4.15)	(3.06)	(4.51)	(4.53)	(4.10)	(4.71)	(2.68)	(4.60)	(3.69)
Hours/day spent at school	5.16	6.46	6.13	6.21	6.23	5.83	6.25	5.98	6.20	6.27
	(0.39)	(1.48)	(1.16)	(1.44)	(1.41)	(1.60)	(1.48)	(1.15)	(1.40)	(1.68)
Travel time to school (in minutes)	11.33	17.78	21.00	16.38	16.63	15.00	16.33	17.40	16.08	19.84
	(5.45)	(8.21)	(18.15)	(7.70)	(8.25)	(6.69)	(7.74)	(10.00)	(7.75)	(10.28)
Hours/day spent in paid activity	0.42	0.75	0.69	0.68	0.75	0.28	0.65	0.80	0.68	0.70
	(2.10)	(2.45)	(2.18)	(2.42)	(2.48)	(1.70)	(2.36)	(2.51)	(2.39)	(2.36)
Hours/day in domestic - farming business	0.35	0.91	2.23	0.55	0.88	0.28	0.73	1.04	0.73	1.11
	(1.29)	(1.72)	(2.58)	(1.29)	(1.75)	(0.80)	(1.59)	(1.87)	(1.60)	(1.87)

Hanushek [2003] about significant differences in student outcomes from reduced class size and increased expenditure per student. Also, according to Hanushek [2010], among studies school inputs using per-pupil spending, there is only 27% showing a positive effect and 7% reporting the inefficiency or even harm of increasing resources. These mixed results suggest that simple class size policies could be generally ineffective.

The current education system in Vietnam has three levels: primary, secondary, and tertiary (post-secondary). Primary education consists of grade 1 to grade 5 for children aged 6 to 10. Secondary education includes lower secondary education, which covers grades 6 to 9 (for 11 to 14-year-old students), and upper secondary education, which consists of grades 10 to 12 (for 15 to 17-year-old students). The vast majority of pupils in Vietnam attend public primary and lower secondary schools near their living communities, which follow many national benchmarks such as standard curricula and textbooks. Despite extraordinary achievement in PISA assessment, the schooling system in Viet Nam is still struggling to provide the minimum infrastructure for students, such as ensuring good-quality walls, roofs, and floors for classrooms and adequate sanitation facilities. In terms of physical infrastructure, according to Education Sector Analysis[6], in the 2014-2015 academic year, the proportion of primary schools reaching national standard is only at 50%. The number decreased to 34.59% and merely at 20.45% for lower secondary and upper secondary education. The second noticeable point is that urban schools' student-class ratio is much higher than rural and mountainous areas. However, urban schools are more well-

[6] The Education Sector Analysis Report is produced by The Ministry of Education and Training, which focuses on general education with three key outcomes: access to education, competency-based learning towards development of students' capacities, and renovation of teaching methods to meet the requirements for education development for the 2011-2015 period. https://www.globalpartnership.org/content/education-sector-analysis-vietnam-2017

equipped and have more qualified teachers. In addition, there is an immigration influx from rural areas to the cities. In some remote and underdeveloped regions, the number of students in one class could shrink to less than ten students per class. This fact suggests that the mere student-class ratio can not reflect the quality of education in Vietnam.

Considering the current education status in Vietnam, I construct the school inputs comparable to the family inputs. Specifically, the schooling inputs I use in this analysis are constructed at the level of the child's classroom facilities, school access to services, and school learning-supporting devices. The construction of sub-indices is following:

- The school/class facilities index reflects the basic infrastructure of the class in terms of classroom-related comfort by looking at building of school and classroom. The classroom quality indicator is computed as the simple average of indicators : separate class room for different grades, class board, desk, map, cabin, light, fan. Each variable equals to 1 if school possess adequate device, 0 otherwise. All items having equal weighting in the index.
- School access-to-services index is a measure of the school's ability to meet functional requirements of learning environment. It is a simple average of several indicators: safe water[7], separate toilets for two genders, electricity, library service, internet, availability of non-compulsory classes. Each variable equals to 1 if school possess adequate service, 0 otherwise. All items having equal weighting in the index.
- School learning devices index is a measure of the school's ownership of learning-supporting items. The item should be in working condition. The index is a simple average of a set of variables indicating ownership: IT facilities, computer, radio, television (in primary schools), and additional laboratories (in secondary schools). Each variable equals to 1 if school possess adequate device, 0 otherwise. All items having equal weighting in the index.

In Ranjan and Geoffrey [2005], to cover the the late enrolment as well as regrade or temporary dropout,the author propose the schooling for age index, denoted as SAGE, is calculated by the formula:

$$SAGE = \frac{\text{the highest grade attainted by the child}}{\text{the childs age - 6}}$$

where 6 is the age that children start to enroll in primary school. The index ranges from zero to one, with zero if a child never went to school, one if a child perfectly achieve the required education level without late enrollment, and temporary or permanent dropout.

Nevertheless, I would argue that this index is not a good indicator for the loss year of education. To be more specific, a child enrolls one year late in Round 3, meaning that the current grade is Grade 2 instead of Grade 3 (SAGE= 0.5). When the child grows older, the SAGE increases as one year difference contributes less to the development progress (SAGE=9/10 in Round 5).

[7] I only consider School's own tap is the source of safe water according to safe drinking water ladder in WHO report (p.22) https://www.who.int/water_sanitation_health/monitoring/water.pdf

SAGE index increase even net loss of schooling year is unchanged. Correspondingly, I construct a new indicator in this paper: the actual late schooling year or temporary dropout year.

$$newSAGE = \text{(the childs age - 6) - the highest grade attainted by the child}$$

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Table 2.3.1: Descriptive Sample Statistics of School Inputs

	Urban	Rural	Minority	Majority	Caregiver l.edu	Caregiver h.edu	Less-able	More-able	Not stunting	Early Stunting
8-year-old child										
Facilities index	0.96	0.92	0.84	0.93	0.92	0.95	0.92	0.93	0.93	0.89
	(0.07)	(0.12)	(0.20)	(0.10)	(0.11)	(0.07)	(0.11)	(0.11)	(0.10)	(0.14)
Access to service index	0.94	0.60	0.60	0.67	0.66	0.84	0.67	0.65	0.67	0.64
	(0.11)	(0.17)	(0.27)	(0.20)	(0.21)	(0.17)	(0.20)	(0.25)	(0.21)	(0.22)
Teaching devices index	0.07	0.03	0.02	0.04	0.03	0.10	0.04	0.02	0.04	0.03
	(0.13)	(0.10)	(0.07)	(0.11)	(0.10)	(0.17)	(0.11)	(0.09)	(0.11)	(0.10)
Loss schooling year for age	-0.07	-0.11	-0.03	-0.11	-0.11	-0.01	-0.11	-0.09	-0.10	-0.13
	(0.39)	(0.36)	(0.35)	(0.36)	(0.37)	(0.32)	(0.36)	(0.39)	(0.36)	(0.38)
Number of students in class	37.50	26.72	19.25	29.62	28.62	34.54	28.70	29.28	29.29	26.21
	(7.30)	(6.59)	(7.38)	(7.47)	(7.89)	(8.28)	(7.92)	(8.14)	(7.92)	(7.67)
Ethnic minority students in class	0.10	2.05	12.67	0.74	1.70	0.71	1.54	2.27	1.40	3.16
	(0.30)	(4.93)	(7.39)	(2.48)	(4.55)	(1.99)	(4.21)	(5.53)	(4.08)	(6.09)
Travel time to school (in minutes)	8.36	14.83	18.30	13.18	13.75	8.43	13.41	14.33	13.28	15.21
	(5.05)	(10.98)	(10.05)	(10.36)	(10.50)	(5.53)	(9.96)	(12.23)	(9.79)	(13.26)
Hours/day spent at school	5.81	4.68	4.75	4.91	4.90	5.06	4.91	4.86	4.92	4.82
	(1.76)	(0.82)	(0.75)	(1.18)	(1.14)	(1.55)	(1.16)	(1.15)	(1.19)	(0.94)
Child's age at start of grade 1	5.66	5.57	5.62	5.58	5.58	5.63	5.59	5.58	5.58	5.66
	(0.59)	(0.71)	(0.94)	(0.64)	(0.70)	(0.56)	(0.67)	(0.76)	(0.69)	(0.70)
Enrollment rate	0.99	0.99	0.96	1.00	0.99	1.00	0.99	0.98	0.99	0.99
	(0.07)	(0.10)	(0.20)	(0.07)	(0.10)	(0.07)	(0.09)	(0.13)	(0.09)	(0.12)
Qualified teacher	0.96	0.94	0.89	0.95	0.94	0.98	0.94	0.96	0.95	0.91
	(0.20)	(0.24)	(0.32)	(0.22)	(0.24)	(0.13)	(0.24)	(0.20)	(0.22)	(0.29)
Teacher with university education	0.37	0.23	0.10	0.28	0.26	0.28	0.25	0.27	0.26	0.25
	(0.48)	(0.42)	(0.30)	(0.45)	(0.44)	(0.45)	(0.44)	(0.45)	(0.44)	(0.43)
Average teacher experience in school	16.54	16.44	18.66	16.28	16.47	16.41	16.54	16.10	16.40	16.67
	(4.95)	(6.83)	(7.72)	(6.38)	(6.61)	(5.55)	(6.63)	(5.99)	(6.34)	(7.10)
8-year-old child										
Facilities index	0.87	0.93	0.94	0.92	0.92	0.89	0.93	0.89	0.92	0.94
	(0.04)	(0.08)	(0.12)	(0.08)	(0.08)	(0.07)	(0.08)	(0.09)	(0.08)	(0.08)
Access to service	0.58	0.64	0.75	0.62	0.62	0.66	0.64	0.56	0.62	0.65
	(0.22)	(0.12)	(0.06)	(0.15)	(0.15)	(0.16)	(0.13)	(0.21)	(0.15)	(0.11)
Teaching devices	0.07	0.17	0.22	0.15	0.15	0.13	0.16	0.14	0.16	0.13
	(0.02)	(0.15)	(0.18)	(0.14)	(0.14)	(0.14)	(0.14)	(0.14)	(0.14)	(0.13)
Loss schooling year for age	-0.29	-0.25	-0.25	-0.26	-0.25	-0.30	-0.26	-0.28	-0.25	-0.31
	(0.57)	(0.46)	(0.46)	(0.48)	(0.48)	(0.47)	(0.48)	(0.50)	(0.48)	(0.47)
Number of students in class	40.54	40.29	37.80	40.41	40.31	40.71	40.43	39.87	40.34	40.30
	(1.06)	(2.53)	(4.40)	(2.20)	(2.36)	(1.69)	(2.28)	(2.47)	(2.29)	(2.56)
Ethnic minority students in class	0.19	1.89	20.73	0.99	1.58	1.27	1.62	1.26	1.28	3.72
	(0.35)	(5.82)	(6.65)	(4.02)	(5.31)	(4.62)	(5.19)	(5.66)	(4.67)	(8.35)
Travel time to school (in minutes)	11.33	17.78	21.00	16.38	16.63	15.00	16.33	17.40	16.08	19.84
	(5.45)	(8.21)	(18.15)	(7.70)	(8.25)	(6.69)	(7.74)	(10.00)	(7.75)	(10.28)
Hours/day spent at school	5.16	6.46	6.13	6.21	6.23	5.83	6.25	5.98	6.20	6.27
	(0.39)	(1.48)	(1.16)	(1.44)	(1.41)	(1.60)	(1.48)	(1.15)	(1.40)	(1.68)
Enrollment rate	0.90	0.78	0.65	0.83	0.78	0.95	0.81	0.79	0.82	0.77
	(0.30)	(0.41)	(0.48)	(0.37)	(0.41)	(0.22)	(0.39)	(0.41)	(0.39)	(0.42)
Qualified English teacher	1.00	0.98	0.88	0.99	0.98	1.00	0.99	0.96	0.99	0.97
	(0.00)	(0.13)	(0.35)	(0.10)	(0.13)	(0.00)	(0.09)	(0.20)	(0.11)	(0.18)
Qualified Math teacher	1.00	0.99	1.00	0.99	0.99	1.00	0.99	1.00	0.99	1.00
	(0.00)	(0.09)	(0.00)	(0.09)	(0.09)	(0.00)	(0.09)	(0.00)	(0.09)	(0.00)
Average English teacher experience in school	13.31	13.16	7.49	13.33	12.73	15.69	13.62	11.36	13.54	11.70
	(4.99)	(6.00)	(4.38)	(5.79)	(5.87)	(4.97)	(5.69)	(6.10)	(5.79)	(5.80)
Average Math teacher experience in school	14.99	13.90	13.52	14.10	13.73	16.10	14.56	12.13	14.48	12.47
	(5.42)	(7.55)	(9.40)	(7.18)	(7.47)	(5.30)	(7.09)	(7.53)	(7.02)	(7.87)

Table 2.3.1 reports the mean values of the variables representing for school inputs. In general, there are no evident differences in the basic facilities index among categories in primary and secondary education. That said, most surveyed schools achieved the minimum national standard of infrastructure. However, only a slight difference in access to service and teaching device index is seen among group of advantage or disadvantage. At the primary level, all advantaged groups receive more resources. Surprisingly, the resources distributed to the underprivileged are more than the privileged at the secondary level. For example, the average access-to-service index is 0.58 in urban areas but 0.64 in rural sites. Likewise, access-to-service and teaching devices indices are substantially higher for minority groups.

Nevertheless, the dropout rate of minority students is worrisome. Only 65% of surveyed minority students in the survey still enrolled at any upper secondary school in 2016. In comparison, the average enrollment rate for other groups hovers around 80%. The two groups with the lowest dropout rate are the urban group and children with well-educated caregivers. One noteworthy characteristic of dropout minority students observed from table 2.2.2 is that travel time to school and time for doing domestic and farming activities increase substantially together with large variance from primary to secondary education. These numbers implicitly suggest that there is hidden heterogeneity between minority students and the majority and even within minority society.

As discussed in section 2.2, the Young Lives Study does not provide information on the quality of interaction between children, parents, teachers, and students. The time input of school simply counts the time spent in schools without providing information of instruction styles, such as big group instruction, small group instruction, or individual instruction. The seat time in school might not entirely reflect how human capital is accumulated. The number of hours spent at school in table 2.2.2 differs insignificantly among groups. This time variable alone can not fully control the unobserved heterogeneity of learning quality. One conventional proxy for a high-quality classroom is teacher salary. Nevertheless, Vietnam's schooling system has a standard compensation applied for all teachers and varies slightly by location. In addition, data on teacher salaries and benefits are not readily available. For this reason, I add the teaching experience as one measure of teacher quality. I assume that experienced teachers are more likely to provide better lectures. However, teachers are likely to be changed between two semester of an academic year. As a result, I use the average teaching experience in a grade to represent the teaching quality of that grade in each school. Still, average numbers can potentially hide inevitable heterogeneity.

Chapter 3

Conceptual Framework and Identification Assumptions

3.1 Education Production Function

The production function of cognitive skill provides a good starting point to define estimating equation, I follow Todd and Wolpin [2007, 2003] in writing a child's skill level at time t as a function of the level of inputs from family and school, and other observed child characteristics.

$$A_{it} = f(I_{it}^{j}, X_{it}, \mu_i) \qquad t = 1, 2, ...T \tag{3.1}$$

where A_{it} denotes a child i ability at time t, I_{it}^{j} denotes investment or input for the child i at time t from source of input $j = H, S$. $j = H$ means inputs from family (Home Input) such as home facilities and studying materials. $j = S$ is school inputs, including school service and facilities. X_{it} is other time-varying impact factors (.e.g child's health). μ_i is the variable that embodies unobserved individual-specific traits, such as innate endowment, or mental capacity and parenting practices and styles. And $f(.)$ is the skill production technology.

With the usual data set, the researchers do not observe the true cognitive ability A_{it} but have the information of test score of skill. The relation of test score and child's ability follows a classical error component model.

$$T_{it} = A_{it} + \epsilon_{it} \tag{3.2}$$

where T_{it} denotes a child i test score at time t, ,ϵ_{it} is the idiosyncratic shocks of child i at time t. The production function now can be written as:

$$T_{it} = f(I_{it}^{j}, X_{it}, \mu_i, \epsilon_{it}) \qquad t = 1, 2, ...T \tag{3.3}$$

In the ordinary least squares estimation, the researchers usually impose the orthogonality assumption to consistently estimate the impact of observed investment with unobserved traits and other missing data.

$$T_{it} = f(I_{it}^{j}, X_{it}, e_{it})$$

$$\mathbb{E}(e_{it}|I_{it}^{j}, X_{it}) = 0$$

In this assumption, e_{it} is the error, including latent capability, omitted variable and random shock. $e_{it} = \mu_i + \epsilon_{it}$. This model asserts that included inputs have no association with the unobserved traits and that, there is no confounder between inputs and learning achievement. However, this model is inconsistent with the economic theory of sorting or self-selection, especially parental behavior with their children's cognitive development. Parents care for their children and want to maximize their cognitive development by purchasing goods and investing parental time. I now study the within-child fixed effect model to deal with the classic problems of omitted variables bias and endogeneity.

3.2 Key Identification Assumptions

In this section, I impose three critical assumptions maintained throughout the rest of the paper and discuss two alternative assumption on exogeneity. For illustration purposes, I use the contemporaneous specification, which will be discussed in section 3.3. By breaking down investment by parents and schools, the contemporaneous production function is:

$$T_{it} = \alpha X_{it} + \beta^H I^H_{it} + \beta^S I^S_{it} + \gamma \mu_i + \eta_{it} \tag{3.4}$$

where η_{it} is a residual term of individual i at time t, including the effect of omitted inputs and random shocks.

- Assumption 1: The technology for skill production is identical for all stages, which means:

  $$\alpha_t = \alpha_s, \beta^H_t = \beta^H_s, \beta^S_t = \beta^S_s, \gamma_t = \gamma_s \quad \text{with t} \neq s \tag{3.5}$$

  This assumption can be understood as all inputs have the same impact on skill production all time. Consequently, the impact of the endowment on child achievement is also age-independent. This assumption puts a strong restriction on the production function.

- Assumption 2: There are no time-varying confounders, and the observed inputs are uncorrelated with omitted missing inputs. As no data set is complete, this second assumption ameliorates problems of omitting inputs of schools and families.

  $$\begin{aligned} T_{it} - T_{it-1} = \alpha(X_{it} - X_{it-1}) + \beta^H(I^H_{it} - I^H_{it-1}) + \\ \beta^S(I^S_{it} - I^S_{it-1}) + \gamma(\mu_i - \mu_i) + (\eta_{it} - \eta_{it-1}) \end{aligned} \tag{3.6}$$

  With this assumption, the differenced included inputs are orthogonal to differenced omitted inputs, or those omitted inputs are time-invariant and therefore eliminated by the differencing. The inputs now are allowed to be correlated with unobserved child endowment or omitted inputs, which do not vary over time.

- Assumption 3: In addition, ϵ_{it} is identically and independently distributed across skill test score, individual with zero mean and variance σ^2_ϵ. Together with two above assumptions

1- 2, after taking differencing, we have

$$\mathbb{E}(\epsilon_{it} - \epsilon_{it-1}) = 0$$

Correspondingly, the error term in fixed-effect model possess ideal properties: constant variance and zero covariance.

Besides, the exogeneity conditions of inputs are needed, I consider two cases as follows:

- *Assumption I1*: The strict exogeneity of the disturbance term

$$\mathbb{E}(\epsilon_{it}|I_i^j, X_i) = 0$$

This assumption can be understood:

(i) The current treatment I_{it}^j is not correlated with past shock ϵ_{is} with $s \leq t$ or the past outcomes do not directly affect current treatment. This case rules out feedback effects. To better understand, take a random experiment for any individual i, parents assign a random treatment I_{i1}^j in the first period and continue to randomize the future treatment without taking any consideration on the past achievements. This assumption is also equal to the parental behavior of no compensation or reinforcement.
(ii) Current treatment is uncorrelated with current shock. Same as (i), individual are assigned current random inputs, which are not adjusted according to contemporaneous observed shock.
(iii) Past treatments do not directly affect current outcome.

- *Assumption I2*: Predetermined regressors As the strict exogeneity is a strong assumption. It is not is very plausible in consideration of recent literature of the dynamic relationship between inputs and parent behaviors. Thus, the assumption is relaxed.

$$\mathbb{E}(X_{it-s}\epsilon_{it}) = 0 \text{ for all s } \geq 0$$

The difference between strictly exogeneous and predetermined regressors is that in *assumption I1* we have (i) - (iii) but in this case we only have (ii) - (iii). That said, the treatment I_{it}^j is allowed to be correlated with past shocks, but uncorrelated with contemporaneous and future shocks.

3.3 Alternative Specifications

In this section, I discuss three alternative specifications, which are usually adopted in child development model.

Contemporaneous Specification

This specification assumes that only contemporaneous inputs matter to the production of current achievement. Applying the assumption 1 - 3 to the equation 3.4, I have the estimating equation as follows:

$$\begin{aligned} T_{it} - T_{it-1} = \alpha_t(X_{it} - X_{it-1}) + \beta_t^H(I_{it}^H - I_{it-1}^H) + \\ \beta_t^S(I_{it}^S - I_{it-1}^S) + (\epsilon_{it} - \epsilon_{it-1}) \end{aligned} \tag{3.7}$$

The parameter of investment can be interpreted as the average of the contemporaneous impact of I_{it}^j to test score T_{it}. For consistency, this estimation requires the assumption that time differences in observed inputs are uncorrelated with time differences in unobserved inputs and the idiosyncratic shock. The strict exogeneity ensures unbiased explanatory variables. But when the regressors are predetermined, although I_{it}, I_{it-1} and ϵ_t uncorrelated, the differences terms - ΔI_{it} $\Delta\epsilon_{it}$ - are correlated. The relation is as follows:

$$\begin{aligned} \mathbb{E}(\Delta I_{it}\Delta\epsilon_{it}) = \mathbb{E}(I_{it}\epsilon_{it}) - \mathbb{E}(I_{it-1}\epsilon_{it}) + \mathbb{E}(I_{it-1}\epsilon_{it-1}) \\ -\mathbb{E}(I_{it}\epsilon_{it-1}) = -\mathbb{E}(I_{it}\epsilon_{it-1}) \neq 0 \end{aligned} \tag{3.8}$$

In other words, if family or school inputs observe and respond to the shock of past achievement, the within-child fixed-effect and first differencing are biased. For this problem, it is suggested to use Arellano-Bond Estimator with the instrument set $(I_{i1}, I_{i2}, ..., I_{it-1})$ for the correlated differenced terms. However, the literature results show mixed evidence on feedback effect in within-child fixed-effect cases (or spillover effects in siblings fixed-effects). As previously stated inMitchell et al. [2020], the findings show that parental investment does not respond to a child's past achievement but is influenced by the household's socio-economic conditions. At the same time, other studies using sibling fixed-effect (Qureshi [2018], Black et al. [2021] confirm significant education spillovers, which also means parents react to the revealed human capital of their children. In this paper, given ambiguous evidence and some data limitations, I leave the estimation of predetermined regressors for future works and assume the strict exogeneity on inputs from this point onwards.

Cumulative Specification

As noted previously, most recent theories of child development show important links between early childhood experiences and later cognitive development. In this section, I consider the dynamic model in a panel framework with one-period lagged inputs.

$$\begin{aligned} T_{it} = \alpha_t X_{it} + \alpha_{t-1}X_{it-1} + \beta_t^H I_{it}^H + \beta_{t-1}^H I_{it-1}^H + \\ \beta_t^S I_{it}^S + \beta_{t-1}^S I_{it-1}^S + \gamma_t\mu_i + \eta_{it} \end{aligned} \tag{3.9}$$

Then adopt the assumption 1-3 and take the time difference of each individual:

$$\begin{aligned} T_{it} - T_{it-1} = \alpha_t(X_{it} - X_{it-1}) + \alpha_{t-1}(X_{it-1} - X_{it-2}) + \\ \beta_t^H(I_{it}^H - I_{it-1}^H) + \beta_{t-1}^H(I_{it-1}^H - I_{it-2}^H) + \\ \beta_t^S(I_{it}^S - I_{it-1}^S) + \beta_{t-1}^S(I_{it-1}^S - I_{it-2}^S) + \\ (\epsilon_{it} - \epsilon_{it-1}) \end{aligned} \tag{3.10}$$

The analysis of consistency for coefficient of at time t is analogous with what has been done in equation 3.8. With other lagged input covariates, the predetermined regressor still ensure unbiased estimations.

Value-added Specification

Due to data limitations on past inputs, the researchers usually adopt value-added specifications with lagged dependent variables. The assumption here is that the lagged performance absorbs all historical inputs and can represent as *sufficient statistic* for the omitted and missing data. The most common form is the value-added one-period dependence variable and contemporaneous inputs.

$$T_{it} = \rho T_{it-1} + \alpha X_{it} + \beta^H I_{it}^H + \beta^S I_{it}^S + \gamma \mu_i + \eta_{it} \tag{3.11}$$

where ρ as the persistence coefficient. There are two cases for ρ

- If $\rho = 1$ or there is perfect persistence then the gain in test score is the contribution of contemporaneous inputs or $T_{it} - T_{it-1} = \alpha X_{it} + \beta^H I_{it}^H + \beta^S I_{it}^S + \mu_i \eta_{it}$
- If $\rho \neq 1$ in this case the assumption requires all coefficients of observed inputs and the endowment geometrically decline at the same rate, i.e., $\alpha_t = \rho \alpha_{t-1}$ as presented in Todd and Wolpin [2007]

To eliminates the fixed effect μ_i, I am still using previously stated assumptions (1) - (3). Thus, differencing the lagged dependent variable specification yields.

$$\begin{aligned} T_{it} - T_{it-1} = \rho(T_{it-1} - T_{it-2}) + \alpha_t(X_{it} - X_{it-1}) + \\ \beta_t^H(I_{it}^H - I_{it-1}^H) + \beta_t^S(I_{it}^S - I_{it-1}^S) + \\ (\epsilon_{it} - \epsilon_{it-1}) \end{aligned} \tag{3.12}$$

Despite assuming the strict exogeneity, the transformation 3.12 induces another problem. The trouble is that there is a negative correlation between differenced regressor and error by construction (T_{it-1} is correlated with ϵ_{it-1}). Again, the linear moment condition follow Arellano and Bond [1991] provides a solution after differencing 3.11. In this paper, I focus on the impacts of inputs on learning achievement so ignore the biases in persistence estimates

Chapter 4

Results and Discussions

This chapter examines how differences in home and school inputs affect cognitive development among advantaged and disadvantaged children using within-child fixed effects in the contemporaneous and value-added specification. I first begin by briefly discussing estimates of the effect of family and school inputs and then the implications of the results. For simplicity, I only report the home and school coefficients. I present the nested effect of family and school inputs interacting with the indicator of advantages or disadvantages (X variables). All tables give the estimates under the assumption that inputs are strictly exogenous.

4.1 Estimated Impacts by Contemporaneous Specification

In tables 4.1.1 and 4.1.2, I present the estimates of contemporaneous specification in equation 3.6. In general, the results suggest that the increase in non-basic learning materials at home, household durables, and access to service are associated with improving PPVT test performance in advantaged and disadvantaged groups. Likewise, improving school teaching devices and access to services positively impact children's learning. As shown in Table 4.1.1, a 10-point increase in access-to-service at home would lead to an increase of 1.27, 1.61, 1.37, and 1.31 in the percentile score for rural students, females, being early stunting and having low-educated mother students, respectively. The coefficients associated with the non-basic learning materials at home (calculator, computer, and internet) also show significantly positive signs. Besides, time use in studying outside school also shows a positive effect but is statistically insignificantly different from zero.

In contrast, the time investment for extra classes even has (insignificantly) adverse impacts on achievement except for the group of students who have a well-educated mother. In particular, 5 hours more per week for private tutor classes would help increase 3.84 percent in the PPVT test score. Another, perhaps surprising, result is that a one-year loss of schooling would cost the group having well-educated caregivers 9.57 percent points but would not significantly affect the opposite peer group. At first, this result seems illogical as children with well-educated caregivers could expect to be less affected by a one-year loss of schooling. However, consider from another angle, this is briefly identifying that students are more dependent on caregiver's instruction outside school, especially well-educated caregivers. In other words, one year more of schooling would increase PPVT test scores substantially for the child with high ability mother.

Overall, the estimated effect of all explanatory variables seems to have the expected sign, which

Table 4.1.1: The impact of family input by advantage status
Specification: Contemporaneous

	(1) UrbanSite	(2) Majority	(3) Moreable	(4) Female	(5) Stunting	(6) Caregiver Edu.
X=0 × Housing quality index	0.0654	1.497***	0.0504	-0.0107	0.0729	0.0447
	(0.178)	(0.000)	(0.357)	(0.909)	(0.147)	(0.394)
X=1 × Housing quality index	-0.146	0.0592	0.152	0.0867	-0.111	0.134
	(0.697)	(0.225)	(0.080)	(0.135)	(0.526)	(0.143)
X=0 × Access to services index	0.127*	-1.070***	0.101	0.0687	0.137**	0.131*
	(0.010)	(0.000)	(0.060)	(0.294)	(0.008)	(0.010)
X=1 × Access to services index	-0.0980	0.113*	0.166	0.161**	0.0897	-0.143
	(0.575)	(0.019)	(0.111)	(0.007)	(0.357)	(0.271)
X=0 × Consumer durables index	0.141*	-1.717***	0.174*	0.297**	0.0728	0.167*
	(0.045)	(0.000)	(0.026)	(0.004)	(0.344)	(0.019)
X=1 × Consumer durables index	0.279	0.169*	0.0474	0.0436	0.497**	-0.140
	(0.199)	(0.018)	(0.771)	(0.622)	(0.001)	(0.463)
X=0 × Basic home learning materials	-0.000217	-2.207***	-0.0414	-0.00213	-0.0209	-0.0409
	(0.997)	(0.000)	(0.514)	(0.986)	(0.759)	(0.494)
X=1 × Basic home learning materials	-0.281	-0.0336	0.0363	-0.0393	-0.0312	-0.0200
	(0.085)	(0.563)	(0.781)	(0.523)	(0.744)	(0.922)
X=0 × Other home learning materials	0.0892*	0.734***	0.121***	0.112**	0.117***	0.109***
	(0.011)	(0.000)	(0.000)	(0.002)	(0.001)	(0.001)
X=1 × Other home learning materials	0.225***	0.112***	0.0927	0.124**	0.112	0.190***
	(0.000)	(0.000)	(0.180)	(0.003)	(0.064)	(0.001)
X=0 × Hours/week extra classes	-0.0539	-0.827*	0.134	0.128	0.0663	-0.0665
	(0.774)	(0.014)	(0.501)	(0.628)	(0.712)	(0.721)
X=1 ×Hours/week extra classes	0.201	0.0795	-0.119	-0.0136	0.0544	0.768*
	(0.591)	(0.633)	(0.639)	(0.944)	(0.898)	(0.014)
X=0 × Hours/day studying outside school	0.233	0	0.508	0.605	0.561	0.738
	(0.710)	(.)	(0.453)	(0.491)	(0.403)	(0.257)
X=1 × Hours/day studying outside school	4.205*	0.490	0.210	0.371	1.109	-0.119
	(0.012)	(0.422)	(0.865)	(0.616)	(0.395)	(0.923)
Observations	737	737	737	737	737	737

Within-child fixed-effects estimates. Robust standard errors in parentheses. Clustered standard errors by childid in brackets. *** $p<0.01$, ** $p<0.05$, * $p<0.10$. Child controls include all home inputs and school inputs and time use and height-for-age Z-score.
X variables represent the interaction of invariant advantage or disadvantage status. For example, the results in column (1) X is Urban location. (2) The majority is the majority group - Kinh people. (3) The more-able is defined as a child at the top decile of the CDA test at 5-year-olds. (4) Female group. (5) The stunting is the group of children suffering early stunts at first 5-year-olds. (6) The children with well-educated caregivers who finished at least upper secondary education.
Dependant variable: Percentage score PPVT

is in line with other studies, except in the case of the minority group. The increased home index, namely consumer durable score and access to service over time, strongly negatively affects child development. In particular, a 10-point increase in service score, consumer durables, and primary learning material would lead to 10.7, 17.2, and 22.1 decreases in the PPVT percentile score. A potential explanation for these inverse impacts is the unusually high dropout rate of minority students, as presented in Chapter 2. Only 65% minority students in the sample still enrolled in upper secondary level, compared to 80% on average. As presented in Tam et al. [2013], the dropout 15-year-old children are likely to engage in economic activity, including unpaid family farming and domestic tasks or paid work, and there is a strong positive correlation between the asset index and participation in unpaid work by dropout children. Consequently, even household assets increase, the child's cognitive development decreases. Thus, it is not simply that higher wealth accumulation would mean increased human capital.

Table 4.1.2: The impact of school inputs by advantage status
Specification: Contemporaneous

	(1) UrbanSite	(2) Majority	(3) Moreable	(4) Female	(5) Stunting	(6) Caregiver Edu.
X=0 × Facilities index	0.136	1.108***	-0.0894	-0.0870	-0.253*	-0.0359
	(0.187)	(0.000)	(0.347)	(0.473)	(0.022)	(0.697)
X=1 × Facilities index	-0.432	-0.0578	-0.000462	-0.0384	0.371*	-0.610
	(0.059)	(0.534)	(0.998)	(0.765)	(0.016)	(0.143)
X=0 × School access to service index	0.170**	-0.451	0.0418	0.0516	0.0122	-0.000727
	(0.003)	(0.063)	(0.310)	(0.373)	(0.763)	(0.986)
X=1 × School access to service index	-0.0619	-0.0330	-0.0728	-0.0476	0.0197	0.155
	(0.491)	(0.452)	(0.349)	(0.337)	(0.813)	(0.115)
X=0 × Teaching devices index	0.299***	-0.0429	0.337***	0.303***	0.319***	0.332***
	(0.000)	(0.364)	(0.000)	(0.000)	(0.000)	(0.000)
X=1 × Teaching devices index	0.381***	0.322***	0.316***	0.373***	0.356***	0.315***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
X=0 × Hours/day spent at school	0.630	6.998*	-0.395	-0.0291	0.217	-0.452
	(0.451)	(0.022)	(0.629)	(0.975)	(0.809)	(0.572)
X=1 × Hours/day spent at school	-2.621	0.627	-0.463	-0.610	-1.276	-0.241
	(0.091)	(0.541)	(0.752)	(0.518)	(0.163)	(0.885)
X=0 × Loss schooling year	-1.214	16.65***	-1.340	3.535	-1.290	0.876
	(0.648)	(0.000)	(0.644)	(0.372)	(0.667)	(0.766)
X=1 × Loss schooling year	9.413	-1.192	2.944	-5.160	-2.619	-9.571*
	(0.214)	(0.698)	(0.621)	(0.130)	(0.654)	(0.039)
X=0 × Average teaching experience	-0.214	0	-0.135	-0.462	-0.125	-0.239
	(0.185)	(.)	(0.443)	(0.065)	(0.489)	(0.163)
X=1 × Average teaching experience	1.169	-0.234	-0.379	0.0840	-0.0841	0.735
	(0.141)	(0.224)	(0.342)	(0.651)	(0.707)	(0.201)
Observations	737	699	737	737	737	737

Within-child fixed-effects estimates. Robust standard errors in parentheses. Clustered standard errors by childid in brackets. *** p<0.01, ** p<0.05, * p<0.10. Child controls include all home inputs and school inputs and time use and height-for-age Z-score.
X variables represent the interaction of invariant advantage or disadvantage status. For example, the results in column (1) X is Urban location. (2) The majority is the majority group - Kinh people. (3) The more-able is defined as a child at the top decile of the CDA test at 5-year-olds. (4) Female group. (5) The stunting is the group of children suffering early stunts at first 5-year-olds. (6) The children with well-educated caregivers who finished at least upper secondary education.
Dependant variable: Percentage score PPVT

4.2 Estimated Impacts by Value-added specification

Moving to the dynamic panel estimators, as discussed in Chapter 3, the basic idea behind this specification is that lagged achievement will capture the contribution of all previous inputs and shocks. Compared to the contemporaneous specification, the value-add model is more demand-

Table 4.2.1: The impact of home inputs by advantage status
Specification: Value-added with one-period-lagged value

	(1) UrbanSite	(2) Majority	(3) Moreable	(4) Female	(5) Stunting	(6) Caregiver Edu.
Lagged test score	0.453***	0.452***	0.468***	0.458***	0.454***	0.458***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
X=0 × Housing quality index	0.0110	0.238	0.0143	0.0168	0.0213	-0.00919
	(0.834)	(0.502)	(0.807)	(0.829)	(0.691)	(0.867)
X=1 × Housing quality index	-0.0922	0.00881	0.0687	0.00519	-0.142	0.0128
	(0.800)	(0.864)	(0.413)	(0.935)	(0.390)	(0.848)
X=0 × Access to services index	0.0957*	-0.0972	0.0454	0.0318	0.0929*	0.104*
	(0.032)	(0.644)	(0.331)	(0.578)	(0.042)	(0.024)
X=1 × Access to services index	-0.0905	0.0845	0.238*	0.125*	0.0637	-0.139
	(0.605)	(0.053)	(0.014)	(0.034)	(0.495)	(0.293)
X=0 × Consumer durables index	0.0637	-0.267	0.125	0.183	0.0130	0.0926
	(0.315)	(0.366)	(0.087)	(0.053)	(0.853)	(0.144)
X=1 × Consumer durables index	0.400	0.0920	-0.174	0.00225	0.382**	-0.105
	(0.062)	(0.164)	(0.238)	(0.977)	(0.003)	(0.614)
X=0 × Basic home learning materials	-0.00536	-0.456	-0.0283	0.00191	-0.00925	-0.0477
	(0.922)	(0.257)	(0.600)	(0.986)	(0.879)	(0.374)
X=1 × Basic home learning materials	-0.125	-0.0227	0.0589	-0.0397	-0.0559	0.215
	(0.495)	(0.660)	(0.652)	(0.454)	(0.553)	(0.210)
X=0 × Other home learning materials	-0.0163	0.152	-0.0170	-0.0293	0.00265	-0.0141
	(0.633)	(0.068)	(0.614)	(0.401)	(0.936)	(0.658)
X=1 × Other home learning materials	0.0616	-0.00808	0.00370	0.0192	-0.0555	0.0898
	(0.378)	(0.802)	(0.952)	(0.659)	(0.411)	(0.157)
X=0 × Hours/week extra classes	0.0557	0	0.166	0.0633	0.122	0.0298
	(0.687)	(.)	(0.313)	(0.760)	(0.411)	(0.840)
X=1 × Hours/week extra classes	0.226	0.125	0.212	0.207	0.103	0.718*
	(0.548)	(0.369)	(0.416)	(0.258)	(0.810)	(0.029)
X=0 × Hours/day studying outside school	0.158	0	0.146	0.168	0.301	0.405
	(0.777)	(.)	(0.818)	(0.824)	(0.595)	(0.487)
X=1 × Hours/day studying outside school	0.756	0.145	-0.928	-0.108	-0.445	-0.938
	(0.646)	(0.792)	(0.395)	(0.875)	(0.727)	(0.374)
Observations	670	670	670	670	670	670

Within-child fixed-effects estimates. Robust standard errors in parentheses. Clustered standard errors by childid in brackets. *** $p<0.01$, ** $p<0.05$, * $p<0.10$. Child controls include all home inputs and school inputs and time use and height-for-age Z-score.
X variables represent the interaction of invariant advantage or disadvantage status. For example, the results in column (1) X is Urban location. (2) The majority is the majority group - Kinh people. (3) The more-able is defined as a child at the top decile of the CDA test at 5-year-olds. (4) Female group. (5) The stunting is the group of children suffering early stunts at first 5-year-olds. (6) The children with well-educated caregivers who finished at least upper secondary education.
Dependant variable: Percentage score PPVT

ing in data requirement. First, the results of the lagged score confirm a strong relationship with current achievement. The persistent rate is significantly lower than one, rejecting the hypothesis perfect persistence $\rho = 1$. In addition, the results from column (6) table 4.2.1 again indicate strong support for the hypothesis that mothers who completed at least 12 grades of schooling are more successful in helping children to acquire cognitive skills than mothers who have not completed high school. As shown in column (6), students with well-educated caregivers can increase 3.59 percent point by 5 hours more per week in extra classes. This evidence is compatible with the role of caregiver's education in many other the literature(Estrada et al. [1987], Murnane et al. [1981], Todd and Wolpin [2003], Raikes et al. [2006]. That said, mothers with higher education acquire more cognitive skills themselves, provide better-qualified guidance, and allocate resources to fulfill children's needs successfully.

As seen from table 4.2.1 and 4.2.2, the second noticeable point is that the impact of school and home input of minority groups is still negative even though insignificant. This evidence confirms the association between the asset index and the household's economic participation of young minority people. In other words, these results suggest that differences between schools, while undoubtedly playing some role, are unlikely to mean improvement in cognitive skills of children's educational progress.

Last but not least, the estimated covariates in value-added specification reveal little or indistinguishable from zero effects that current home and school inputs impact on a child's development. Compared to the previous specification, the contemporaneous input estimates in table 4.2.1 and 4.2.2 fall and become insignificant, which also signals that omitting historical inputs would lead to biases the current input estimates upward. However, remember that the model relies on the within-variation; the small time-varying regressors could be reduced its estimated impact compared to other highly varying variables. The effect is there, but the model may fail to detect it.

Table 4.2.2: The impact of school inputs by advantage status
Specification: Value-added with one-period-lagged value

	(1) UrbanSite	(2) Majority	(3) Moreable	(4) Female	(5) Stunting	(6) Caregiver Edu.
PPVT lagged test score	0.439***	0.466***	0.467***	0.465***	0.457***	0.459***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
X=0 × Facilities index	0.0678	0.271	-0.0224	-0.0180	-0.133	0.00403
	(0.465)	(0.462)	(0.796)	(0.874)	(0.177)	(0.963)
X=1 × Facilities index	-0.252	-0.0112	0.0287	0.0257	0.219	-0.268
	(0.408)	(0.894)	(0.885)	(0.826)	(0.187)	(0.430)
X=0 × School access to service index	0.0223	-0.258**	-0.0204	0.0376	-0.0215	-0.0575
	(0.743)	(0.009)	(0.637)	(0.544)	(0.620)	(0.184)
X=1 × School access to service index	-0.158	-0.0425	-0.0750	-0.130**	-0.0985	0.139
	(0.155)	(0.313)	(0.393)	(0.008)	(0.208)	(0.313)
X=0 × Teaching devices index	0.0913**	-0.0196	0.0867*	0.0597	0.0820*	0.0893**
	(0.007)	(0.722)	(0.014)	(0.110)	(0.021)	(0.009)
X=1 × Teaching devices index	0.0941	0.0866*	0.0961	0.122**	0.0930	0.0834
	(0.198)	(0.015)	(0.091)	(0.001)	(0.068)	(0.247)
X=0 × Hours/day spent at school	-0.212	2.662	-0.690	-0.369	-0.434	-0.607
	(0.769)	(0.076)	(0.347)	(0.627)	(0.536)	(0.368)
X=1 × Hours/day spent at school	0.0172	-0.573	-0.148	-0.946	-0.108	-1.036
	(0.991)	(0.378)	(0.891)	(0.217)	(0.915)	(0.414)
X=0 × Loss schooling year	-3.235	2.177	-1.347	-0.831	-2.490	-1.880
	(0.165)	(0.728)	(0.563)	(0.793)	(0.338)	(0.453)
X=1 × Loss schooling year	7.938	-2.269	-3.963	-3.535	-1.491	-4.559
	(0.117)	(0.330)	(0.508)	(0.298)	(0.754)	(0.470)
X=0 × Average teaching experience	0.0984	0	0.214	0.0839	0.260	0.127
	(0.498)	(.)	(0.180)	(0.677)	(0.118)	(0.408)
X=1 × Average teaching experience	2.297**	0.183	-0.0390	0.283	-0.00113	0.722
	(0.001)	(0.260)	(0.922)	(0.132)	(0.996)	(0.235)
Observations	633	633	633	633	633	633

Within-child fixed-effects estimates. Robust standard errors in parentheses. Clustered standard errors by childid in brackets. *** $p<0.01$, ** $p<0.05$, * $p<0.10$. Child controls include all home inputs and school inputs and time use and height-for-age Z-score.
X variables represent the interaction of invariant advantage or disadvantage status. For example, the results in column (1) X is Urban location. (2) The majority is the majority group - Kinh people. (3) The more-able is defined as a child at the top decile of the CDA test at 5-year-olds. (4) Female group. (5) The stunting is the group of children suffering early stunts at first 5-year-olds. (6) The children with well-educated caregivers who finished at least upper secondary education.
Dependant variable: Percentage score PPVT

Taken together, I find that omission of historical inputs causes a decent-sized bias of both home and school effects. The omission of such data leads to an overestimation of the effect. However, I did not attempt to conclude that current home and school input contribute little or no to developing a child's cognitive skill. It is also interesting to note that the findings in this paper are very similar to other researchers' suggestions regarding the sign of the effect.

Chapter 5

Conclusion

In this paper, I presented an analysis of the learning achievement in the influences of home environment variables and school characteristics. I reviewed literature in educational production function across countries and Vietnam schooling system and presented descriptive evidence and some analyzes on trends and characteristics of children's performance under many kinds of advantaged and disadvantaged status. Using Young Lives longitudinal data, I implemented within-child fixed-effect by two alternative specifications of the production function. In value-added models, the estimates of low persistence are consistent with recent studies, and the estimated magnitudes of contemporaneous inputs decrease and become insubstantial.

Overall, the findings align with existing evidence on the determinant of Vietnamese learning achievement. Although the impact of access-to-service and learning devices decrease substantially from contemporaneous to value-added specification, the results show that caregivers play an essential role in a child's performance ability. The estimated impact of mother influence on the child through study-associated variables is significantly positive across the specifications. In addition, one of the most noticeable points is that there is substantial heterogeneity not only between the majority students and the minority groups but also within minority groups. Even though the qualitative evidence does not support that private tutoring is one factor contributing to learning gaps between the privileged and the unprivileged, the problem still requires much attention from empirical researchers and policymakers.

Even though the findings in this paper do not indicate which type of goods or investment is efficient to a child's development progress, the results suggest that ethnic differences and private tutor continue to impose substantial challenges for Viet Nam's schooling system. The public debates on the number of children who have dropped out of school or left after finishing lower secondary level have increased in recent years. The knowledge of educational production function, socio-economic background, and behavior of poor households is required to answer these challenges.

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Statement of authorship

I hereby confirm that the work presented has been performed and interpreted solely by myself except for where I explicitly identified the contrary. I assure that this work has not been presented in any other form for the fulfillment of any other degree or qualification. Ideas taken from other works in letter and in spirit are identified in every single case

Bonn, December 6, 2021