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Living with parents and educational outcomes in developing countries: empirical evidence from PISA Thailand

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Abstract Family is a fundamental determinant of children's welfare outcomes, not only in terms of good or bad behaviour, but also in terms of child development, comprising emotional, social, and cognitive skills. Family structure is even more important in a developing country in which educational achievement tends to lag. Using a national sampling from the Program for International Student Assessment (PISA) conducted in 2009 and 2012 in Thailand as a case study for a developing country, this paper quantifies impacts the effects of family structure on cognitive skills and learning performance among Thai students. The findings reveal that family structure, especially for those living with both father and mother, can positively affect the academic achievement of Thai students compared to those who do not live with both parents. Thus, strengthening family structures should be another necessary policy to could promote positive educational outcomes in this developing country.

Keywords Family structure · Living with parents · Educational outcomes · Thailand

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Introduction

Since education matters for human development, including health, economic growth, and democracy, improving education is included in the policy agendas in most countries around the world (Lutz and Samir 2011). There is a growing literature describing the correlations between children's educational outcomes and family structure in several countries. For the most part focusing on developed countries, previous studies have investigated the impact of family structure on children's education and arrive at a similar conclusion, namely, that living with biological parents is a pivotal factor. Thus, living with biological parents is absolutely important and influential for the human capital development of a country, which in turn affects a country's competitiveness and its social and economic development in the long run. Using test scores as a standard measurement of educational achievement, Ginther and Pollak (2004), for example, investigated the impact of family structure on the educational achievement of children in the United States by controlling for influential demographic factors such as number of siblings living in a family, birth order, family religion, household income, and parents' educational attainment. Results suggested that children growing up in families with two biological parents tended to have higher test scores in the areas of reading and mathematics than did children growing up in other types of families. These findings are consistent with studies by Pong et al. (2003) on maths and science scores in 11 OECD countries, by Ram and Hou (2003) on maths and reading scores in the US, by Ham (2004) on high school students' grade point averages, by Myers et al. (1987) on educational achievement of high school students in the US, and by Pong (1998) on students in Grade 10. All of these note that living in non-traditional families, for example single parent families or families with one step-parent, has a negative impact on children's educational outcomes.

Although many studies have examined associations between family structure and children's educational achievement at the individual level, few studies have considered how the increase in single-parent households may have affected children's educational achievement at the population level. A study by Amato et al. (2015) examined changes in the percentage of children living with single parents between 1990 and 2011 and state mathematics and reading scores and found that changes in the percentage of children living with single parents were not associated with test scores. Increases in maternal education, however, were associated with improvements in children's test scores during this period. These results do not support the notion that living with a single parent has serious consequences for children's school achievement in the US.

Besides those studies using test scores to measure the educational outcomes of children, a study by Sandefur et al. (1992) investigated and compared the likelihood of graduation for secondary-school students who lived in traditional and nontraditional families, such as single-parent families, in the US from 1979 to 1985. The study revealed that children living in single- or non-parent families tended to have significantly lower likelihood of high school graduation when compared with children living in two-parent families. In a similar way, Painter and Levine (2000)

discovered that children living in single- or non-parent families were significantly less likely than children living in two-parent families to participate in higher education.

Apart from effects on educational achievements, family structure is also found to play a crucial role in determining children's behaviour. A study by Rodgers and Pryor (1998), for example, concluded that kids growing up with divorced parents are significantly more susceptible to behavioural problems compared to children living in two-parent families. Behavioural problems include, for example, aggressive behaviour, the use of violence to solve problems, negative relationships with surrounding people (parents, friends, and teachers), pessimism, lack of self-confidence, psychological and physical health problems, and depression. Miller (1997) also studied the relationship between family structure and alcohol consumption and drug abuse among students 15–16 years of age in the United Kingdom. The study discovered that children living in two-parent families were less likely than other children to be associated with alcohol consumption and drug abuse. Moore and Chase-Lansdale (2001) investigated the relationship between family structure and sexual activity and teenage pregnancy. The study found that children living with single parents had a significantly higher likelihood of being involved in sexual activities and teenage pregnancy than did children living with both biological parents. Furthermore, a study by Chilton and Markle (1972) discovered that American children growing up with divorced parents are more likely than children growing up with two biological parents to take part in illegal activities such as robbery and other crimes.

There are three main factors explaining roles of family structure on development of children (Amato 2005). The first one is economic hardship and poverty within the family. Commonly, nontraditional families tend not to provide as many financial and educational resources as do two-parent families, causing nontraditional families to lack supportive factors for children's cognitive development. Consequently, children from single-parent families or families with one biological parent are likely to have lower levels of cognitive development than do children living with both biological parents. On average, single-parent families, or families with non-parent caretakers, tend to be poorer than traditional families (Heckman 2008). Parents or caretakers of such families are more likely to have a low level of education and low-paying careers. Moreover, they tend to partner people of the same social and economic status. This results in less ability to invest in the education of their children, which in turn leads to a wider gap and more economic inequality between poor and wealthy families (Greenwood et al. 2014).

The second factor concerns the quality of parenting. In most cases, non-biological parents or caretakers are less likely to give their full attention and assistance to children than do biological parents by, for example, participating in school activities, helping with homework, and so on. This may cause children growing up in this kind of family to be deprived of love, leading to emotional problems, which in turn can retard development in other areas. Hence, development of such children tends to be lower than that of children living with two biological parents. If the household environment of non-parent or single-parent families does not support children's cognitive development due to poverty, inappropriate rearing

practices, or family conflict, then children living in such households will tend to achieve less in terms of education than do children living with their biological parents.

The third factor concerns stress. In general, children from nontraditional families are likely to experience more stress than are children from traditional families. This is because children in nontraditional families may be affected by their feelings about the lack of parenting quality relative to other children. In addition to poverty, which can result in parents spending more time working than with their children, there are also cases in which children lose contact with one of their biological parents due to divorce, separation, or death. All these factors can cause stress, which can negatively affect a child's cognitive development.

Research in developed countries shows that the influence of family structure on educational outcomes has remained stable or declined over time. In contrast, very little is known about this issue in the developing world (Torche 2010). Unlike child and family studies in developed countries described above, the study of child development in developing countries is itself under-developed. Many studies from developed countries, as mentioned above, show a positive correlation between living with parents and child development. But this living situation in developing countries still needs to be investigated. Due to the relatively high level of economic inequality and poverty in developing countries, the majority of families are able to provide only relatively low-quality parenting. For example, low-income parents who initially live in rural areas are often tend to migrate to urban areas in order to seek better employment. They work long hours to earn enough for themselves and their families, but this makes them unable to provide quality parenting, thus affecting the quality of child-rearing in general (Woessmann 2015). Children are left behind under the care of relatives (mostly grandparents with little or no education) or family friends, or left to fend for themselves. Often, the caretakers have neither the physical ability, financial means, nor knowledge needed to take care of these children. This causes these children to suffer developmental issues.

For developing countries in East Asia, there are a few studies that deliver similar results. In South Korea, for example, Park (2008) found that children living in single-parent families tend to have significantly more absences from school as well as less desire to continue their studies and go on to higher education. In addition, in the case of Vietnam, De Loenzien (2016) discovered that the number of children living with a single mother who enrol and complete primary and lower-secondary education is significantly lower than that of children living with both parents. In the study, mothers' social and economic characteristics were controlled.

Thailand can serve as another good case study of a developing country in which the quality of children's development is considered a crucial issue, especially in terms of educational achievement. Thailand has emphasized educational investment and reform of its educational system. This can be proven by noting the continuing increase in the education budget from 3.8% of GDP in 2007 to 5.8% in 2012. The portion of the national budget allocated for education in Thailand is no less than for other countries in the region.

In spite of the relatively large portion of the budget allotted to education, education indicators tend to gauge success only in the terms of "quantity," as

measured by the increase in the Gross Enrolment Ratio of all school grades. However, quality indicators, including the standard national test called the "Ordinary National Education Test (O-NET)"[1] and international tests such as the Programme for International Student Assessment (PISA) reveal that Thai students, on average, actually have low, declining scores, and poorer performance than do students of other countries with similar economic and social conditions. This finding serves to warn of the potentially low quality of human resources, which will constrain Thailand's competitiveness in the future (World Bank 2012, 2015).

Another cause of low educational achievement comes from a rapid change in economic structure. Compared to other countries in Southeast Asia, Thailand has enjoyed a long period of robust and successful economic growth that has led to its advancement as a middle-income country. Even though poverty has been reduced rapidly from 21% in 2000 to about 12.6% in 2012, the poverty rate is still high in rural areas. Some regions—particularly the North and Northeast—and some ethnic groups lag behind others, and the benefits of economic success have not been shared equally, especially between Bangkok, Thailand's largest urban area, and the rest of the country. Income inequality and lack of equal opportunities have persisted. Income inequality, as measured by the Gini coefficient, is 39.4. While income growth has a strong positive effect on poverty reduction, income inequality has a sharply negative effect.[2] The rapid economic development throughout Thailand has caused a rich-poor gap forcing millions of workers to emigrate from rural areas to cities.

Poverty and inequality have caused millions of children to be left behind in rural areas under the care of relatives. Under this economic situation, the Thai family is under strain. The number of divorces has risen sharply. With a rapidly ageing society, almost a third of households are now headed by an elderly person. Rapid economic development and inequality can then be considered another factor preventing Thai children from living with their own parents (UNDP 2014).

Coming back to our earlier hypothesis, since the family is widely regarded as the institution where humanity and civility are first experienced and taught, the family also plays a crucial role in determining the quality of children's education and thus their quality of life. As a case study of a developing country, this paper aims to investigate the impacts of family structure on the quality of education in Thailand. Using nationally representative data, this study aims to quantify the impact of family structure on students' cognitive development, a topic that has not received much attention in developing countries.

The next section describes characteristics of the dataset and methods used in our analysis. The third section discusses the results from our econometric models. The conclusion will be presented in the fourth section.

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[1] Ordinary National Educational Test (O-NET) is a test of basic education divided into six subject areas: Thai language, mathematics, sciences, social studies, religion and culture, and foreign languages (English). The test consists of writing and multiple-choice sections.

[2] www.th.undp.org.

Data and methods

This study analyzes nationally representative secondary data gained from Thai students' scores on the Program for International Student Assessment (PISA) run by the Organization for Economic Co-operation and Development (OECD). The program aims to evaluate education systems worldwide.[3] PISA tests students' literacy in three main areas: reading literacy, mathematical literacy, and scientific literacy. The unique aspect of PISA is that the tests are not directly related to school curricula. Instead, they are designed to assess students' ability to apply their knowledge in real-life situations. In the program, the sampling frame is divided into two parts to cover all Thai students across the country.[4] In Thailand, the Institute for the Promotion of Teaching Science and Technology (IPST) administers the PISA tests and collects data.

This paper uses student-level survey data from PISA 2009 and 2012 and covers 11,190 Thai students.[5] According to the data analysis, the majority of students (67.97%) lived with both biological parents, followed by students living with a single parent (16.44%), and students living with non-parent caretakers (15.59%). Regarding family economic status, children living in high-income households tended to be living with both parents. In other words, around 82.47% of students from high-income families were living with both parents, whereas merely 11.50 and 6.02% of students from high-income families were living with a single parent or non-parent caretaker, respectively.

Regarding parents' educational attainment, it was found that parents with high educational attainment tended to live with their children more so than did parents with low educational attainment. The percentage of children whose father or mother had a bachelor's degree or higher education and who lived with both parents was as high as 78.86% (for fathers with a bachelor's degree) and 79.64% (for mothers with a bachelor's degree). In contrast, only 14.34% of children whose father had a bachelor's degree lived with only their father or only their mother, and 6.80% with only a non-parent caretaker. Only 13.85% of children whose mother had a bachelor's degree lived with only their father or only their mother and 6.51% with only a non-parent caretaker (Fig. 1).

With respect to parents' occupations, we found that children whose parents worked in professional occupations tended to live with both parents. The percentage of such children who lived with both parents was as high as 80.23% if the father (only) was a professional and 81.66% if the mother (only) was a professional. On

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[3] PISA was first conducted in 2000 and is conducted every 3 years. The latest assessment was in the year 2015, which is the sixth round of the assessments. The program involves students in 70 countries, 34 of which are members of the OECD and the rest non-member countries, including Thailand.

[4] For the first stage, samples of 15-year-old students, who were studying at Grade 7 or higher, in schools all over Thailand, were randomly chosen. In the second stage, 15-year-old students in schools located in each region were randomly chosen to ensure that the data represented students all over the country and that the chances of being selected were equal for all students.

[5] The reason for using data from these 2 years is that the previous surveys from previous years (2000, 2003, and 2006) do not contain a question on family structure of a student. Besides, data on assessment results of the year 2015 had not yet been released at the time of this writing.
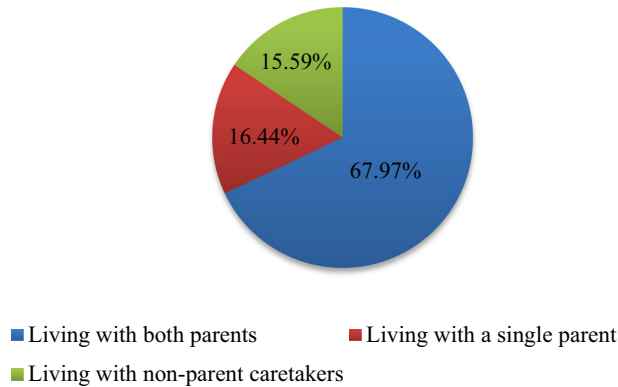
Source: Computed from data of PISA 2009 and 2012

Fig. 1 Percentage distribution of Thai students by living status with parents

the other hand, only 15.40% of children whose father was a professional and 13.78% whose mother was a professional lived with either only their father or only their mother. And only 4.38% of children with professional fathers and 4.56% with professional mothers lived with non-parent caretakers. On the other hand, children whose parents worked in unskilled occupations had a higher chance of living with either only their father or only their mother. As many as 20.03% of children whose parents worked in unskilled occupations tended to live with a single parent (either only their father or only their mother). Likewise, children whose father worked in an unskilled occupation and whose mother worked as an industrial machine controller tended to live with non-parent caretakers (Fig. 2).

Examining the relationship between Thai students' PISA 2009–2012 results and their family structures, we discovered that those children who lived with both biological parents tended to have higher scores in all three areas of competencies than did children who lived with a single parent or non-parent caretakers (Fig. 3).

But the difference in academic achievement as described above is likely caused by several factors, including students' characteristics, family background and school factors, which could cause an error in the estimation of the effect of family structure on students' academic achievement. To solve this issue, econometric models were applied to control for variables, as demonstrated in the next part.

Even though our analysis begins with descriptive statistics to provide a broad understanding, education outcomes also depend on various socioeconomic variables. Econometric estimations can be applied here in order to examine the relationship between factors related to family structure and factors related to the assessment of students' competencies in all three areas tested.[6]

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[6] PISA score in all the three areas, in this study, refers to plausible value as there are multiple sets of tests involved and each set does not equally assess competency in the three areas, making it improper to compare scores of each student. In response to this issue, the test scores were transformed into five probability values called "plausible values," of which the average value was used for comparing students' scores.
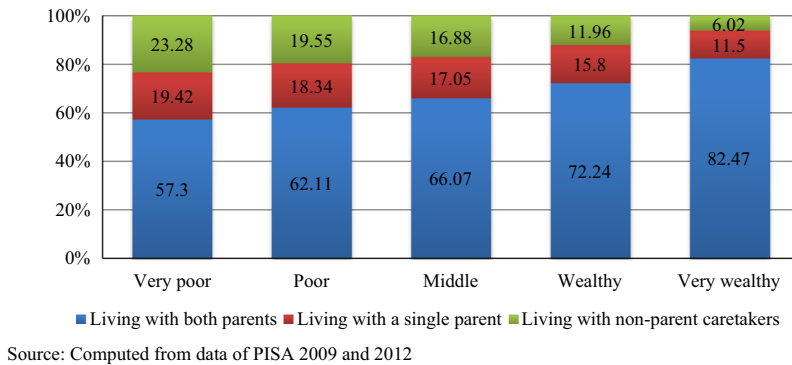
Source: Computed from data of PISA 2009 and 2012

Fig. 2 Living status with parents of Thai students by economic status

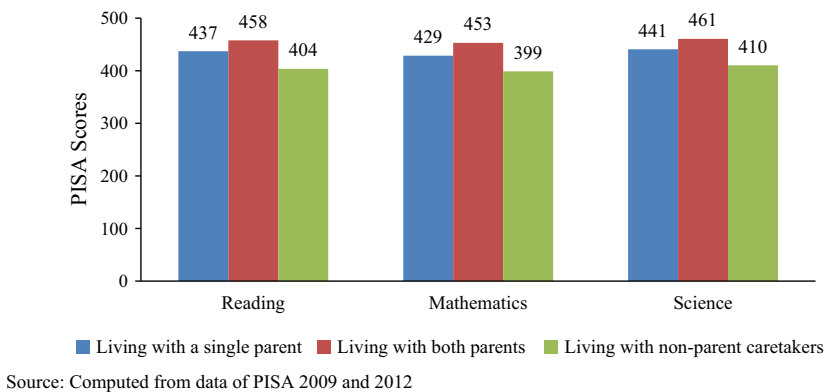Source: Computed from data of PISA 2009 and 2012

Fig. 3 Educational outcomes of Thai students by living status with parents

According to Fasih (2008), using concepts from educational economics theory, factors influencing education can be categorized into a demand side and a supply side. The demand side involves student and family characteristics such as gender, age, school level, economic status, parents' educational attainment, and students' and parents' interest in education. Moreover, community and societal characteristics such as distance between a community and a school, community's interest in education, community's culture, and available amenities in a community are also regarded as demand-side factors. On the other hand, supply-side concerns include school characteristics such as school size, school location, supervising body of a school, quality and number of teachers, and school resources. School management, e.g., methods for a school's internal assessment, management transparency, and parents' participation are also regarded as supply-side factors.

Therefore, the factors relating to students' characteristics and family background include gender, grade, main language spoken at home, number of books at home, parents' educational attainment, parents' occupation, and economic status of the

family. This study used household possessions as indicators of family economic wealth. This was measured by using four indicators in PISA, including family wealth, cultural possessions, home educational resources, and number of books in the home. In the analysis, household possessions were used to divide households into five levels: very poor, poor, average, wealthy, and very wealthy. Households in the lowest quintile are categorized as "very poor", whereas those in the highest quintile were regarded as "very wealthy."

As for school factors, we used data on school size, location, quality and number of teachers, and teaching and learning resources. Additionally, indicators of quality of educational resources were obtained from calculations using the following factors: lacking teaching and learning resources including lack of equipment for scientific experiments, lack of computers, lack of an Internet connection, lack of educational software, lack of library supplies, and lack of audio equipment. Positive values for indicators imply that school resources were not lacking.

School factors also encompass school management, for instance, methods for school internal assessment, management transparency, parents' participation, internal environment of a school, number of hours of classes related to the three subject areas, and school independence. For an indicator of school independence, this paper used school responsibility for resource allocation, such as independence in teacher recruitment and dismissal, independence in determining teacher salary and raises, and independence in school internal budget allocation. The variable also involves school responsibility for curriculum and assessment, independence in developing student assessment policy, independence in selecting textbooks, and independence in curriculum development.[7]

Regarding family structure, samples were divided into three main groups. The first group includes students who live in two-parent families, the second includes students living in single-parent families, and students living with non-parent caretakers, such as grandfathers, grandmothers, and siblings comprise the third group. Students in the first group were used as the base group to compare differences between their academic achievement and that of students not living with both parents.

In applying econometric models to quantify long-term impacts of family structure on Thai students' academic achievement, influential variables need to be controlled to prevent errors, as mentioned above. To control for variables, this paper refers to the aforementioned theory of Education Economics. Similar to research from Pholphirul (2016) that also used survey data from the Program for International Student Assessment (PISA) Thailand, independent variables are classified into the following three groups:

1. *Student characteristics* gender, grade, main language spoken at home.
2. *Family characteristics* number of books in the home, economic status, parents' educational attainment, and main occupations.

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[7] Supported by van de Werfhorst and Mijs (2010), who reviewed the comparative literature on the impact of national-level educational institutions on inequality in student achievement. Two types of institutions that characterize the educational system of a country were examined, namely, the system of school-type differentiation (between-school tracking) and the level of standardization (e.g., with regard to central examinations and school autonomy). He finds inequality in terms of dispersion of student test scores and inequality of opportunity by social background and race/ethnicity of students.

3. *School characteristics* school size, location, quality and number of teachers, methods of internal assessment, school management transparency, parents' participation, school independence, internal environment of a school, and number of hours of classes related to the three subject areas.

Dependent variables refer to PISA scores in three subject areas (reading, mathematics, and science), which are in log function. In the log model, estimation results are explained in terms of percentage changes, which are easier to understand than level estimation. Besides, the log model is more appropriate in the case that the relationship between independent variables and the assessment results might be nonlinear.

Results and discussion

As shown in Table 1, results reveal that student characteristics have a significant impact on academic achievement. For instance, whereas female students had significantly higher scores in reading and science than male students, (7.48 and 1.17% higher, respectively), male students tended to score 1.61% higher in mathematics than female students. Furthermore, students who spoke a dialect as their main language at home tended to fare significantly better in reading and mathematics than did students who spoke central Thai language as their main language at home, by 1.10 and 1.71%, respectively.[8]

As for family background, having more books in the home correlates with higher levels of cognitive skills of students. Students in homes with more than 100 books tended to have significantly higher scores in reading, mathematics, and science than did students in homes with fewer than 10 books, by 3.24, 3.69, and 3.55%, respectively. Explicitly, this finding suggests that reading environment at home contributes to cognitive development, thus enhancing the ability to solve problems in daily life. Moreover, students living in wealthy families tended to have significantly higher scores in mathematics than did students living in economically disadvantaged families, by 2.38%. Parents' educational attainment and main occupations were also found to have a positive impact on students' academic achievement.

With regard to school factors, the results indicate that students' academic achievement varies directly with school size. Students in a school with more than 2500 students tended to have significantly higher reading scores (by 6.6%) than did students in a school with fewer than 120 students. Specifically, students in metropolitan areas seemed to fare significantly better than students in the countryside. Students in metropolitan areas were found to score higher in reading, mathematics, and science than did students in the countryside by 3.45, 5.61, and 5.19%, respectively.

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[8] Due to missing data on family structure (living with parents), the number of observations decreases from 11,690 to 6343 observations. This missing data may reduce the representativeness of the sample and can therefore distort inferences about the population. Nevertheless, the remaining 6343 observations are still enough to ensure unbiased estimation.

Table 1 Estimation results of coefficients of variables representing living status with parents and effects on PISA score of Thai students

Variable	PISA score		
	Reading	Mathematics	Science
Family structure (benchmark: living with both parents)			
Living with a single parent	− 0.0164***	− 0.0249***	− 0.0154**
	[0.006]	[0.007]	[0.007]
Living with non-parent caretakers	− 0.0570***	− 0.0561***	− 0.0482***
	[0.005]	[0.006]	[0.006]
Student characteristics			
Female (benchmark: male)	0.0748***	− 0.0161***	0.0117***
	[0.004]	[0.005]	[0.004]
School grade (benchmark: Grade 7)			
Grade 8	− 0.1976**	− 0.1428***	− 0.2398***
	[0.086]	[0.049]	[0.063]
Grade 9	− 0.0917	− 0.0714***	− 0.1481***
	[0.076]	[0.024]	[0.042]
Grade 10	− 0.0674	− 0.0530**	− 0.1417***
	[0.075]	[0.024]	[0.041]
Grade 11	− 0.0153	0.0029	− 0.0937**
	[0.075]	[0.027]	[0.043]
Main language spoken at home (benchmark: Central Thai)			
Dialects	0.0110*	0.0171**	0.0101
	[0.006]	[0.008]	[0.007]
Other languages	− 0.025	0.0115	− 0.0309
	[0.027]	[0.034]	[0.028]
Family characteristics			
Number of books in the home (benchmark: less than 10 books)			
11–100 books	0.0174***	0.0176***	0.0114**
	[0.005]	[0.006]	[0.006]
More than 100 books	0.0324***	0.0369***	0.0355***
	[0.007]	[0.009]	[0.008]
Economic status (benchmark: very poor)			
Poor	0.0005	− 0.0041	0.0006
	[0.006]	[0.007]	[0.007]
Middle	− 0.0007	− 0.0012	− 0.0044
	[0.007]	[0.008]	[0.007]
Wealthy	− 0.0008	0.0046	− 0.0034
	[0.008]	[0.009]	[0.010]
Very wealthy	0.0111	0.0238**	0.0109
	[0.010]	[0.011]	[0.011]

Table 1 continued

Variable	PISA score		
	Reading	Mathematics	Science
Father's educational attainment (benchmark: no education)			
Primary education	− 0.0277***	− 0.0104	− 0.0290***
	[0.010]	[0.012]	[0.011]
Lower-secondary education	− 0.0112	0.0057	− 0.0122
	[0.012]	[0.015]	[0.013]
Upper-secondary education	− 0.014	− 0.0077	− 0.0118
	[0.011]	[0.014]	[0.012]
Bachelor's degree and higher	0.0042	0.0214	0.0002
	[0.012]	[0.015]	[0.014]
Mother's educational attainment (benchmark: no education)			
Primary education	0.0005	0.0011	− 0.006
	[0.010]	[0.011]	[0.010]
Lower-secondary education	− 0.0036	0.0077	− 0.0043
	[0.011]	[0.012]	[0.011]
Upper-secondary education	0.0003	0.0134	0.0011
	[0.012]	[0.013]	[0.011]
Bachelor's degree and higher	0.0125	0.0428***	0.02
	[0.013]	[0.015]	[0.013]
Father's main occupation (benchmark: unskilled)			
Civil service/manager	0.0242***	0.0207**	0.0181**
	[0.008]	[0.009]	[0.009]
Professional	0.0195**	0.0079	0.0047
	[0.010]	[0.012]	[0.012]
Technician	0.0271***	0.0184	0.0242**
	[0.010]	[0.012]	[0.011]
Clerk	0.0092	0.0082	0.0006
	[0.014]	[0.015]	[0.016]
Service staff	0.0145**	0.0111	0.0056
	[0.007]	[0.009]	[0.008]
Agricultural worker	0.0118*	0.0142*	0.0152**
	[0.007]	[0.008]	[0.007]
Craftsman	0.0265***	0.0218**	0.0221***
	[0.007]	[0.009]	[0.008]
Industrial machine controller	0.0248***	0.0152*	0.0188**
	[0.007]	[0.008]	[0.008]
Mother's' main occupation (benchmark: unskilled)			
Civil service/manager	0.0169	0.0088	0.0174
	[0.011]	[0.012]	[0.012]
Professional	0.0163	0.0048	0.0151
	[0.011]	[0.013]	[0.012]

Table 1 continued

Variable	PISA score		
	Reading	Mathematics	Science
Technician	0.0271**	0.0155	0.0186
	[0.011]	[0.012]	[0.013]
Clerk	0.0279**	0.0183	0.0258**
	[0.012]	[0.014]	[0.013]
Service staff	− 0.004	− 0.0072	− 0.0054
	[0.006]	[0.008]	[0.007]
Agricultural worker	− 0.0160*	− 0.0086	− 0.0181*
	[0.009]	[0.010]	[0.010]
Craftsman	0.0089	0.0139	0.0085
	[0.008]	[0.010]	[0.009]
Industrial machine controller	0.0179	0.0068	0.0019
	[0.013]	[0.014]	[0.015]
School characteristics			
School size (benchmark: fewer than 120 students)			
121–200 students	0.0018	0.0481	0.028
	[0.039]	[0.061]	[0.048]
201–300 students	0.009	0.0765*	0.0072
	[0.028]	[0.043]	[0.034]
301–499 students	− 0.007	− 0.0154	− 0.0354
	[0.024]	[0.036]	[0.029]
500–1499 students	0.0083	− 0.0093	− 0.0229
	[0.023]	[0.034]	[0.029]
1500–2499 students	0.0328	0.0156	− 0.0016
	[0.025]	[0.036]	[0.031]
More than 2500 students	0.0660**	0.0475	0.0257
	[0.027]	[0.036]	[0.033]
School type (benchmark: public school)			
Private school receiving government subsidy	− 0.025	− 0.0232	− 0.0252
	[0.016]	[0.019]	[0.017]
Private school not receiving government subsidy	− 0.0229	− 0.0098	− 0.0382
	[0.028]	[0.029]	[0.026]
School location (benchmark: countryside)			
Town	0.0155*	0.0172*	0.0206**
	[0.009]	[0.010]	[0.010]
Metropolitan	0.0345**	0.0561***	0.0519***
	[0.015]	[0.019]	[0.017]
Number of schools in the same area (benchmark: none)			
One school	0.0213*	0.0318*	0.0336**
	[0.013]	[0.018]	[0.015]

Table 1 continued

Variable	PISA score		
	Reading	Mathematics	Science
More than two schools	0.0088	0.0096	0.0064
	[0.011]	[0.016]	[0.013]
Quality indicator of educational resources at school	0.0077*	0.0090**	0.0106**
	[0.004]	[0.004]	[0.004]
School characteristics			
Student/teacher ratio	− 0.0009	− 0.0006	− 0.0007
	[0.001]	[0.001]	[0.001]
Ratio of certified teachers	− 0.0174	− 0.0239	− 0.0105
	[0.034]	[0.033]	[0.038]
Ratio of teachers with bachelor's degrees or higher	0.2327**	0.2767**	0.2816**
	[0.090]	[0.131]	[0.141]
Disclosing students' academic assessment results (benchmark: none)	− 0.0068	− 0.0046	− 0.0123
	[0.009]	[0.011]	[0.010]
Having continuous evaluation (benchmark: none)	− 0.0135	− 0.011	− 0.0118
	[0.010]	[0.015]	[0.013]
Parental involvement and pressure on students' school performance (benchmark: none)			
Limited parental involvement	− 0.0022	− 0.0181	− 0.011
	[0.010]	[0.013]	[0.011]
Substantial parental involvement	− 0.0005	− 0.0096	− 0.0143
	[0.010]	[0.013]	[0.011]
School environment (benchmark: none)			
Having teachers with expectations of students' academic performance	− 0.0252**	− 0.0236**	− 0.0193
	[0.010]	[0.011]	[0.012]
Having teachers who have a negative relationship with students	− 0.0019	− 0.0062	0.0023
	[0.011]	[0.013]	[0.012]
Having teachers who do not pay attention to students' needs	0.0174	0.0114	0.0222
	[0.011]	[0.012]	[0.014]
Having teachers who are too strict	− 0.0097	− 0.0047	− 0.0037
	[0.008]	[0.010]	[0.009]
Having teachers who do not encourage students to study to their full potential	− 0.0264*	− 0.0111	− 0.0208
	[0.014]	[0.017]	[0.015]
Having teachers who are absent from teaching	0.0056	− 0.007	− 0.008
	[0.015]	[0.016]	[0.015]
School characteristics			
Indicator of independence in budget management	− 0.0005	− 0.0023	− 0.0023
	[0.004]	[0.005]	[0.004]
Indicator of independence in curriculum management	0.0063	0.0056	0.0047
	[0.005]	[0.006]	[0.006]
Amount of time in Thai language class (minutes per week)	0.0001	0.0001	0.0001
	[0.001]	[0.001]	[0.001]

Table 1 continued

Variable	PISA score		
	Reading	Mathematics	Science
Amount of time in mathematics class (minutes per week)	0.0003***	0.0003***	0.0003***
	[0.001]	[0.001]	[0.001]
Amount of time in science class (minutes per week)	0.0001***	0.0002***	0.0002***
	[0.001]	[0.001]	[0.001]
Control variable in 2012	0.0378***	0.0114	0.0413***
	[0.008]	[0.009]	[0.008]
Constant	5.7661***	5.7250***	5.8653***
	[0.121]	[0.133]	[0.140]
R^2	0.44	0.35	0.33
Number of students	6343	6343	6343

Note: Standard errors are in brackets. $*p < 0.1$, $**p < 0.05$, $***p < 0.01$

In general, educational resources, teacher quality and the amount of time spent on each subject all had a positive impact on a student's academic achievement. However, factors related to school's internal environment, such as having a teacher with a low expectation with respect to a student's academic ability or a teacher who does not encourage students to study and learn up to their full potential, were found to have a negative impact on academic achievement.

As for the factors related to the research question, the findings suggest that students living with both parents tended to have the highest academic achievement. Students living with either their mother only or their father only tended to have significantly lower scores in all three subject areas, especially in mathematics, compared to students living with both parents. Students living with either their mother only or their father only had lower scores in reading, mathematics, and science, by 1.64, 2.49, and 1.54%, respectively. In the same manner, students living with non-parent caretakers tended to have lower scores in all areas, reading in particular, than did students living with both parents. Students living with non-parent caretakers were found to have significantly lower scores in reading, mathematics, and science by 5.70, 5.61, and 4.82%, respectively.

Additionally, as shown in Table 2, categorizing students according to the socioeconomic status of their families whilst controlling for other factors shows that there are negative effects of weak family structure that affect learning outcomes in all economic strata, especially among students from middle-income to wealthy families. Students from middle-income to wealthy families tended to experience the largest negative effect on scores from living with a single parent, with lower scores in reading (by 3.1–3.27%), sciences (by 3.1%), and mathematics (by 3–4%) than students living with both parents. Similarly, students from middle-income to wealthy families living with non-parent caretakers tended to have even lower scores in reading (by 6.4–9.7%), sciences (by 6.1–8.2%), and mathematics (by 5.8–9.4%) than those students living with both parents (Table 2). Thus, parental involvement

Table 2 Estimation results of the effect of living status with parents on PISA score of Thai students, classified by economic status

Pisa score	Living with a single parent					Living with non-parent caretakers				
	Very poor	Poor	Middle	Wealthy	Very wealthy	Very poor	Poor	Middle	Wealthy	Very wealthy
Reading	− 0.001	− 0.0088	− 0.0310***	− 0.0327***	0.0142	− 0.0289***	− 0.0618***	− 0.0641***	− 0.0967***	− 0.0457**
	[0.013]	[0.011]	[0.012]	[0.012]	[0.013]	[0.010]	[0.009]	[0.011]	[0.013]	[0.021]
Mathematics	− 0.0113	− 0.0193	− 0.0399***	− 0.0301**	0.0011	− 0.0366***	− 0.0569***	− 0.0581***	− 0.0939***	− 0.0302
	[0.013]	[0.012]	[0.013]	[0.014]	[0.017]	[0.012]	[0.011]	[0.012]	[0.015]	[0.022]
Science	0.0094	− 0.0156	− 0.0311**	− 0.0311**	0.0168	− 0.0144	− 0.0552***	− 0.0614***	− 0.0817***	− 0.0376
	[0.013]	[0.012]	[0.012]	[0.013]	[0.016]	[0.012]	[0.011]	[0.012]	[0.015]	[0.024]
Sample size	1208	1300	1235	1261	1339	1208	1300	1235	1261	1339

Note: Standard errors are in brackets. *Significant at 10%; **significant at 5%; ***significant at 1%. The models are controlled by student characteristics, family characteristics and school characteristics. Base group is living with both parents

seems to be one of the most important predictors of academic outcome among students.

In accordance with studies in other countries, the results of this research indicate that living in a nontraditional family environment, including a single-parent family or a non-parent caretaker family, has a negative impact on students' cognitive skill development. In contrast, two-parent families positively influence the development of students' cognitive skills in the long run. The main reason is that children who live with both parents tend to receive better care and attention. When they encounter problems, their parents will help by giving suggestions and guidance. As a result, these children feel secure and are thus ready to develop in all other aspects of life.

Furthermore, children living with non-parent caretakers, regardless of the economic status of their families, tend to have significantly lower scores than do children living with both parents. This finding demonstrates that not having both parents in a family has a negative impact on the cognitive development of Thai children since they cannot benefit from parents' care, attention, and guidance, which in turn negatively affects children's mental health by causing them to have lower motivation for development in other areas than do children living with both parents.

Children living with their biological parents can be expected to have higher educational achievement than children living in no-parent or single-parent families if the household environment in the latter does not support children's cognitive development because of factors such as poverty, inappropriate rearing practices, or family conflict.[9] Therefore, a country can reduce educational inequality between children living in single-parent families and children living in two-parent families by implementing policies that support economically disadvantaged families (Hampden-Thompson 2013).

Due to the limitations of our dataset, our model cannot measure qualitative variables mentioned in the literature review, such as quality of parenting, quality of the home environment, parental involvement in children's education, family conflict, and stress among family members. This omission of some qualitative variables may cause an upward-bias in our estimated coefficients.

Conclusion

This study aims to analyze and quantify the effects of family structure on children's cognitive development. The results reveal that living in a nontraditional family has a negative effect on children's academic achievement in a developing country. According to the results from PISA Thailand, students living with either their father only or their mother only tend to have significantly lower scores in reading, mathematics, and science than students living with both parents, by 1.64, 2.49, and 1.54%, respectively. Similarly, students living with non-parent caretakers were also

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[9] A study conducted by Ghazarian and Buehler (2010) found that American children living with parents who argue excessively tend to have significantly lower educational achievement than children living with parents who do not argue excessively. However, nontraditional families that provide an environment that supports cognitive development can help children achieve their educational goals better than children living in traditional families that do not foster such an environment.

found to have lower scores in reading, mathematics, and science than students living with both parents, by 5.70, 5.61, and 4.82%, respectively. The findings of this study are consistent with studies in other countries, indicating that not living with both parents has a detrimental impact on children's cognitive development in the long run.

Furthermore, by classifying students according to the economic status of their families, this study investigates the effects of family characteristics on students' academic achievement. For instance, it was found that a student living with a single parent will have a higher score in mathematics provided that his or her family is wealthy. This implies that wealthy parents are capable of providing educational resources for their children, which positively contributes to the learning environment in a family and thus facilitates higher educational achievement. On the other hand, for children living with non-parent caretakers, the wealth of the family had no positive effect on cognitive development.

Results from our econometric models also highlight the importance of living in a two-parent family in terms of students' academic achievement. Therefore, schools should provide additional attention and assistance to students not living in this type of family who may not have as supportive a home learning environment as children living with both parents. In addition, Thailand can reduce educational inequality between children living in single-parent families and children living in two-parent families by implementing policies that support economically disadvantaged families.

There are several limitations of this study. First, due to limitation of our dataset, we cannot measure qualitative variables such as quality of parenting, quality of the home environment, parental involvement in children's education, family conflict, and stress among family members. All of these are factors determining the quality of parenting and potentially affecting the educational outcomes of their children. Second, this research lacks panel data that would provide a time series and thus the possibility of continuously examining trends in students' academic achievement. In addition, the study assesses only cognitive skills through test scores, excluding children's non-cognitive skills such as teamwork, positive-thinking, creativity, dealing with undesirable behaviours, and so on. Data on these behavioural skills would contribute to more accurate quantification of the effects of family structure on students' cognitive development and development of behavioural skills, and thus help inform better policy recommendations.

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