Parental Time and Material Investments in Rural Thailand*

Ngọc Tú T. Đinh and Weerachart T. Kilenthong
University of the Thai Chamber of Commerce

Abstract

This paper studies the roles of family structure, wage and child's gender on parental time and material investments in rural Thailand. Our findings consistently show that female children received more time, but less material investments. The material investment was significantly lower for children in households with no parents, while the difference in time investment was not significant. Based on an economic model of parental investment, these results suggest the factor share of time relative to material input is larger for girls and households with no parents. We also identified the elasticity of substitution between time and material investments, which suggests that both of the inputs are surprisingly complementary. We cannot reject that the skill formation is a Cobb-Douglas production function.

Keywords: parental investment; time investment, material investment, early childhood development; family structure; skipped-generation family, child's gender, elasticity of substitution

JEL classification: D10, J12, J13, J24

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1 Introduction

Parental investment during early life is important not only for school readiness but also lifelong success (e.g., Currie and Almond, 2011; Heckman and Mosso, 2014). Both time and material investments are key inputs for skill formation technology, (see Attanasio et al., 2015; Cunha et al., 2010; Todd and Wolpin, 2007, for example). However, the parental investment literature has focused on either time investment (e.g., Guryan et al., 2008; Kalil et al., 2014; Kimmel and Connelly, 2007) or material investment (e.g., Kornrich and Furstenberg, 2013), separately. We aim to bridge this gap by jointly analyzing both at the same time.

This paper analyzes both parental time and material investment decisions, focusing primarily on the influences of family structure, household-average wage and child's gender, using the data from the Reducing Inequality through the Early Childhood Education (RIECE Thailand) program[1]. This new dataset contains both time and material investments, as needed. Our measures of the investment are based mainly on developmentally appropriate activities. In particular, the material investment is measured by the outlays on books, toys and learning devices, while only adult-child interactive activities, including singing, dancing, learning numbers and letters, reading books and playing blocks, are counted as the time investment. In addition, to compare with the literature, we consider the total child caring time as well.

The RIECE dataset reveals an interesting phenomenon regarding family structure. In particular, we found that about 45 percent of the children were living with no parents at home while the number is much lower in the United States (less than 5 percent in the Panel Study of Income Dynamics (PSID), for example). Most of those children were left behind with the old and mostly low-educated grandparents or relatives. This skipped-generation family structure is clearly a concern. However, its impact on parental investment is rarely found in the literature. One reason is the lack of the data because most of the data in the past came from Western countries where this type of family is rare. Most of the existing

[1]The RIECE Thailand project aims to improve human capital for young children in rural Northeast Thailand through the large-scale implementation of the HighScope curriculum of the Perry Preschool project.

literature focused on the comparison between two-biological-parents, single-biological-parent and step-parent families (e.g., Gayle et al., 2015; Hofferth, 2006; Hofferth and Anderson, 2003; Kalil et al., 2014). Therefore, another contribution of this paper is to study the impact of the skipped-generation family structure on parental investment by taking advantage of its prevalence in our data. Our key finding is that material investment was significantly lower for children without parents, while the difference in time investment was not significant. In addition, we found that both time and material investments decrease significantly with caregivers' age.

Wages play a key role in the parental investment decision as is evident in our simple economic model. Based on the theoretical model, we derived a structurally-linked estimation specification, under which we can identify the elasticity of substitution between parental time and material investments from the estimation coefficient of the wage variable. To the best of our knowledge, this paper is the first to estimate this parameter. There is one problem in the empirical analysis, however. We could not observe the wages of caregivers and others who were not wage earners. Following Kimmel and Connelly (2007), we imputed it using the two-step Heckman procedure. Our findings regarding this issue indicate that both of the inputs are surprisingly complementary, and the Cobb-Douglas production function cannot be rejected.

This paper is also related to the literature studying the impact of a child's gender on parental investment (e.g., Barcellos et al., 2014; Hofferth and Anderson, 2003; Kornrich and Furstenberg, 2013). Most of the papers found that girls received less investment than boys. Our findings, however, consistently show that Thai girls received more time but less material investments relative to boys. Based on the theoretical model, these results suggest that time investment is more effective for girls relative to boys, and vice versa.

The remainder of this paper is organized as follows. Section 2 presents a simple economic model of parental investment and its implications. In Section 3, we discuss the RIECE data. The reduced-form and structurally-linked empirical specifications are described in Section 4. Section 5 presents and discusses the empirical results. Section 6 concludes the paper

and provides further discussion. Appendix A provides the summary statistics of the RIECE data. The construction processes of key variables are described in Appendix B. Appendix C and D present the questionnaire for the time and material investments and an economic model with CRRA utility function and CES technology of skill formation, respectively.

2 Time and Material Parental Investments through the Lens of a Unitary Model

Consider a household with two agents, called a parent and a child. The household's preferences are represented by $U(c, \ell, \theta)$, where c is the consumption, ℓ is leisure, θ is the skill of the child.

The utility function $U(c, \ell, \theta)$ is assumed to be strictly increasing and concave in all arguments. The positivity of the marginal utility of children skill θ, i.e., $U_\theta(c, \ell, \theta) > 0$, implies that the household is altruistic toward the child. This altruism is one of the key channels through which characteristics of household, caregiver or the child, e.g., the household structure, caregiver's age and child's gender can influence parental investment.

Consider a skill formation technology that transforms the time investment I_t, and the material investment I_m into the skill of the child θ. More formally, let the skill formation process be as follows:

$$\theta = Af(I_t, I_m), \tag{1}$$

where A denotes the productivity of skill formation. The production function $f(I_t, I_m)$ is assumed to be homothetic, i.e., $f(I_t, I_m) = I_m f\left(\frac{I_t}{I_m}, 1\right)$. The main implication of this assumption is that the ratio of the marginal products of time and material investments is a function of the ratio of time and material investments, i.e.,

$$\frac{f_t(I_t, I_m)}{f_m(I_t, I_m)} = g\left(\frac{I_t}{I_m}\right), \tag{2}$$

where $f_j(I_t, I_m) \equiv \frac{\partial f(I_t, I_m)}{\partial I_j}$ with $j = \{t, m\}$ denoting the marginal product with respect to argument j.

The household's decision problem is to choose consumption c, leisure ℓ, time investment in the child I_t, and material investment in the child I_m to maximize household utility:

$$\max_{c,\ell,I_t,I_m} U(c, \ell, \theta) \tag{3}$$

subject to the full-income budget constraint, and the skill formation technology, respectively,

$$c + w\ell + wI_t + I_m \leq wT + b, \tag{4}$$

$$Af(I_t, I_m) = \theta, \tag{5}$$

where w is the wage rate, b is a non-labor income (e.g, remittances from relatives and friends), and T is the total time endowment.

An optimal condition for an interior solution to the model is

$$\frac{f_t(I_t, I_m)}{f_m(I_t, I_m)} = g\left(\frac{I_t}{I_m}\right) = w, \tag{6}$$

which results from the first-order conditions with respect to the time investment I_t and the material investment I_m, and the homothetic assumption (2) of the skill production function.

The key implication of this condition is that the productivity parameter A has no influence on the ratio of time and material investments, $\frac{I_t}{I_m}$. In addition, there will be also no influence of preference parameters, including altruism and leisure preference, on the ratio of time and material investments, $\frac{I_t}{I_m}$. More specifically, if we assume that the skill production function is a constant elasticity of substitution (CES) as follows:

$$f(I_t, I_m) = \left[\mu I_t^{\rho} + (1-\mu) I_m^{\rho}\right]^{\frac{1}{\rho}}, \tag{7}$$

where $0 \leq \mu \leq 1$ is the factor share; and $\frac{1}{1-\rho} \geq 0$ is the elasticity of substitution. Under this CES assumption, the optimal condition with respect to time and material investments becomes

$$\ln\left(\frac{I_t}{I_m}\right) = -\frac{1}{1-\rho}\ln w - \frac{1}{1-\rho}\ln\left(\frac{1-\mu}{\mu}\right). \tag{8}$$

A clear prediction of the model is that the coefficient of the log wage should be negative and significant. In fact, one can identify the elasticity of substitution, $\frac{1}{1-\rho}$ from this specification through the coefficient of the log wage rate. In addition, we will use this model

to interpret the impact of our determinants of interest, such as family structure and gender preference through μ.

Note that if we specify the utility function, e.g., a constant relative risk aversion utility, we can derive a closed-form solution to the model as shown in Appendix D. However, those formula are so complicated that their linearized versions are not plausible, and therefore it is difficult to recover any structural parameters from a linear regression based on those solutions. On the other hand, the optimal condition (8) is linear in log form. Further, it does not require a utility functional form.

3 Data

This paper uses the baseline survey data from the Reducing Inequality through Early Childhood Education program (RIECE), which has been trying to improve the quality of early childhood education in rural Thailand by adopting the HighScope curriculum of the Perry preschool project since 2015. At the beginning, the RIECE Thailand project covered approximately 2,000 children aged between 2 and 5 years old in 50 rural child care centers distributed across 24 Tambons or subdistricts in Mahasarakham province and 2 Tambons in Kalasin province. The baseline survey in 2015 is a stratified random sample based on children's age and the child care center. In particular, each center has no more than 25 randomly selected children. If a center has fewer than 25 children, all children will be selected. Approximately 60 percent of the samples in each center are children more than 3 years old and the rest are children younger than that. The final data set includes 1,105 children from 1,054 households[2].

The survey comprises three main components, including the household, the children and the teacher data. In this paper, we focus on the first two components. The household questionnaire is collected based on the annual Townsend Thai Data survey with additional information on chronic disease. This survey component provides detailed information about Scio-economic status of the household, e.g., education, income, expenditure, labor supply,

[2]There are 50 households with more than one sampled child.

leisure, housing characteristics, assets, borrowing and lending.

The child questionnaire is drawn from several existing surveys, including Cohort Study of Thai Children, Denver Developmental Screening Test, The World Health Organization Quality of Life, National Educational Panel Study and Early Childhood Longitudinal Program. The respondent of this part is required to be the child's main caregiver. A household with more than one sampled child must be interviewed for each child separately. So, we have individual information for each child. Importantly, this part of the survey collected both time and material investment information for each sampled child. Time use and material expenses are collected by asking the respondent to provide an amount of time or an expense for pre-specified items, e.g., singing and dancing with the child, reading to the child, buying books for the child etc. These selected activities and materials are considered as developmentally appropriate and intended for preschool children. Beside this, we also collect the information on the child rearing time of the main caregiver and parents (if at home). See the questionnaire for time use for activity, for child rearing and material expense in Appendix C, and the detailed construction of some key variables in Appendix B.

The summary statistics of key variables related to children, households, and parents and main caregivers are presented in Tables A.1 - A.3, respectively. In each table, the first four columns show the statistics of the sample that remains after controlling for missing values from all regressors used in empirical works later while the last two columns show the statistics of the whole sample. Overall the two samples give similar statistics. Each set of statistics is conveyed under two types of family structures, i.e., having at least one parent and having no parents at home[3]. Note also that in Table A.2, the first four columns present the summary statistics using only households with one child younger than five years old (preschool child) while the last two columns are for the whole sample. For household-related statistics, we can only present them this way because it is impossible to define precisely the

[3]We separated family structures into three types based on the number of biological parents living with the child. The statistics of two-biological-parent and one-biological-parent family type are almost indifferent, except for total caring time. As a result, we grouped them together as families having at least one biological parent.

family structure variables, i.e., a family with at least one parent and a family with neither of them, for households with more than one preschool child.

The data reveals that approximately 55 percent of children in the sample are living with at least one parent at home. The rest, roughly 45 percent, are living with relatives who are not biological parents[4] (see the last row of Table A.1). In addition, Table A.3 shows that biological parents of children who are living with no parents at home are the youngest. Main caregivers of children in this group are significantly older and have fewer years of schooling than the others. That is because those caregivers are grandparents mostly. This fact is not specific to Thailand at all. It is an Asian phenomenon (Chen et al., 2011). This skipped-generation family structure has raised a concern for child development in the literature (Solomon and Marx, 1995). This new data set from the area where skipped generation is prevalent should be able to help us understand this issue better.

The children's characteristics are homogeneous across family structures as shown in Table A.1. In particular, the average age is roughly 3 years old, the average birth weight is about 3 kilograms, and the fraction of female children is slightly less than 0.50 for all groups. Beside this, on average 98 percent of children in our sample were attending local early childhood education centers which provide free childcare service on the weekdays. As a result, less than 1 percent of children used paid childcare services. This homogeneity of those children's characteristics reflects the fact that the survey randomly chose the children. On the other hand, child-related material expense, activity time, total household caring time, and caring time of the main caregiver are heterogeneous across family structures. Notably, a child without both parents received significantly lower investment, both in material and activity time.

The average income of the whole sample in 2015 was around 15,453 Baht per month, and the average income per adults (aged above 15) was approximately 5,085 Baht per month (see Table A.2). Apparently, households with no parents at home (considered only households with one child) have the lowest average income, around 8,445 Baht per month, while the

[4]Note that, among 45 percent of children living with relatives, most of their parents were still married but moved away to work somewhere else. Only 25 percent of those were divorced.

average income of a household with at least one parent is almost triple that. In addition, the average household size of the whole sample is about 4.71, which is slightly larger than the average household size of the whole country.[5] Again, households with no parents have the smallest size at 3.76.

4 Empirical Analysis

This section firstly estimates stylized linear models of time, material investment, total caring time and the main caregiver's caring time. These models are stylized in that they might be motivated by economic models implicitly, but could not be derived or linearized from a simple economic model (see a unitary model presented in Appendix D, for an example). Without an explicit linkage with an economic model, we find that some of the empirical results in this section are quite difficult to interpret. Therefore, we also estimate a structurally-linked specification derived explicitly from the economic model in Section 2. The results from both estimations should be complementary.

4.1 An Empirical Specification without an Explicit Economic Model

We focus mainly on three independent variables including family structures, child's gender, and household-average wage rate. More formally, let d_i^f denote a dummy variable for a child i living in a household without parents. That is, having-parent-at-home is excluded from the regression as the reference group. Similarly, let d_i^g be the dummy variable indicating if child i is a girl or not, and w_i be the average wage rate per hour of the household.

More specifically, we estimate the following linear specification for the impact of family structures, child's gender, and household wage rate on an outcome variable y_i:

$$y_i = \beta_w w_i + \beta_f d_i^f + \beta_g d_i^g + \boldsymbol{\beta}_0 \mathbf{X}_i + \epsilon_i, \tag{9}$$

[5]The average household size in a national representative household survey, the Socio-economic Survey of Thailand in 2015, is about 3.8.

where $\mathbf{X}_i$ is a set of control variables including income, remittance, number of adults (household members who are older than 15 years), number of children, memory digit span score of the questionnaire's respondent, child's birth weight, child's age, female head dummy, household head age, and a constant. As shown in Section 3, since the market for childcare service is so thin, we would not be able to observe as well as impute the price of childcare in our sample. We therefore exclude it from our estimation. Note further that income is highly correlated with imputed household-average wage rate[6]. Empirically, we found that the estimated coefficient for household-average wage rate would tend to be less significant when we include income in the estimation. On the other hand, the household-average wage rate is a key variable of interest. Therefore, the income variable used in all the analysis in this paper is a residual after linearly projecting income onto household-average wage rate.

The set of interested outcome variables[7] includes four child-specific variables, in which time use for developmentally appropriate activities (time investment) and expenditure on developmental material (material investment) are the key outcome variables. Another outcome variable is total caring time, which is the sum of child-rearing time from main caregiver and parents (if at home) only. Unfortunately, we might miss some inputs from other adults because the survey asked the caring time from those specific adults only. On the other hand, the activity time or time investment is from all adults. Therefore, estimations on total caring time should be interpreted with care. In addition, we also look at child caring time of the main caregiver alone. The baseline estimation uses specification (9) for each children-specific outcome using the sample of 775 children after accounting for missing values of all related regressors.

Moreover, we also estimate the above specifications using the log-form, where the dependent and independent variables are the logarithms of the corresponding variables when applicable. One might also argue that a household might have more than one preschool child which would affect household choices of allocations. To deal with this issue, we run specification (9) again with a restricted sample which includes only households with one

[6]The correlation between income and imputed selection-corrected wage rate per hour is 0.28.

[7]See Appendix B for the details of how we measure these variables.

preschool child.

4.2 An Empirical Specification from the Economic Model

Based on the optimal condition (8), we employ the following linear specification

$$\ln\left(\frac{I_t}{I_m}\right)_i = -\frac{1}{1-\rho}\ln w_i + \eta_f d_i^f + \eta_g d_i^g + \boldsymbol{\eta}_0 \mathbf{X}_i + \epsilon_i, \tag{10}$$

where I_t and I_m are time and material investment, respectively; and the $\mathbf{X}_i$ is the set of control variables similar with specification (9). Even though we do not observe μ directly, we will interpret the estimated impacts of family structures and child's gender through this parameter.

There are four potential channels through which the family structure can influence the household decision problem. The first one is entering as the altruism toward the child. More formally, the marginal utility of children skill θ potentially depends on the family structure σ, i.e., $U_\theta(c, \ell, \theta|\sigma) \neq U_\theta(c, \ell, \theta|\sigma')$ when $\sigma \neq \sigma'$. For example, we could think of an additively separable utility function, $U(c, \ell, \theta) = u(c, \ell) + \lambda(\sigma) v(\theta)$, where $\lambda(\sigma)$ is the altruistic level of the family towards the child as a function of the family structure.

The second channel is to influence the productivity of the skill formation A. It is possible that the biological mother and father are more effective in producing the child's skill, relative to other members of the household, e.g., grandparents. Under this simple unitary model, such difference in productivities can be incorporated as part of the productivity of skill production. More formally, the productivity of skill production is a function of the family structure σ, i.e., $A(\sigma)$. The third channel is the non-labor income $b(\sigma)$. As shown in Table A.1, the family structure is strongly correlated with the remittances.

Importantly, the first three channels do not enter equation (8) at all. That means if there were no other channel available, the coefficients of family structure dummy should have not been significant. On the other hand, if the coefficients are statistically significant, then there should be another or other channels through which family structure can impact parental investments.

The last channel and the only one that can potentially enter the model specification (8) is through the factor share of time investment in the production function, μ. Different generations might form different beliefs about the factor share. More specifically, the older generation may put more weight on time investment (higher μ) than the younger one. On the other hand, households with no parents tend to be dominated by the older generation. This implies that the term $\ln\left(\frac{1-\mu}{\mu}\right)$ for households with no biological parents should be smaller than those with at least one parent. Empirically, the coefficient of no-parent dummy or caregiver's age should be positive and significant.

Similarly, there are two potential channels through which the gender preference can influence the household decision problem. The first channel is entering as the altruism towards the child. For example, a household may feel more altruistic towards boys than girls. More specifically, with an additively separable utility function presented above, this argument implies that $\lambda\left(boys\right) > \lambda\left(girls\right)$. Again this channel does not enter the specification (8).

The second one is through the factor share of time investment in the production function, μ. For example, the adult might believe that the factor share of time investment is higher for girls than for boys, i.e., $\mu\left(girls\right) > \mu\left(boys\right)$. This implies that the coefficient of the dummy for girls should be positive.

4.3 Imputation of the Hourly Household-Average Wage

We obtained all variables discussed earlier from the RIECE data except the hourly household-average wage. The wage variable is calculated by first estimating a sample-selection-corrected wage equation using the Labor Force Survey[8] (LFS) and then imputing an individual wage based on the individual characteristics from the RIECE data.

More specifically, we estimated the two-step Heckman estimation (Heckman, 1974, 1976)

[8]The Labor Force Survey is a national representative labor dataset of Thailand. The survey has been conducted by the National Statistical Office of Thailand since 1985. To better match with our data, we use the LFS data from the rural Northeast part of Thailand in the third quarter of 2015.

based on the following specification:

$$\ln w_i = \beta_0 + \beta_1 s_i + \beta_2 Expr_i + \beta_3 ExprSq_i + \beta_4 d_i^g + \beta_5 d_i^m + \epsilon_i \tag{11}$$

where s_i denotes the years of education of individual i; $Expr$ and $ExprSq$ denote potential experience and its square, respectively; d_i^g and d_i^m denote female dummy and marital status. Our problem is slightly different from the labor force participation considered in Kimmel and Connelly (2007). Our RIECE sample includes a significant fraction (44.84 percent) of individuals who were not wage workers[9], but we would like to get their imputed wage. For simplicity, we divided the LFS sample into two groups, wage workers and the rest. As a result, our exclusion restrictions are the ratio of years of schooling of each individual to the highest years of schooling of all household members, and male adult ratio, which capture the occupation selection of the rural population. These instrumental variables enter the selection equation (into the wage earning occupation), but not the wage equation. The selection equation also includes all control variables in the wage equation (11). Note that the inversed Mills ratio in the second step is significant at 1 percent level.

We then imputed the log hourly wage of each individual using the estimated coefficients from the two-step model and individual characteristics from the RIECE data. The hourly household-average wage was then calculated by averaging the hourly wage of all adults in the household. For robustness, we also used a simple Mincerian estimation based on specification (11) as an alternative measure of wage rate. See Table 1 in Online Appendix for the estimates of sample-selection-corrected wage regression and Mincerian wage regression.

5 Empirical Results

This section firstly presents and discusses the impacts of determinant variables on key outcome variables. For convenience, the estimated coefficients of the variables of interest from

[9]Non-wage-workers are individuals who are out of labor force (15 percent), unemployed (0.38 percent), working in agriculture only (28.6 percent), working in family business only (3.05 percent), and working in both agriculture and family business (12.8 percent).

specifications (9) are summarized in Tables 1 - 4. The first four columns of each table present the effects of key determinants on the dependent variable of interest using the imputed selection-corrected household-average wage while the other four columns use Mincerian household-average wage. Each table is also organized into two main panels. The upper and lower panel represent the results from the baseline and the restricted sample estimation, respectively. We then end this section by discussing the estimation results of the structurally-linked specification (10) in Tables 5 and 6. Full tables of all regressions, including the log-form specifications of outcome variables are available in Tables 2 - 19 in the Online Appendix.

5.1 Impacts of Family Structures

The estimation coefficient of household structure variable in the baseline specification for time investment (the first row and first column on the upper panel of Table 1) is negative and statistically significant. On the other hand, when we restricted the sample to households with only one preschool child, this effect is no more significant (see the lower panel of Table 1). Note that the difference between the two samples is still intact when we use the Mincerian-imputed wage. The question is why the estimation results are different between the two samples.

One potential argument is that we have not accounted for caregiver's characteristics, particularly age and education. Firstly, the older the main caregiver, the more the preference for leisure of the elderly. On the other hand, the higher the leisure preference, the lower the time investment. Secondly, an older and lower education person might have a lower productivity of human capital formation, A, which can lead to less time investment. Thirdly, different generations might form different beliefs about the factor share of time investment, μ. Specifically, the older generation may put more weight on time investment (higher μ) than the younger one because they had been raised with minimal materials in the past due to lack of resources.

To test the ideas, we added caregiver's age, education, and both into the specification, and

the estimation results are presented in the second, third and fourth columns, respectively. The results in Table 1 confirm that the caregiver's age is the key determinant to time investment, not the household structure per se. In particular, the family structure variable is not significant in both the baseline and the restricted sample estimations after controlling for either caregiver's age or education. On the other hand, the caregiver's age is negative and statistically significant in all specifications, as anticipated, while education is not significant. Given that the caregiver in an average household with no parents is about 16 years older than the one with at least one parent, the baseline estimation result in the second column of Table 1 implies that the former group spent about 7 hours per month (0.441×16) of activity time less than the latter.

Family structure does matter to material investment, however. The estimates of the no-parents dummy variable are negatively significant for material investment in all specifications (see the first row in each panel of Table 2). The results estimated from the whole sample imply that after controlling for income and remittance, an average no-parent household still spends less on developmental materials than an average at least one parent household by roughly 254 Baht per month. It is worthy of emphasis that after controlling for both age and education of the caregiver, the estimates of no-parent variable are still significant with material investment while they are not with time investment. This might be due to the fact that investing in developmental materials does not require the join-presence of parents as caregiver with the child in the same way that time investment does. As long as they are at home, parents can regularly bring home developmental materials. As a result, households with at least one parent invest in material more than the other. To sum up, we found that family structure is significant for material investment but not for time after controlling for caregiver's age.

To better compare with the literature (e.g., Barcellos et al. (2014)), we also report the estimation results for caring time of the household and caring time of main caregiver in Tables 3 and 4. The results in Table 3 indicate that children living with only relatives receive a substantially less amount of caring. And this result is robust to all specification changes. It

is not so surprising to see that having at least one parent at home means significantly more caring time. But it is interesting to learn that having no parent at home increases the caring time from the main caregiver, as shown in Table 4. In fact, the baseline estimation implies that the main caregiver in a family without parent spends about 15 hours per month more than in a family with parents. This is because without a parent at home the main caregiver needs to be fully responsible all the time. On the other hand, in a family with at least one parent, the main caregiver can leave the child with his/her parents when they are at home. That would reduce the caring time from the main caregiver, but potentially increase the sum of caring time from both the main caregiver and the parents.

5.2 Impacts of Child's Gender

All estimations consistently confirm that girls receive less developmental material investment, but more time investment. In particular, the baseline estimation suggests that a girl receives about 140 Baht per month less in material investment (see the second row, first column in the upper panel of Table 2). The impact is slightly larger in magnitude when we restrict the sample to households with one child only. The negative effect of girl dummy in this paper is in contrast to Kornrich and Furstenberg (2013) who used American Consumer Expenditure Survey to show that girls enjoy more advantage in household spending than boys.

On the other hand, girls receive roughly 10 hours per month more of activity time than boys. This result is again robust across all specifications. However, the results are different when we consider household caring time and the main caregiver's caring time. The impact on total caring time is negative but rarely significant. In addition, the effect of a girl on main caregiver's caring time is significantly negative in most of the specifications. This negative impact on the main caregiver's caring time is similar to Barcellos et al. (2014), who found that boys in India receive significantly more caring time than girls. On the contrary, our findings suggest that Thai girls receive more time investment when we consider activity time as the time investment. This difference is likely to stem from the fact that Barcellos et al. (2014) did not focus on the activity time, which is more developmentally related.

Overall, girls receive more developmentally appropriate activity time, but less material investment. As discussed further in Section 4.2, our findings suggest that households may believe that activity time input is more productive relative to material investment for girls than for boys.

5.3 Impacts of Household-Average Wage Rate

Another key variable of interest is the household-average wage rate, which in principle should reflect both an opportunity cost of time and purchasing power. Again the most robust part is for the material investment (see Table 2). In particular, the baseline estimation suggests that one Baht increase in average potential wage rate per hour raises 8-9 Baht per month of the developmental material expenses. Remember that the imputed wage is predicted by two methods, two-step Heckman procedure and Mincerian regression, both of which used education and potential experience of adults in the households as key determinants. Higher-potential-wage households must have higher education, which implies a larger productivity of human capital production. As a result, they should invest in developmental materials more than a lower potential-wage household.

The same reason can explain the positive impact of the potential wage rate on time investment as well. The baseline estimation implies that one Baht increase in average potential wage raises 0.2 hour per month (see Table 1). This positive impact is robust to specification changes. In fact, it is also the case for household caring time. This positive result is consistent with Kimmel and Connelly (2007), who suggested that this positive impact results from a strong income effect. However, given that households in our sample are mostly poor with noticeably low potential wages[10], it is more sensible to explain our positive result using the productivity instead of an income effect. Note also that we could not find a significant impact of potential wage on the main caregiver's caring time. This is consistent with Hallberg

[10]The average potential two-step Heckman wage and Mincerian wage in our data is respectively about 43.5 and 44.2 Baht per hour, which is roughly 350 Baht per day for an eight-hour working-day. This level is slightly higher than the minimum wage in Thailand, which was at 300 Baht per day in 2015.

and Klevmarken (2003) and Kooreman and Kapteyn (1987), who showed that own wages do not affect childcare time. The difference between the impacts on the main caregiver's caring and household activity time suggests that they are distinct and should be treated differently.

To summarize, we so far have shown that (i) family structure matters only for material investment but not for time investment, (ii) girls receive more time investment but less material, and (iii) household wage raises both time and material investments. However, it is still difficult to link these results with fundamental parameters of the economic model. To shed light on this issue, we estimate below the structurally-linked specification (10), which is based on the optimal condition of the economic model (8). The advantage of this estimation specification is that it is clear which parameters of the model should affect the results. More specifically, only two parameters, the factor share of time investment μ and the elasticity of substitution $\frac{1}{1-\rho}$, enter this model. Therefore, we can interpret the estimation results based on those parameters only.

5.4 Results of the Structurally-Linked Estimation

As discussed earlier, any variables other than wage could enter the specification (10) only through the factor share of time investment μ. On the other hand, the coefficient of log wage is the elasticity of substitution $\frac{1}{1-\rho}$. Therefore, we should interpret the results accordingly.

Let us begin with the impact of the child's gender, which is strongly robust. Estimation results in both Tables 5 and 6 show a strongly positive significance of female child dummy in all specifications. These suggest that a household might believe that the factor share of time investment is higher for girls than for boys, as discussed in Section 4.2. This difference in the factor share could really describe the true production function (girls and boys create their skills differently), or just reflect the belief of adults. Unfortunately, we are unable to distinguish between these possibilities.

The results in Tables 5 and 6 (the first row of each table) suggest that family structure matters, but not as robustly as the child's gender. The positive significance of the coefficients indicates that household without parents again has a larger factor share. Similarly, the

positive impact of caregiver's age (the fifth row of each table) implies that an older generation might put more weight on time investment (higher factor share μ) than the younger one. As discussed in Section 5.1, there could be more channels through which different generations could affect their investment in a child. Unfortunately, we can only show that the factor share part seems significant but cannot say anything regarding leisure preference and productivity of skill formation. Note also that these results suggest that one should have both family structures and caregiver's age in an estimation of parental investment.

We also found that the family structure affects girls and boys differently. The results in column (5) and (11) of Tables 5 and 6 show that the coefficients of the interaction term between female child dummy and no-parents variable are positively significant. On the other hand, the estimates of no-parents variable become much smaller and are not only insignificant anymore. These results suggest that the family structure has a significant impact on girls, but not on boys. This finding is consistent with our arguments above. Recall that the factor share should be higher for girls and for no-parents households. Subsequently, the impacts of both factors amplify the magnitude and significant level as seen in the estimated coefficients of the interaction term, which is generally larger than the original no-parents coefficient. On the other hand, the impacts of boys (lower factor share) and no-parents (higher factor share) seem to offset each other, leading to an insignificant result of the no-parents dummy.

As mentioned above, the coefficient of log wage can be interpreted as the elasticity of substitution $\frac{1}{1-\rho}$. The estimation results with the two-step Heckman wage and no interaction term with the wage variable in Table 5 indicated that the elasticity of substitution ranges from 0.584 to 0.749 (except one case with an insignificant result). Moreover, we formally tested whether the estimated coefficient is equal to one (being a Cobb-Douglas). We found that the hypothesis could not be rejected in all cases when both caregiver's age and caregiver's education were included. The results were then confirmed with the Mincerian wage and with the restricted sample with one child only. This rejection implied that it may be reasonable to assume that the technology of skill formation is a Cobb-Douglas function in this early childhood development context.

The estimation results with the interaction term between female child dummy and household-average wage suggest that the elasticity of substitution for girls is significantly larger than for boys. In particular, the estimated coefficients of the interaction term in column (6) and (12) of Table 5 are negatively significant, while the coefficients of log wage are still negative but not significant anymore. We again fail to reject the hypothesis that the production function is Cobb-Douglas for girls but can reject it for boys. However, the result is not robust to a sample restricted to one child households, as shown in Table 6.

6 Conclusion

We have analyzed the parental time and material investments in rural Thailand using two complementary approaches, a flexible reduced-form model without an explicit link to an economic model, and a structurally-linked model derived from an economic model. We mainly focused on the roles of child's gender, family structure and household-average wage on parental investments.

Our findings consistently showed that female children received more time but less material investments. This result is robust to all specification changes. Our structurally-linked estimation then suggested that this phenomenon may result partly from the difference in the factor share of time investment between boys and girls. In particular, a household might believe that time is more important (relative to material investment) for girls than boys. Unfortunately, we could not yet tell if this difference is a true nature of the skill formation processes or simply a false belief. It is, of course, important to distinguish between the two. But it requires more information than we do have at the present. In order to answer this question in the near future, we are currently collecting the data on caregiver beliefs regarding time and material investments following Cunha et al. (2013).

The impact of family structure is more subtle, however. It seems to significantly affect only material investment after controlling for caregivers' age. On the other hand, the structurally-linked estimation suggested that a household without parents or with an older caregiver tends to put more weight on time investment. In addition, adults in a household

with no parents tend to be old. Putting together, we might conclude that an older household would put more weight on time investment. Perhaps a better interpretation would be that the older generation does not only invest less in both time and material, but also puts more weight on time investment (relative to the material) than the younger generation. In other words, it is not age per se that matters. It is different life-experiences between the two generations that lead to disparate beliefs.

Another contribution of the paper is the estimation of the elasticity of substitution between time and material investments, which is a fundamental parameter of the economic model. The estimates suggested that both of the inputs are surprisingly complementary, with none of the elasticities ever greater than one. In other words, rural Thai households seem to realize that they need to invest in both time and materials at the same time. Note that our formal tests indicated that we could not reject that the production function is Cobb-Douglas, however. Again, we could not tell if the estimated elasticity of substitution is simply caregivers' belief or a true parameter of the production function. Hopefully, with the additional data on caregivers' expectations, we will be able to answer this question in the future.

One surprising result, even for us, is an indifferent effect of family structure on time investment. This is a very good news. However, this paper only looked at the quantity of the investment. Participating in the same type of developmental activities may not guarantee the same outcomes. The quality of an adult-child interaction matters enormously. Therefore, it is important to understand the diversity of the quality of time investment across family structures. With the limitation of data, we have to leave this question unanswered in this paper.

Another limitation of this paper concerns the measurement of the time and material investments, each of which was an aggregate investment the child received from all adults in the households. That is, we cannot observe precisely who spent time interacting with the child or bought those developmentally appropriate materials for the child. This issue could be crucial for understanding the role of family structure on parental investments and

more generally an intra-household allocation in a collective model (e.g., Blundell et al., 2005). We also left another issue unanswered for future research. One testable implication of our economic model with homotheticity is that the log ratio between time and material investments should not depend on any preference parameter. To test this implication, we need data on household preferences, e.g., hyperbolic discounting or risk aversion.

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Table 1: The impacts of interested determinants on time investment

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Baseline sample estimations								
No parents at home	-5.933*	-0.342	-4.210	-0.704	-5.820*	-0.242	-4.041	-0.493
	(3.390)	(3.834)	(3.787)	(3.873)	(3.409)	(3.858)	(3.782)	(3.883)
Female child dummy	10.41***	10.60***	10.18***	10.52***	10.40***	10.59***	10.20***	10.52***
	(3.044)	(3.120)	(3.089)	(3.126)	(3.045)	(3.121)	(3.090)	(3.128)
Heckman wage	0.205*	0.250**	0.136	0.320**				
	(0.106)	(0.110)	(0.133)	(0.157)				
Mincerian wage					0.204*	0.251**	0.125	0.316*
					(0.112)	(0.117)	(0.140)	(0.167)
Caregiver's age		-0.441***		-0.542***		-0.438***		-0.526**
		(0.142)		(0.204)		(0.143)		(0.206)
Caregiver's yrs of schooling			0.765	-0.594			0.819	-0.516
			(0.562)	(0.812)			(0.561)	(0.818)
Adjusted R^2	0.035	0.044	0.037	0.043	0.034	0.043	0.037	0.042
Observations	775	745	759	745	775	745	759	745
Restricted sample estimations								
No parents at home	-4.293	2.230	-1.549	2.129	-4.086	2.411	-1.393	2.352
	(3.997)	(4.451)	(4.425)	(4.510)	(4.006)	(4.465)	(4.409)	(4.505)
Female child dummy	10.18***	10.16***	9.799***	10.15***	10.18***	10.16***	9.800***	10.15***
	(3.434)	(3.488)	(3.464)	(3.495)	(3.435)	(3.490)	(3.464)	(3.496)
Heckman wage	0.267**	0.295***	0.151	0.316*				
	(0.111)	(0.113)	(0.143)	(0.170)				
Mincerian wage					0.276**	0.305**	0.147	0.322*
					(0.119)	(0.121)	(0.152)	(0.183)
Caregiver's age		-0.521***		-0.553**		-0.518***		-0.542**
		(0.181)		(0.244)		(0.181)		(0.247)
Caregiver's yrs of schooling			1.141	-0.188			1.180*	-0.142
			(0.702)	(0.978)			(0.705)	(0.991)
Adjusted R^2	0.033	0.043	0.036	0.042	0.033	0.043	0.035	0.041
Observations	607	589	599	589	607	589	599	589

Robust standard errors in parentheses; * $p < 0.10$, ** $p < 0.05$, *** $p < 0.010$.

Table 2: The impacts of interested determinants on material investment

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Baseline sample estimations								
No parents at home	-254.3***	-148.7**	-179.0**	-143.1**	-246.4***	-140.2**	-178.0**	-137.3*
	(59.97)	(68.81)	(72.19)	(72.60)	(59.51)	(68.16)	(71.36)	(71.32)
Female child dummy	-148.1***	-135.8**	-134.8**	-134.7**	-148.3***	-135.9**	-135.3**	-135.1**
	(55.01)	(57.14)	(56.68)	(57.74)	(54.96)	(57.09)	(56.65)	(57.71)
Heckman wage	8.328***	8.610***	5.724*	7.497**				
	(2.502)	(2.573)	(3.249)	(3.459)				
Mincerian wage					9.138***	9.439***	6.533*	8.657**
					(2.682)	(2.761)	(3.535)	(3.793)
Caregiver's age		-7.739***		-6.124*		-7.757***		-6.696**
		(2.961)		(3.175)		(2.960)		(3.193)
Caregiver's yrs of schooling			22.66	9.523			21.11	6.266
			(14.49)	(17.61)			(14.69)	(17.95)
Adjusted R^2	0.079	0.083	0.080	0.082	0.080	0.085	0.081	0.083
Observations	775	745	759	745	775	745	759	745
Restricted sample estimations								
No parents at home	-254.6***	-164.4*	-206.4**	-163.0*	-245.5***	-155.0*	-205.2**	-155.8*
	(72.44)	(84.47)	(89.28)	(88.65)	(71.85)	(83.58)	(88.33)	(87.00)
Female child dummy	-160.5***	-151.9**	-152.7**	-151.7**	-160.1***	-151.6**	-152.8**	-151.7**
	(61.15)	(62.93)	(62.40)	(63.16)	(61.09)	(62.85)	(62.33)	(63.08)
Heckman wage	8.458***	8.892***	6.819*	8.602**				
	(2.856)	(2.822)	(3.733)	(3.946)				
Mincerian wage					9.411***	9.858***	7.887*	10.09**
					(3.098)	(3.062)	(4.106)	(4.374)
Caregiver's age		-7.338**		-6.888*		-7.344**		-7.682*
		(3.548)		(4.162)		(3.546)		(4.176)
Caregiver's yrs of schooling			16.66	2.663			14.30	-2.004
			(16.99)	(21.62)			(17.31)	(22.11)
Adjusted R^2	0.095	0.099	0.095	0.098	0.098	0.102	0.096	0.100
Observations	608	590	600	590	608	590	600	590

Robust standard errors in parentheses; * $p < 0.10$, ** $p < 0.05$, *** $p < 0.010$.

Table 3: The impacts of interested determinants on total caring time

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Baseline sample estimations								
No parents at home	-101.5***	-135.1***	-126.1***	-137.1***	-101.2***	-134.9***	-124.9***	-136.5***
	(9.021)	(10.87)	(10.18)	(11.03)	(9.043)	(10.87)	(10.13)	(11.01)
Female child dummy	-8.542	-11.41	-11.59	-11.80	-8.551	-11.43	-11.67	-11.83
	(7.850)	(7.808)	(7.753)	(7.785)	(7.851)	(7.810)	(7.752)	(7.785)
Heckman wage	0.655**	0.579**	1.726***	0.978***				
	(0.276)	(0.257)	(0.354)	(0.354)				
Mincerian wage					0.677**	0.602**	1.834***	1.030***
					(0.291)	(0.271)	(0.374)	(0.379)
Caregiver's age		2.712***		2.127***		2.716***		2.131***
		(0.508)		(0.604)		(0.508)		(0.604)
Caregiver's yrs of schooling			-9.130***	-3.421			-9.236***	-3.430
			(1.878)	(2.273)			(1.901)	(2.306)
Adjusted R^2	0.369	0.406	0.398	0.407	0.369	0.406	0.397	0.407
Observations	771	742	756	742	771	742	756	742
Restricted sample estimations								
No parents at home	-105.4***	-134.2***	-128.1***	-136.6***	-105.1***	-133.9***	-126.8***	-135.8***
	(10.30)	(12.71)	(11.64)	(12.86)	(10.30)	(12.70)	(11.57)	(12.82)
Female child dummy	-5.844	-6.962	-6.901	-7.162	-5.855	-6.982	-6.926	-7.182
	(8.717)	(8.711)	(8.610)	(8.670)	(8.720)	(8.714)	(8.612)	(8.674)
Heckman wage	0.663**	0.531*	1.613***	1.057***				
	(0.293)	(0.272)	(0.389)	(0.383)				
Mincerian wage					0.678**	0.545*	1.713***	1.109***
					(0.313)	(0.290)	(0.419)	(0.414)
Caregiver's age		2.506***		1.678**		2.512***		1.690**
		(0.636)		(0.708)		(0.635)		(0.705)
Caregiver's yrs of schooling			-9.554***	-4.863*			-9.645***	-4.850*
			(2.229)	(2.546)			(2.269)	(2.588)
Adjusted R^2	0.367	0.391	0.392	0.395	0.367	0.391	0.392	0.394
Observations	605	587	597	587	605	587	597	587

Robust standard errors in parentheses; * $p < 0.10$, ** $p < 0.05$, *** $p < 0.010$.

Table 4: The impacts of interested determinants on caring time of main caregiver

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Baseline sample estimations								
No parents at home	15.34***	13.12**	13.32***	13.07**	15.33***	13.23**	13.41***	13.16**
	(4.952)	(5.246)	(5.153)	(5.282)	(4.971)	(5.251)	(5.136)	(5.279)
Female child dummy	-6.751*	-6.597*	-7.278**	-6.608*	-6.750*	-6.598*	-7.293**	-6.616*
	(3.755)	(3.740)	(3.672)	(3.713)	(3.755)	(3.740)	(3.669)	(3.710)
Heckman wage	-0.123	-0.0131	0.0747	-0.00339				
	(0.146)	(0.128)	(0.163)	(0.189)				
Mincerian wage					-0.129	-0.0111	0.0856	0.00566
					(0.154)	(0.135)	(0.176)	(0.202)
Caregiver's age		0.204		0.190		0.204		0.181
		(0.207)		(0.281)		(0.206)		(0.280)
Caregiver's yrs of schooling			-0.720	-0.0827			-0.756	-0.134
			(0.795)	(1.099)			(0.805)	(1.112)
Adjusted R^2	0.038	0.040	0.040	0.039	0.038	0.040	0.040	0.039
Observations	776	746	760	746	776	746	760	746
Restricted sample estimations								
No parents at home	13.55**	12.69**	12.09**	12.51**	13.64**	12.76**	12.23**	12.63**
	(5.672)	(6.329)	(6.037)	(6.323)	(5.671)	(6.324)	(6.012)	(6.318)
Female child dummy	-8.634**	-8.516**	-8.483**	-8.538**	-8.634**	-8.518**	-8.486**	-8.540**
	(4.192)	(4.270)	(4.195)	(4.256)	(4.193)	(4.271)	(4.195)	(4.256)
Heckman wage	-0.00607	-0.0112	0.0607	0.0254				
	(0.139)	(0.139)	(0.180)	(0.208)				
Mincerian wage					-0.0109	-0.0155	0.0625	0.0239
					(0.149)	(0.149)	(0.196)	(0.226)
Caregiver's age		0.103		0.0463		0.104		0.0472
		(0.258)		(0.347)		(0.257)		(0.345)
Caregiver's yrs of schooling			-0.686	-0.337			-0.696	-0.338
			(0.964)	(1.336)			(0.980)	(1.356)
Adjusted R^2	0.050	0.046	0.047	0.044	0.050	0.046	0.047	0.044
Observations	608	590	600	590	608	590	600	590

Robust standard errors in parentheses; * $p < 0.10$, ** $p < 0.05$, *** $p < 0.010$.

Table 5: The impacts of the interested determinants on the logarithm of the ratio between time and material investments using the baseline sample

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
No parents at home	0.487***	0.293	0.365*	0.301	0.0133	0.319	0.476***	0.283	0.362*	0.291	-0.0000515	0.307
	(0.174)	(0.192)	(0.195)	(0.196)	(0.248)	(0.196)	(0.175)	(0.193)	(0.194)	(0.196)	(0.247)	(0.195)
Child female dummy	0.932***	0.904***	0.907***	0.905***	0.672***	3.945***	0.933***	0.905***	0.908***	0.906***	0.671***	3.815**
	(0.132)	(0.135)	(0.135)	(0.136)	(0.166)	(1.465)	(0.132)	(0.135)	(0.135)	(0.136)	(0.166)	(1.530)
Log Heckman wage	-0.584***	-0.625***	-0.397	-0.731**	-0.749**	-0.346						
	(0.211)	(0.215)	(0.253)	(0.307)	(0.304)	(0.341)						
Log Mincerian wage							-0.627***	-0.665***	-0.439*	-0.793**	-0.817**	-0.423
							(0.220)	(0.224)	(0.265)	(0.320)	(0.317)	(0.358)
Log caregiver's age		0.533**		0.647*	0.644*	0.638*		0.530**		0.663*	0.663*	0.656*
		(0.258)		(0.361)	(0.359)	(0.356)		(0.257)		(0.358)	(0.357)	(0.354)
Log caregiver's yrs of schooling			-0.223	0.124	0.0952	0.125			-0.212	0.145	0.120	0.145
			(0.193)	(0.273)	(0.273)	(0.271)			(0.194)	(0.274)	(0.274)	(0.272)
Female & No parents at home					0.585**						0.589**	
					(0.289)						(0.289)	
Female & Log Heckman wage						-0.815**						
						(0.385)						
Female & Log Mincer wage												-0.777*
												(0.400)
Null hypothesis: $\frac{1}{1-\rho}=1$	Reject	Reject	Reject	Fail	Fail	Reject	Reject	Fail	Reject	Fail	Fail	Reject
Adjusted R^2	0.105	0.110	0.104	0.109	0.114	0.112	0.106	0.110	0.104	0.109	0.114	0.112
Observations	636	616	623	615	615	615	636	616	623	615	615	615

Robust standard errors in parentheses; * $p<0.10$, ** $p<0.05$, *** $p<0.010$.

Table 6: The impacts of the interested determinants on the logarithm of the ratio between time and material investments using the restricted sample of households with one preschool child only

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
No parents at home	0.579***	0.468**	0.539**	0.474**	0.152	0.484**	0.569***	0.460**	0.533**	0.461**	0.135	0.471**
	(0.201)	(0.223)	(0.219)	(0.224)	(0.271)	(0.225)	(0.202)	(0.224)	(0.218)	(0.224)	(0.271)	(0.225)
Child female dummy	0.904***	0.877***	0.877***	0.879***	0.579***	2.529	0.904***	0.878***	0.877***	0.879***	0.577***	2.428
	(0.154)	(0.157)	(0.156)	(0.158)	(0.197)	(1.595)	(0.154)	(0.157)	(0.156)	(0.158)	(0.197)	(1.672)
Log Heckman wage	-0.473**	-0.515**	-0.464*	-0.758**	-0.773**	-0.552						
	(0.229)	(0.231)	(0.275)	(0.337)	(0.333)	(0.373)						
Log Mincerian wage							-0.504**	-0.545**	-0.501*	-0.811**	-0.835**	-0.615
							(0.240)	(0.242)	(0.290)	(0.352)	(0.349)	(0.393)
Log caregiver's age		0.327		0.621	0.583	0.617		0.323		0.630	0.597	0.627
		(0.301)		(0.415)	(0.409)	(0.412)		(0.301)		(0.411)	(0.405)	(0.409)
Log caregiver's yrs of schooling			-0.0224	0.301	0.263	0.298			-0.0125	0.318	0.285	0.314
			(0.213)	(0.300)	(0.299)	(0.298)			(0.214)	(0.300)	(0.299)	(0.299)
Female & No parents at home					0.712**						0.718**	
					(0.333)						(0.333)	
Female & Log Heckman wage						-0.444						
						(0.419)						
Female & Log Mincer wage												-0.414
												(0.437)
Null hypothesis: $\frac{1}{1-\rho} = 1$	Reject	Reject	Reject	Fail	Fail	Fail	Reject	Reject	Reject	Fail	Fail	Fail
Adjusted R^2	0.091	0.090	0.085	0.090	0.097	0.089	0.091	0.091	0.086	0.090	0.098	0.090
Observations	500	487	492	486	486	486	500	487	492	486	486	486

Robust standard errors in parentheses; * $p < 0.10$, ** $p < 0.05$, *** $p < 0.010$.

A Summary statistics

Table A.1: Summary statistics of children's characteristics by family structures

	With parent	Without parents	Total	Obs	Whole sample	Obs
Female child dummy	0.46	0.48	0.47	775	0.49	1101
	(.5)	(.5)	(.5)		(.5)	
Birth weight	3.03	3.07	3.05	775	3.05	1064
(kilogram)	(.48)	(.46)	(.47)		(.47)	
Child age	39.16	39.81	39.46	775	39.40	1055
	(7.54)	(8.01)	(7.76)		(7.8)	
Parental remittance	1561	6135	3654	775	3365	1085
(Baht per month)	(3842)	(6551)	(5728)		(5612)	
Attending child care center	0.98	0.98	0.98	775	0.98	1102
	(.14)	(.14)	(.14)		(.14)	
Using paid childcare service	0.01	0.00	0.01	775	0.006	1103
	(.1)	(.05)	(.08)		(.079)	
Material Expense	585	267	439	775	490	1102
(Baht per month)	(1018)	(463)	(827)		(973)	
Activity time	45.98	36.77	41.77	775	42.32	1102
(Hours per month)	(42.69)	(40.78)	(42.05)		(43.45)	
Caring time	429	280	361	775	368	1098
(Hours per month)	(148)	(48)	(136)		(140)	
Main caregiver's caring time	265	280	272	775	271	1103
(Hours per month)	(58)	(48)	(54)		(54)	
Fraction of sample	54.65%	45.35%	100%			

† Standard deviations in parentheses. Obs is number of observations. The first four columns report statistics and numbers of observations of child-related variables for the sample used in the baseline estimation. The last two columns show the statistics of children's characteristics and number of observations of the whole sample.

Table A.2: Summary statistics of household's characteristics by family structures

	With parent	Without parents	Total	Obs	Whole sample	Obs
Income	20564	8445	14784	606	15453	892
(Baht per month)	(24731)	(12254)	(20680)		(20821)	
Income per adult	6494	3558	5094	606	5085	892
(Baht per month)	(7307)	(5062)	(6499)		(6541)	
Two-step Heckman wage	46.16	39.52	43.00	606	43.50	938
(Baht per hour)	(16.41)	(18.81)	(17.89)		(17.02)	
Mincerian wage	47.18	39.68	43.60	606	44.18	938
(Baht per hour)	(15.65)	(17.51)	(16.97)		(16.28)	
Household size	4.78	3.76	4.29	606	4.71	1023
	(1.31)	(1.09)	(1.31)		(1.53)	
No. of adults	3.21	2.25	2.75	606	3.01	1023
	(1.22)	(.88)	(1.17)		(1.29)	
Memory digit span score	7.78	6.76	7.30	606	7.23	1041
	(1.61)	(1.39)	(1.59)		(1.54)	
Highest years of schooling	11.56	7.36	9.56	606	9.95	1023
	(2.83)	(3.39)	(3.75)		(3.81)	
Age of household head	48.83	55.54	52.03	606	52.61	1044
	(13.45)	(8.26)	(11.76)		(12.25)	
Female household head	0.45	0.47	0.46	606	0.46	1052
	(.5)	(.5)	(.5)		(.5)	
Faction of female	0.53	0.54	0.53	606	0.53	1023
	(.17)	(.2)	(.19)		(.18)	

† Standard deviations in parentheses. Obs is number of observations. The first four columns report statistics and numbers of observations of household-related variables used in the restricted-sample estimation (households with one child only.) The last two columns show the statistics of household's characteristics and number of observations of the whole sample.

Table A.3: Summary statistics of parent and caregiver's characteristics by family structures

	With parent	Without parents	Total	Obs	Whole sample	Obs
Father's age	34.03	30.75	33.02	503	32.68	826
	(7.42)	(5.34)	(7.)		(6.96)	
Mother's age	30.47	27.96	29.69	503	29.33	940
	(6.46)	(4.84)	(6.11)		(6.18)	
Caregiver's age	36.50	52.28	41.39	503	44.56	1010
	(10.85)	(8.)	(12.42)		(13.25)	
Caregiver female dummy	0.93	0.89	0.92	503	0.91	1045
	(.26)	(.31)	(.28)		(.28)	
Father's yrs of schooling	10.21	10.92	10.43	503	10.50	927
	(3.12)	(2.85)	(3.05)		(3.13)	
Mother's yrs of schooling	10.84	11.43	11.03	503	10.90	1021
	(3.15)	(2.82)	(3.06)		(3.07)	
Caregiver's yrs of schooling	9.46	5.46	8.22	503	7.45	1044
	(3.66)	(2.53)	(3.82)		(3.77)	

† Standard deviations in parentheses. Obs is number of observations. The first four columns report statistics and numbers of observations of children-related variables for the sample used in the baseline estimation. The last two columns show the statistics of children's characteristics and number of observations of the whole sample.

B Detailed construction of key variables

This Appendix describes how we construct some key variables including monthly income, memory digit span score, time and material investments, total caring time.

Monthly household income

Using highly detailed data from the survey, we first convert each income source to an annual basis. We then sum all the sources of income, including wage, agricultural products, livestocks, household business, for each adult. We then sum the annual income across all adults in the household and divide by 12 months to get monthly household income.

Memory digit span score

Memory digit span tests the respondent's ability to hold a sequence of numbers in memory. It requires the respondent to firstly read out loud a sequence of number, wait for 10 seconds, and then recall the sequence correctly in their forward order. Digit sequences are presented at beginning with 4 digits and ending with 11 digits. Memory digit span score is the maximum number of digits that the respondent can recall correctly.

Time investment

Time investment in this paper is constructed from the amount of time that adults in the household monthly interact with the child through developmentally appropriate activities, including helping the child to learn letters, numbers, sorting and comparing; playing blocks, drawing, coloring and inventing with the child; singing, dancing and playing sports with the child; and reading books to the child.

Material investment

We first sum annual expenditures that household spends on purchasing developmentally appropriate materials including books, toys, learning devices then divide it by 12 months.

Total caring time

Total caring time is the sum of monthly child-rearing time from main caregiver and parents (if at home). We count child-rearing time of each individual above in schooling day and weekend or holiday separately. The rearing time of a schooling day starts since the child wakes up until going to school plus after school until going to bed. The rearing time of a weekend day or holiday is counted since s/he wakes up until going to bed.

C Time and material investment questionnaire

C.1 Time use for child caring

The interviewer calculates amount of time per week and record in the relevant variables

6A)	How many hour per week that father spend time to take care (child name)?				**For interviewer**
	(If child's father live outside household, record "NA" in CC6A)				(hours)
	Monday - Friday	Before school	From ..... (am)	to ..... (am)	CC6A:.....
		After school (until going to bed)	From ..... (pm)	to ..... (pm)	
	Weekend or holiday		From	to	
6B)	How many hour per week that mother spend time to take care (child name)?				
	(If child's mother live outside household, record "NA" in CC6B)				
	Monday - Friday	Before school	From ..... (am)	to ..... (am)	CC6B:.....
		After school (until going to bed)	From ..... (pm)	to ..... (pm)	
	Weekend or holiday		From	to	
6C)	How many hour per week you take care (child name)?				
	(If child's father or mother is the primary caregiver, record "NA" in CC6C)				
	Monday - Friday	Before school	From ..... (am)	to ..... (am)	CC6C:.....
		After school (until going to bed)	From ..... (am)	to ..... (am)	
	Weekend or holiday		From	to	

Note: do not count sleep and resting time of caregiver in Question 6A-6C

C.2 Time use for activity

Use the activity card to ask how frequent does the household do each activity with the child. Then ask how many hours does the household spend with (child name) in each activity if the frequency of doing that activity is at least once a week.

In the past 12 months, how frequent do you and household members do the following activities with (child name)?

- 9 - More than once a day
- 7 - Once a day
- 5 - At least once a week

- 3 - At least once a month
- 1 - Less than once a month
- 0 - Never

The interviewer then records respondent's answer and calculate amount of time that household spends doing each activity with (child name) in the table below.

	Activity	**If never, record "0"**	**For data collector**		
			Frequency	Hours	Minutes
A	Doing comparison, sorting, reading numbers, alphabets	Do: .... time/per ..... Duration: ... hours ... mins	CC9A: ...	CC9AA: ...	CC9AB: ...
B	Playing blocks, molding clay, drawing, coloring, inventing	Do: .... time/per ..... Duration: ... hours ... mins	CC9B: ...	CC9BA: ...	CC9BB: ...
C	Playing sports, singing, dancing, music	Do: .... time/per ..... Duration: ... hours ... mins	CC9C: ...	CC9CA: ...	CC9CB: ...
D	Reading books with child	Do: .... time/per ..... Duration: ... hours ... mins	CC9D: ...	CC9DA: ...	CC9DB: ...
E	Telling stories (without books)	Do: .... time/per ..... Duration: ... hours ... mins	CC9E: ...	CC9EA: ...	CC9EB: ...
F	Taking the child to the zoo, museum, art gallery, cinema, theater, concert.	Do: .... time/per ..... Duration: ... hours ... mins	CC9F: ...	CC9FA: ...	CC9FB: ...
G	Taking the child to the temple	Do: .... time/per ..... Duration: ... hours ... mins	CC9G: ...	CC9GA: ...	CC9GB: ...
H	Taking the child to library	Do: .... time/per ..... Duration: ... hours ... mins	CC9H: ...	CC9HA: ...	CC9HB: ...

C.3 Expenditures on developmental materials

During the past 12 months, how often and how much did your household buy the following items for (child name)? Please specify the average cost and record in table below.

The frequency comprises of per week, per month, per quarter, per 6 months and per year.

	Item	Times	Frequency	Frequency code	Cost/time
1	Books				
2	Toys				
3	Tablet/Ipad				
4	Cell phone				
5	Other, specify				

D A unitary model with CRRA preference and CES technology of skill formation

The household's decision problem is to choose consumption c, leisure ℓ, investments in the child, time investment I_t, and material investment I_m to maximize utility as follows:

$$\max_{c,\ell,I_t,I_m} \frac{c^{1-\gamma}-1}{1-\gamma} + \eta\frac{\ell^{1-\gamma}-1}{1-\gamma} + \lambda\theta \tag{D.1}$$

subject to the full-income budget constraint, and the skill formation technology, respectively,

$$c + w\ell + wI_t + I_m \leq wT + b, \tag{D.2}$$

$$A\left(\mu I_t^{\rho} + (1-\mu)\, I_m^{\rho}\right)^{\frac{1}{\rho}} = \theta, \tag{D.3}$$

where w is the wage rate, b is a non-labor income (e.g., remittances from parents who are not at home or relatives and friends), T is the total time endowment, and A is the productivity parameter. With some calculation, we can show that

$$c = \left[\lambda A\left(\mu D^{\rho} + (1-\mu)\right)^{\frac{1-\rho}{\rho}}(1-\mu)\right]^{-\frac{1}{\gamma}}, \tag{D.4}$$

$$\ell = w^{-\frac{1}{\gamma}}\eta^{\frac{1}{\gamma}}\left[\lambda A\left(\mu D^{\rho} + (1-\mu)\right)^{\frac{1-\rho}{\rho}}(1-\mu)\right]^{-\frac{1}{\gamma}}, \tag{D.5}$$

$$I_m = \frac{(wT+b) - \left(1 + w^{\frac{\gamma-1}{\gamma}}\right)\left[\lambda A\left(\mu D^{\rho} + (1-\mu)\right)^{\frac{1-\rho}{\rho}}(1-\mu)\right]^{-\frac{1}{\gamma}}}{1+wD}, \tag{D.6}$$

$$I_t = \frac{D\left\{(wT+b) - \left(1 + w^{\frac{\gamma-1}{\gamma}}\right)\left[\lambda A\left(\mu D^{\rho} + (1-\mu)\right)^{\frac{1-\rho}{\rho}}(1-\mu)\right]^{-\frac{1}{\gamma}}\right\}}{1+wD}, \tag{D.7}$$

where $D = \left[\left(\frac{(1-\mu)}{\mu}\right)w\right]^{\frac{1}{\rho-1}}$.