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FOR ECONOMIC RESEARCH

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by

Sasiwooth Wongmonta

September 2021

Discussion Paper

No. 161

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Sasiwooth Wongmonta*

Abstract

Education is a crucial component of human capital and make a contribution to social welfare. In rural developing countries, shocks and financial constraints on households are generally recognized as obstacles to children's schooling opportunities. This paper investigates the effects of income shocks and borrowing constraints on household demand for education in rural Thailand, using the Townsend Thai panel data spanning from 2013 to 2017. Information on annual rainfall at provincial level is used to estimate a transitory income component for Thai rural households. Estimation results indicate that income risks and borrowing constraints have a substantial negative impact on child schooling outcomes, including educational attainment and years delayed in school. However, it finds that the transitory income results in an increase in household education expenditures conditional on child's attendance at school. Further evidence shows that the interaction between income risk and borrowing constraints has no effect on household schooling decision. These findings suggest that in addition to household socioeconomic status, children's human capital is at risk mainly due to income uncertainty and the absence of well-developed financial and insurance markets.

Key Words: Income shocks; Borrowing constraints; Education; Child schooling; Thailand.

JEL Classification: D10; I21; I25; O15

* Department of Economics, Faculty of Humanities and Social Sciences, Burapha University, Chon buri, Thailand, 20131.
Email: sasiwooth@buu.ac.th

1. Introduction

Investments in children's education are typically considered as a pathway to provide benefits to individuals, as well as to improve social and economic mobility. It also promotes economic growth and development of a country. Thus, the governments of developing countries have committed themselves to provide access to schooling opportunities for all children, especially for rural and poor families. Children's schooling decisions are primarily determined by the household economic situation and their attitudes toward education (Glewwe, 2002). However, extensive research for different countries has established that income risks and borrowing constraints can seriously impede children from enrolling in school since they may be forced to drop out of school to work for paid jobs or family businesses (Jacoby and Skoufias, 1997; Sawada, 2003; Beegle et al., 2006; Sawada and Lokshin, 2009). Furthermore, households are more likely to cut spending on education for their enrolled children in response to negative income shocks (Kazianga, 2012; Dung, 2013). This can interrupt later-life human capital accumulation at household level, and in turn negatively affect worker productivity and economic growth at national level.

However, in addition to direct costs of education, there is the child's opportunity cost of schooling in terms of foregone earnings or time spent on household work such as cleaning, taking care of younger siblings or elderly grandparents, and work on family farms. These costs would be high for households residing in rural areas where most of them engage in agricultural production. It is evident that their incomes are low and highly uncertain due to a number of factors, e.g., weather condition, crop yield variation, and the incidence of pests and diseases. Therefore, most of rural households may choose not to send their children to secondary school, particularly in upper secondary level, even tuition fees are fully exempted for children enrolling in public schools.

Over the two decades, the Thai government has embarked on an ambitious program of free basic education for all. More specifically, Thailand's National Education Act (NEA) of 1999 stated that all Thai children have the right to receive at least 12 years of basic education provided by the State without charge. It consists of 6 years for primary, 3 years for lower secondary, and 3 years for upper secondary. Like most countries, Thai children usually begin primary school at the age of six or seven. However, the compulsory education is 9 years from primary to lower secondary level. Subsequently, in 2009, the basic education was extended to 15 years of schooling with an additional three years of schooling for pre-primary. Since then, the Thai government has allocated a substantial amount of budget to education with an average of 17.6 percent of total government budget or approximately 3.3 percent of GDP during the recent five years from 2016 to 2020 (Bureau of the Budget, 2021). Moreover, slightly more than two-thirds of total government spending on education has been devoted to providing

basic education. This suggests that most Thai households with school-age children are likely to benefit from the free basic education program, thereby resulting in a significant decrease in the direct costs of sending their children to school.

Thailand is a particularly interesting country to examine how and the extent to which income uncertainty and financial constraints prevent households from undertaking educational investments in their children in the context of implementing the universal basic education for all. Expansion of secondary education has been remarkably improved since the promulgation of the 1999 NEA. More specifically, Thailand's gross secondary enrollment rates have risen steadily, reaching almost 80 percent, and the transition rate form primary to lower secondary was almost universal in 2019 (UNESCO, 2021). However, the enrollment rates are relatively low at upper secondary levels for children from poor and rural households. Moreover, differences in school quality across regions and individual schools may inhibit educational progress for Thai children enrolling in small rural schools, which often have inadequate educational resources, including qualified teachers, school equipment, and physical facilities (World Bank, 2015). This may prompt parents to withdraw their children from school to work.

The primary objective of this paper is to systematically investigate the effects of transitory income shocks and borrowing constraints on household's human capital investment in rural Thailand, using the Townsend Thai panel data from 2013 to 2017. Following Paxson (1992), this paper first exploits information on annual rainfall deviations at provincial level to estimate the transitory income shocks. Afterwards, household schooling decisions are examined to explore the separate effects of transitory and permanent income components on schooling decisions (Sawada, 2003; Gubert and Robilliard, 2008; Thai and Falaris, 2014). In this paper, three specific educational outcomes are examined: 1) school attendance, 2) household expenditures on education, and 3) the number of years of school delay.

Three key results emerge from this paper: first, rainfall shocks have a substantial impact on household transitory income, thereby affecting children's educational outcomes. Second, permanent income significantly contributes to the increased human capital for all educational outcomes tested, while higher transitory income results in lower school attendance but the increased household spending on education. Third, borrowing constraints tend to reduce educational investment in children to some extent. This paper makes contributions to a growing literature on the role of income risk and incomplete credit markets on demand for education in low- and middle-income countries. The empirical results also provide policy implications on improving access to credit and insurance markets for rural households to protect them from unexpected negative income shocks, thus spurring continued investments in children's human capital.

The remainder of the paper is organized as follows. Section 2 provides a brief literature review on the role of income risks and borrowing constraints on household schooling decision, with an emphasis on empirical studies in developing countries. Section 3 presents a theoretical model employed to examine factors that determines child educational outcomes under incomplete credit and insurance markets. Section 4 describes the empirical strategies and the data. Section 5 presents the estimation results and discussion. Section 6 concludes the paper with important policy implications.

2. Related Literature Review

Much of the literature has shown that the vast majority of rural households in developing countries rely on farm income as the main income of household. They are often afflicted with uncertainty of income and incomplete financial markets, thus leading to difficulties in using credit or savings to smooth both their consumption and educational investment against income fluctuations (Jacoby, 1994; Jacoby and Skoufias, 1997; Dung, 2013; Thai and Falaris, 2014). Most of these studies have revealed that a high level of income risk results in an increase in children dropping out of school to work and the large decline in household spending on education. Additionally, it is commonly observed that the adverse effects on schooling opportunities are more pronounced for children from households with borrowing constraints.

Studies focusing on the role of imperfect credit and insurance markets on children school attendance in poor rural agricultural areas include work by Jacoby (1994) and Jacoby and Skoufias (1997). Using a cross-sectional data in Peru, Jacoby (1994) found that children from borrowing constrained households are more likely to withdraw early from school. Jacoby and Skoufias (1997) further analyzed the effects of incomplete financial markets on household schooling decision in rural India. They found that lack of formal insurance against village-level aggregate and idiosyncratic shocks has a substantial negative impact on school attendance when farm income is seasonally low.

Recent studies have demonstrated that transitory income shocks are highly associated with the increased child labor for poor households lacking savings or access to credit and insurance to offset the shocks (Beegle et al., 2006; Guarcello et al., 2010). Using a panel data of Tanzania, Beegle et al. (2006) found that rich households are more likely to use assets as collateral to access funds in response to unexpected shocks, whereas poor households often choose to sell their productive assets, together with taking their children out of school to work. A study of Guarcello et al. (2010) is also intended to investigate the extent to which credit constraints and income shocks influence household decisions on school attendance and child labor in Guatemala. Their results indicated

that children from credit-constrained households are less likely to enroll in school, but more likely to engage in working activities. However, such negative impacts are attenuated when at least one household member are covered by formal medical insurance. Overall, the two studies have demonstrated that limited access to insurance or credit in times of adverse shocks may impede children in rural areas from attaining a higher level of education.

To evaluate the impacts of income shocks on household schooling decision, information on rainfall variability, following the work of Paxson (1992), has been widely used to estimate changes in transitory income (Jensen, 2000; Sawada, 2003; Fitzsimons, 2007; Gubert and Robillard, 2008, among many others). In theory, if income risk is perfectly insured across households, the transitory income should have no effect on household schooling decision. However, empirical evidence from most studies conducted in low- and middle-income countries has illustrated that the unforeseen shocks have the potential to disproportionally affect rural children's educational achievement. Sawada (2003) used household panel data of rural Pakistan to investigate the effect of income shock on schooling decisions. His estimation results showed that, on average, educational attainment is more sensitive to changes in transitory income than permanent income, indicating that most households have limited financial capabilities to deal with the income risk. Furthermore, the magnitude of income shock on educational attainment appears to be larger for girls than that of boys.

Using household data of Côte d' Ivoire, Jensen (2000) reported that adverse weather shocks led to a considerable decrease in school enrollment by about one-third for both boys and girls. Following the methodology of Sawada (2003), Gubert and Robilliard (2008) examined the impact of income risk on household schooling decisions in rural Madagascar, finding that unexpected negative income shocks increase the incidence of withdrawing children from school. In contrast to evidence in most developing countries, their results revealed that parents allocate household education resources in favor of girls than boys. Another study conducted in a low-income country is Kazianga (2012). He used household surveys in rural Burkina Faso to assess the extent to which child schooling decisions are affected by idiosyncratic risk, once controlling for village-level aggregate shocks. The main results are consistent with the literature in that income risk has a negative significant impact on children's educational achievement in terms of school enrollment, household educational expenditures, and years of schooling attained.

Several studies have investigated the impact of income risk on household demand for education in Southeast Asian countries, including Indonesia and Vietnam. Fitzsimons (2007) decomposed risk into household-level and village-level components to analyze its effect on children's educational investment in Indonesia. Specifically, the historical rainfall data were used to quantify aggregate village risk. She found that only village-

level risk has a substantial negative effect on educational attainment, indicating evidence of partial insurance across households within the village against income shocks. As one of the fastest-growing economies in East Asia, Vietnam is a particularly interesting country to examine how well households are able to mitigate the effects of income risk on their on children's educational investment. Dung (2013) used a household panel data from rural Vietnam to analyze the effects of crop and health shocks on three key educational outcomes, consisting of the incidence of dropping of school, time spent on study outside school, and household expenditures on education. Estimation results indicate that adverse shocks lower both child school enrollment and the household budget allocated to education, with larger negative impacts for children from resource constrained households. In contrast, Thai and Falaris (2014) focused on the impact of early-life rainfall shocks on children's later educational and health outcomes in rural Vietnam. The crucial finding was that a positive rainfall shock at the third year of life led to the significant decreases in years of school entry delay and age-grade distortion (overaged enrollment). The overall results suggest that negative shocks occurred during childhood can impede long-term human capital formation.

To summarize, a growing literature on risk and child schooling has demonstrated that incomplete financial market can substantially lead to underinvestment in child's human capital, especially for children in poor and uninsured households. However, the extent that financial market incompleteness and income shocks impact child schooling decisions is rather an empirical matter.

3. Theoretical Model

In order to assess the impacts of income risk and borrowing constraint on human capital investment, this paper employs the household model of schooling decisions under uncertainty. The present model is taken from the work by Jacoby and Skoufias (1997), Sawada and Lokshin (2001), and Sawada (2003). To begin, consider a household consisting of parents and one child chooses consumption and child schooling to maximize the expected discounted utility subject to household resources, human capital production, and a borrowing constraint. A household's optimization problem can be written as:

$$\underset{C_{it},S_{it}}{\text{Max}}\ E_0\left\{\sum_{t=0}^{T-1}\beta^t U(C_{it}) + \phi_T(H_{iT}, A_{iT})\right\}, \tag{1}$$

subject to the constraints

$$A_{it+1} = [A_{it} + Y_{it} + W_{it}(1 - S_{it}) - C_{it}](1 + r_t), \tag{2}$$

$$H_{it+1} = H_{it} + g(S_{it};\ \theta_{it}), \tag{3}$$

$$A_{it} + Y_{it} + W_{it}(1 - S_{it}) + B_{it} \geq C_{it}, \tag{4}$$

$$B_{it} > 0, A_0, B_0 \text{ are given, and } A_T \geq 0 \quad (5)$$

where $U(\cdot)$ is a concave utility function of consumption C_{it}, E_0 is the expectations operator for information available to the household at time zero, and parameter β is a time-invariant discount factor.

The increasing concave function $\phi_T(H_{iT}, A_{iT})$ represents the value of child's human capital (H_{iT}) and financial assets (A_{iT}) which are accumulated until period T. The household's budget constraint is given by equation (2) in that household assets are piled up over time from savings with an interest rate of r_t. Total consumption is denoted by C_{it}, and household income includes exogenous parental income,Y_{it}, and child income, $W_{it}(1 - S_{it})$ depending on time allocated to schooling (S_{it}), where $0 \leq S_{it} \leq 1$. Equation (3) states that how the child's stock of human capital (H_{it}) is augmented through the function $g(S_{it};\ \theta_{it})$, which is increasing in schooling S_{it}. Parameter θ_{it} represents *education productivity shifter*, which reflects other factors that influence human capital formation such as child's ability, school quality, or school supply side effect (Jacoby and Skoufias, 1997).

In addition, a borrowing constraint may potentially lead to the increased dropping out of school for children in rural areas, despite of high returns to education if they pursue a higher level of education. In the case of borrowing-constrained households, equation (4) is binding since household decisions on consumption and child schooling depend on current income and assets and credit limits B_{it}, where $B_{it} > 0$. The intuition behind this is that constrained households cannot borrow a sufficient fund in times of need against temporary income shocks, even their expected long-term average income is high enough to repay the debt.

To investigate the extent that a binding borrowing constraint affects child schooling, the analysis first considers a case of perfect financial market. Unconstrained households can borrow an amount of money to smooth consumption and maintain educational investments in their child across time and states of nature at a fixed interest rate. More specifically, the household chooses consumption and child schooling to maximize equation (1) subject to equations (2) and (3), and the Euler equation characterizing the interior solution of child schooling is:

$$\left(\frac{\partial g/\partial S_{it+1}}{\partial g/\partial S_{it}}\right)\left(\frac{W_{it}}{W_{it+1}}\right) = \frac{1}{(1+r_t)} \quad (6)$$

Equation (6) implies that the household chooses the schooling level in a way that equalizes the marginal rate of transformation of schooling and the market interest rate. Following Sawada and Lokshin (2001), assume that the utility function form exhibits the constant absolute risk aversion (CARA),

$$U(C_{it}) = \bar{\alpha} - \frac{1}{\alpha}\exp(-\alpha C_{it}) \quad (7)$$

where α is the coefficient of absolute risk aversion. Assume further that the human capital production, $g(S_{it};\ \theta_{it})$, follows the exponential function as,

$$g(S_{it};\ \theta_{it}) = \theta_{it}[\gamma_0 - \gamma_1 \exp(-S_{it})] \tag{8}$$

where γ_0 and γ_1 are positive.

Substituting equations (7) and (8) into equation (6) and rearranging yields

$$\Delta S_{it} = -\log(1 + r_t) - \log\left(\frac{\theta_{it+1}}{\theta_{it}}\right) + \log\left(g_{it} + 1\right) \tag{9}$$

where g_{it} is the growth rate of child wage computed from $\frac{W_{it+1}}{W_{it}} - 1$. Hence, the reduced form of schooling demand can be written as

$$S_{it}^{*} = S(r_t, , \theta_{it}, g_{it};\ S_{it-1}^{*}) \tag{10}$$

Notice that parental income and a credit limit have no effect on the optimal schooling under perfect financial markets. As can be seen, household's schooling decision is separable from consumption.

Consider the case of a binding borrowing constraint. The household chooses consumption and child schooling to maximize equation (1) subject to equations (2) to (4). The intertemporal Euler equation characterizing the interior solution of schooling can be modified as:

$$\left(\frac{\partial g/\partial S_{it+1}}{\partial g/\partial S_{it}}\right)\left(\frac{W_{it}}{W_{it+1}}\right) = E_t\left(\frac{\beta U'(C_{it+1})}{U'(C_{it})}\right) \tag{11}$$

Substituting equations (7) and (8) into equation (11) and rearranging obtains

$$\Delta S_{it} = \log(\beta) - \alpha \Delta C_{it} - \log(1 + r_t) - \log\left(\frac{\theta_{it+1}}{\theta_{it}}\right) + \log\left(g_{it} + 1\right) \tag{12}$$

In equation (12), it shows that the separability of consumption and schooling is no longer valid, which means that consumption and schooling choices are jointly determined. Furthermore, the theoretical model predicts that if households lack access to credit or insurance market, taking children out of school to work could be used as a self-insurance strategy in order to smooth their consumption, as found in Jacoby and Skoufias (1997). Consequently, the reduced form equation for schooling with a borrowing constraint is a function of household income, a credit limit, and an interest rate given by

$$S_{it}^{*} = S(Y_{it}, B_{it}, r_t, , \theta_{it}, g_{it};\ S_{it-1}^{*}) \tag{13}$$

This section provides insights into household schooling decision under binding credit constraints. In essence, the theoretical model suggests that household income is a key factor determining child's human capital, while a borrowing constraint is likely to impede investment in child's human capital. However, the permanent income hypothesis (PIH) postulates the different effects of permanent and transitory income on household consumption, so if a borrowing constraint is binding, one would expect the separate impacts on child schooling decisions as well. The next section will develop the empirical strategy to isolate the effect of permanent and

transitory income changes on the household demand for education, once controlling for other relevant characteristics.

4. Empirical Strategies and Data

4.1 Empirical strategies

In an attempt to investigate the impact of income fluctuations on child's human capital, the empirical analysis first applies the Paxson's (1992) strategy to decompose household income into permanent component and transitory component. The following regression is estimated:

$$\log(Y_{it}) = \beta_i + \mathbf{X}_{it}^{P}\boldsymbol{\beta_1} + \mathbf{X}_{it}^{T}\boldsymbol{\beta_2} + \beta_t + \varepsilon_{it} \quad (14)$$

where $\log(Y_{it})$ is the log of annual household income for household i in year t, $\mathbf{X}_{it}^{P}$ is a vector of characteristics of household and household head that determines permanent income such as household size, demographic composition, and age, education, and occupation of the household head, and $\mathbf{X}_{it}^{T}$ is a vector of specific variables that affects transitory income which consists of rainfall shocks and year effects.

Parameters β_i and β_t are household and year fixed effects, vectors $\boldsymbol{\beta_1}$and $\boldsymbol{\beta_2}$ denote vector of parameters to be estimated, and ε_{it} is a normally distributed term with zero mean. Rainfall deviations from the long-term average and a year effect representing the effect of aggregate shocks can be potentially used as an instrument for income shocks. Following the seminar paper of Sawada (2003), the sum of the first two terms of the right-hand side of equation (14), $\beta_i + \mathbf{X}_{it}^{P}\boldsymbol{\beta_1}$, indicates the permanent income of the household, and the sum of the third and fourth terms, $\mathbf{X}_{it}^{T}\boldsymbol{\beta_2} + \beta_t$, is the transitory income.

To quantify the effects of income shocks and credit constraints on child's human capital investment using individual-level data, the estimated equation for child schooling takes the form:

$$S_{ijt} = \alpha_1 + \alpha_2\widehat{\log(Y_{it}^{P})} + \alpha_3\widehat{\log(Y_{it}^{T})} + \alpha_4 CC_{it} + \alpha_5 X_{jt}^{H} + \alpha_6 X_{ijt}^{C} + e_{ijt} \quad (15)$$

where S_{ijt} denotes is the educational outcome of interest for child j of household i at time t, and $\widehat{\log(Y_{it}^{P})}$ and $\widehat{\log(Y_{it}^{T})}$ are the predicted values of permanent and transitory income components in logarithmic form, obtained from the household income regression equation.

A dummy variable CC_{it} indicates whether a household is borrowing constrained, defined as being below the median of the entire sample measured by the ratio of household's total savings to annual income.[1] In addition,

[1] As argued in the paper of Zeldes (1989), the ratio of household financial wealth (including checking or savings accounts and government bonds) to income would be a good candidate for a measure of borrowing constraint status. Specifically, the low-ratio implies that households have limited ability to borrow against their future income.

other explanatory variables determining schooling decision can be represented by household characteristics (X_{it}^{H}) and child characteristics (X_{ijt}^{C}). In this specification, if the effects of permanent income and transitory income on schooling are different, it is expected that $\alpha_2 \neq \alpha_3$. Meanwhile, if a borrowing constraint hinders the household demand for education, α_4 should be statistically negative.

The methodological framework presented above enables us to empirically disentangle the effects of income shocks and borrowing constraints on child's human capital investments. This paper looks at three educational outcomes: 1) school attendance, 2) household education expenditure per child, and 3) the number of years delayed in school. The measurement of each outcome can be specified as follows. Firstly, school attendance is a dummy variable which equals 1 if a child aged 6 to 18 currently enrolls in school, and 0 otherwise. Secondly, household education expenditure per child is the annual household education expenses (on tuition and fees, books, transportations, uniforms, and other related expenses) divided by number of children being enrolled in school, as in logarithmic form. Lastly, the number of years delayed in school is computed from age of child minus current grade or highest grade completed minus six. Positive values are an indication of delayed in school progress, which may be attributable to many factors such as late school entry, grade repetition, and temporarily dropping out of school to work and re-enrolling in school. Therefore, this paper hypothesizes that children from poor or uninsured households are associated with the higher incidence of delayed school enrollment. In this empirical analysis, the reduced-form regression of each educational measure will be estimated separately using a panel of Thai rural households.

4.2 Data and descriptive statistics

The data used in this paper are drawn from a panel data of Townsend Thai Project for rural areas that covers the years from 2013 to 2017, conducted by Research Institute for Policy Evaluation and Design (RIPED), University of the Thai Chamber of Commerce (UTCC). Data are collected in six provinces in four different regions of Thailand: The Central (Chachoengsao and Lop Buri), the Northeast (Buriram and Sisaket), the North (Phrae), and the South (Satun). The survey covers approximately 1,200 households for each round, and they are reinterviewed in the subsequent years. Survey data provide rich information at household level, which consists of area of residence, household composition, income and expenditures, different types of assets (durables, agricultural capitals, and livestock), household businesses, and savings and liabilities. The data are also collected

at individual level, including age, gender, education, and occupation. The analysis of this paper is restricted to the subset of households with at least one child age 6 to 18 years old at the time of survey, which yields a final sample of 820 households with 1,511 children.

Data on rainfall deviations at provincial level are used to estimate transient income changes. This paper takes rainfall data between 1994 and 2017, which are measured in millimeters, from the Meteorological Department of Thailand. Two additional variables are created: the deviation of annual rainfall from the long-term average (20 years) in absolute value and the deviation squared. The significance of any rainfall variables suggests that it is a key predictor of rural household income, especially households relying heavily on farm income.

Table 1 presents descriptive statistics of variables used for estimating household income equation. The unbalanced panel sample consists of 820 households surveyed from 2013 to 2017, thus obtaining a total of 2944 household-year observations. Household income is calculated from household's total gross income (farm income, non-farm income, and private and government transfers) minus business or farm expenses over the past 12 months. Additionally, reported household income is adjusted to 2017 constant prices using the provincial consumer price index from Thailand's Ministry of Commerce. It is observed that the average income for the typical rural household is 279,568 baht per annum. About three-fourths of the household heads completed primary education level, with an average year of schooling of 5.4 years, while roughly 10 percent attained upper secondary or university levels. In terms of household demographic characteristics, the average household size is 4.6 people, the average age of the household head is 56 years, 43 percent are headed by female, and about two-thirds are married household heads. To take into account the effects of household composition on income, ten age-gender categories are added to the regression, which are males and females in each of the following age groups: 0-5 years, 6-15 years, 16-20 years, 21-59 years, and 60 years and above, respectively.

Insert Table 1 about here

Further, the majority (63 percent) of the household heads reported themselves as owners of business. It is particularly interesting that nearly 80 percent of the sampled households involve in agricultural activities; however, it is not necessarily the primary source of household income. The average amount of land cultivated per household is 16.8 rai or about 2.7 hectares. The average rainfall and rainfall deviations and its squares from the long-term average are also reported in Table 1.

As previously mentioned, the focus of the paper is to evaluate the separate effects of the permanent and transitory income components on child educational investments. The resulting sample at individual level comprises 4,298 child-year observations during the period of 2013-2017. Descriptive statistics of relevant variables used in child schooling regressions are provided in Table 2. Most children in rural Thailand aged 6-18 are currently enrolled in school, approximately 92 percent on average. However, it is worthwhile to note that the child-level enrollment rates based on the survey data have declined significantly by 20 percent after age 15 (see Figure A1 in the Appendix). The mean annual household education expenditure is 10,087 baht per enrolled child, or 16,379 baht per household, which accounts for 17 percent of total household expenditure.

Insert Table 2 about here

As shown in Table 2, the typical household has almost two children in school-going age, and the average child's age is 12.2 years old. The proportion of male and female children is almost equal, and nearly all of the sample (96 percent) are children or grandchildren of the head of household. The years of school delay is, on average, about 0.6 years. The mean ratio of household total savings to annual income is 0.15 or equivalent to almost two-months of income. However, the median for this ratio is relatively low (about 0.06), suggesting evidence of saving heterogeneity across rural households in Thailand. Household savings can take various forms including all types of deposits at financial institutions and rice or other crops in storage. As described in the empirical strategies section, this paper considers the household as borrowing constrained if the ratio of total savings to annual income is less than the median of the entire sampled households. According to the given criteria, 55 percent of children in the analysis are from borrowing constrained households.

5. Results and Discussion

5.1 Estimates of household income

The first set of estimates is for the determinants of household income based on a sample of 840 rural households with at least one child aged 6-18. Fixed effects regression results are presented in Table 3, where the dependent variable is the log of annual household income. The results show that most of estimated coefficients have expected signs and are consistent with the theoretical predictions. For example, the coefficient of a dummy variable indicating whether the household head completed upper secondary level shows a significant and positive

effect (0.49) on household income, compared to households with head attaining a primary education or no schooling (the base group). Several characteristics of the household head, including age, type of work, and marital status are also key determinants of household income.

Insert Table 3 about here

As expected, households headed by female have 11 percent lower annual income than male headed households, which is statistically significant at the 0.10 level. Households with more adult members tend to have higher income throughout most of the life cycle. More specifically, the coefficients for adult males in the 21-59 and 60 and over age groups are positive with values of 0.22 and 0.19, respectively, both statistically significant at the 0.01 level. This is also the case for households with more adult females in the 21-59 age group, but with a lower magnitude of effect (0.06). However, it is somewhat surprising that the coefficients for household members (both males and females) in all school-going age groups have no effect in determining household income.

In addition, the coefficient for the amount of land cultivated appears to be positive and is highly significant, with a p-value less than 0.001. This finding is expected, and it can be interpreted that a one percent increase in the amount of land, on average, leads to an increase in annual household income by almost 9 percent. In terms of rainfall variables used as a proxy for transitory income shocks, both the deviation of rainfall from the 20-year average and its squared term are statistically significant at least the 0.10 level. More specifically, rainfall deviation shows a positive impact on household income, while its squared term has a negative sign. The results suggest that rural household incomes are likely affected by weather conditions and the households still have limited insurance mechanisms in response to the adverse income shocks.[2] Using the regression estimates shown in Table 3, household income can be decomposed into three components: permanent income, transitory income, and unexplained income. Furthermore, these three income measures are allowed to have separate effects on household's schooling decision.

[2] To check for the robustness of the results, the 10-year average rainfall at provincial level is also used as the long-term average rainfall in estimating household income, once controlling for the same explanatory variables (not reported here). The estimates of the two rainfall variables are close to those provided in Table 3 with the same level of statistical significance. These results substantiate that rainfall shocks considerably contribute to income variability in rural Thailand.

5.2 Determinants of school attendance

Table 4 reports mean marginal effects from the random-effects logit estimates of school attendance.[3] Robust standard errors are shown in parentheses, obtained from the delta method. The dichotomous dependent variable takes the value of one if children aged between 6 and 18 years are currently enrolled in school and zero otherwise. Columns 1 and 2 of Table 4 provide estimation results with and without household and head characteristics controls. The choice of explanatory variables follows empirical studies mentioned in the literature review section. In contrast to much of the literature on gender disparities in education, the results show that girls are more likely to attend school than boys with a 4 percentage-point higher probability of attending school, both statistically significant at the 0.01 level for both specifications. Moreover, being children or grandchildren of the head has a positive effect on school attendance, compared to other relative children (the base group). It should be noted that the magnitudes of the estimates decrease considerably as controlling for household's head and household characteristics (see Column 2). The empirical results also show evidence of resource competition among siblings within the household. More specifically, children from households having more school-aged siblings are less likely to attend school, reporting a marginal effect of -1.2 percentage points for the second specification, statistically significant at the 0.10 level.[4]

Insert Table 4 about here

Turning to the coefficients of interest, the transitory income variable (expressed as a logarithm) appears to have a strong negative effect on child schooling, with marginal effects of -13.2 and -10.0 percentage points, statistically significant at the 0.1 level. This result suggests that a higher income risk leads to the decreased probability of being enrolled in school. Furthermore, it may reflect the fact that the performance of financial and insurance markets in rural Thailand are far from being perfect. This finding is broadly consistent with previous research that taking children out of school to work is often used as an informal insurance strategy for low-income families in response to income shocks (Jacoby and Skoufias, 1997; Beegle et al., 2006; Dung 2013). Another

[3]As an alternative to a random effects approach, a fixed effects logit model seems not appropriate since more than half of the sample (716 out of 1,511 children), either being enrolled in school (Y=1) or not being enrolled (Y=0) in all five survey years (2013-2017), will be dropped from the analysis. The significant decrease in the observations may affect the reliability of the results; thus, a random effects logit model is preferred.

[4]Note that this result is consistent with Knodel et al. (1990) finding a negative relationship between the number of children in a household and the likelihood that a child will pursue a secondary level in Thailand.

possible explanation would be that Thai rural households save a high fraction of transitory income to accumulate their savings to cope with future income fluctuations, as pointed out in Paxson (1992).[5] On the other hand, permanent income results in the increased probability of being enrolled, with marginal effects between 4.8 and 8.1 percentage points, while residual income has a negligible impact on school attendance (see Table 4). Overall, the regression results for school attendance demonstrate that permanent income is the predominated variable in determining household investment in child's human capital. Additionally, children from borrowing constrained households, as measured by the ratio of total savings to annual income, are associated with 2.3 to 3.3 percentage points lower probability of attending school.[6] The two coefficients are significant at the 0.01 level.

5.3 Determinants of household education expenditure

The analysis is extended to examine the relationship between income risk and household education expenditure. The OLS results for education expenditure based on the individual-level data are presented in Table 5. The dependent variable is the log of total education expenditure per enrolled child. The analysis is restricted to only children ages between 6 and 18 years who are currently enrolled in school, so the final sample comprises 3,972 observations. Since the household survey lacks information on school characteristics such as types of school (public or private), distance to school, and school quality, a large set of village and time dummies is added to account for differences in the allocation of household resources to child education. The results indicate that children with more siblings tend to receive less education expenditure, revealing that resource competition hypothesis cannot be rejected at conventional levels of significance. It should be noted that the magnitude appears to be larger when household and head of the household characteristics are controlled. However, child's gender and relationship to the household head appear to have no effect on the allocation of education expenditure within households.

Insert Table 5 about here

[5] To explore this possibility, an additional regression of household savings on three separate income components is conducted, once controlling for household and head of the household characteristics. Estimation results are reported in Table A1 in the Appendix. The dependent variable is household annual savings (in logarithm) defined as income minus total expenses. It is found that the coefficient of transitory income (a value of 4.58) is quite high relative to those estimates for permanent income (1.62) and residual income (2.88), respectively. Note that all three estimates are statistically significant at the 0.01 level. Overall, the results here support the analysis of Paxson (1992) using household surveys in rural Thailand during the period of 1975-1988.

[6] However, additional regression analysis shows no evidence of interaction effect between transitory income and borrowing constraint on the probability of school attendance (results not reported here).

Contrary to the results for educational attainment (see also Table 4), the crucial result here is that a transitory income is positively associated with expenditure on child education. Moreover, the estimated coefficients are robust to model specifications, about 1.62 as shown in Columns (1) and (2) in Table 5. Given the opposite effects of transitory income on school enrollment and educational expenditure, the most plausible explanation is that higher transitory income may imply the increased opportunity cost of schooling, thereby leading to the increased incidence that the child will drop out of school to work. However, households may compensate this by raising their spending on education for younger children already enrolled in school instead. In addition, the results show the small positive effects of permanent income (0.14) and residual income (0.08) on education expenditure only for the first specification (without control for household's head and household characteristics). These coefficients are statistically significant at the 0.10 level. Surprisingly, estimation results indicate that the borrowing constraint variable has no significant impact on educational expenditure for both specifications.

Limited by data availability, the results above should be interpreted with caution since only total educational expenditure is used in the analysis. Indeed, it consists of various categories, including school fees, school uniforms, private tutors, and transportation expenses, so one would expect to observe differences in household spending patterns for a specific education expenditure category. For example, permanent income may play an important role in the decision on the allocation of expenditure on tuition and school fees. This is because high permanent income households are more likely to send their child to private schools, while low-income or uninsured households may choose public schools since tuition and school fees are fully exempted under the free basic education. Therefore, the insignificance of permanent income may be attributable to the fact that the vast majority of rural children are enrolled in public schools, so their parents are less likely to pay tuition and school fees. Hence, there is a strong possibility that reported household educational expenditures in the survey are primarily concentrated on non-school fee costs of education.

5.4 Determinants of years of school delay

This section investigates the role of income shocks and borrowing constraints on the age-grade enrollment for school-going children of rural Thailand. It is worth to mention that 55 percent of sampled children are in the age-appropriate grade level, while the other percentage of children are delayed in school. Table 6 presents Tobit estimates of years of school delay on a sample of children aged 6 to 18 with robust standard errors. On average, the predicted value of years of school delay is approximately 0.63 years for all children, but the mean

value increases to 1.45 for those delayed in school. Column 2 of Table 6 reports the unconditional marginal effects for children with either positive or zero years of delaying school.[7] It finds that grandchildren of the household head are more likely to attend school at the appropriate grade with a marginal effect of -0.39, while the marginal effect of children of the household head is also negative, but it is not statistically significant. Additionally, the results show no evidence of gender differences in the age-grade distortion.

Insert Table 6 about here

The results also suggest that household head's years of education is one of the key determinants of the age-grade school progress, which contributed to the decreased years of school delay about 0.3 year with a p-value less than 0.001. However, the marginal effect of female head is negatively associated with years of a school delay but showing insignificant effect. Consistent with results for schooling attainment and the allocation of household educational expenditures, it is observed that children with more siblings aged 6-18 are highly associated with delayed enrollment, about 0.19 years.

The most striking result in Table 6 is that permanent income improves children's school progress through the grades. More specifically, a one percent increase in permanent income results in, on average, a decrease of 0.21 years of delay in school, which is statistically significant at the 0.05 level. However, the positive marginal effects of transitory income and residual income on a school delay suggest that income risk appears to impede children's educational progress in school, even if these estimates are not significant at conventional levels. This result may be implied that a large proportion of children already dropping out of school to work are less likely to re-enroll in school. Lastly, children from borrowing constrained households have a school delay of 0.06 years, which is statistically significant at the 0.10 level.[8]

6. Conclusion

This paper has presented a comprehensive analysis of household schooling decisions in rural Thailand, using the Townsend Thai household panel data over the period of 2013-2017. The main research question is to

[7] See Wooldridge (2010, pp 671-677) for a detailed discussion of Tobit model.
[8] An additional regression analysis is conducted to test an interaction effect between transitory income and borrowing constraints on children's delay in school enrollment. It is found that the coefficient of interaction term is not statistically significant. Because of limited space, additional results are not shown in this paper but can be obtained from the author upon request.

test whether and to what extent income shocks and borrowing constraints affect household demand for schooling. Three different educational outcomes are analyzed: schooling attainment, total educational expenditures per child, and years of school delay. The results indicate that a permanent income component is the key variable enhancing investments in children's human capital for all three measures studied. On the other hand, a transitory income change, mainly due to rainfall variation, leads to the decreased probability of being enrolled in school, but it shows a strong positive and significant effect on educational expenditures per child. The most plausible explanation for opposite effects of income shock is that higher transitory income implies an increase in the child's opportunity cost of schooling, especially for boys in upper secondary school ages. Hence, some parents may decide to withdraw their children from school to work.

As in most developing countries, Thailand's rural financial markets are not well functioned, suggesting that most households cannot borrow a sufficient amount when facing negative income shocks. To cope with income uncertainty, they tend to save a large fraction of transitory income to build their own savings. However, it is conjectured that most parents are likely to spend positive transitory income more on education for younger children currently enrolled in school. Further, more than half of children in the analysis are from constrained households, as defined by the ratio of wealth to household income. The results obtained from regression analysis suggest that borrowing constraints appear to be the main obstacle preventing rural children from school attendance and age-appropriate grade enrollment. In terms of household demographic socioeconomic status factors, it finds that girls are more likely to attend school than boys, but no gender differences are detected for total education expenditures and years of school delay. Finally, this paper provides robust evidence of sibling resource competition within household for all three measures of children's educational investments.

The empirical evidence provides valuable information for policymakers in reducing the likelihood of children's dropping out of school before completing upper secondary level, particularly during the transition from lower secondary to upper secondary level. Targeted additional subsidies for children completing compulsory education (grade 9) from low-income families are recommended in order to increase upper secondary enrollment. In addition, improving access to institutional credit and insurance coverage provided by the government for uninsured households in rural areas would help them better cope with temporary adverse income shocks. These policy recommendations are likely to result in the increase in children's human capital investment. Despite promising results, further investigations should be explored to evaluate the effectiveness of formal and informal insurance arrangements to mitigate the adverse shock impacts on child's schooling outcomes, particularly for

uninsured rural households with low assets. Such further studies are pivotal in order to greater insights into household schooling decisions under income uncertainty.

Acknowledgements

The author gratefully acknowledges the financial support from the Puey Ungphakorn Institute for Economic Research (PIER). The author would like to thank Research Institute for Public Policy Evaluation and Design (RIPED), University of the Thai Chamber of Commerce (UTCC) for allowing the author to access the Townsend Thai panel data used in this paper. The opinions and interpretations expressed here do not necessarily reflect the view of PIER and Burapha University. Any errors that remain in the paper are solely the author's responsibility.

Tables and Figures

Table 1 Descriptive Statistics of Variables Used in Income Regression

Variable	Mean	SD
Annual household income (thousand baht)	279.568	324.302
Head's years of education	5.355	3.124
Head has no education (0/1)	0.055	0.228
Head completes primary education (0/1)	0.759	0.428
Head completes lower secondary education (0/1)	0.091	0.287
Head completes upper secondary education (0/1)	0.073	0.260
Head completes university (0/1)	0.023	0.149
Head's age	55.621	12.024
Female head (0/1)	0.434	0.496
Head works as government worker (0/1)	0.017	0.129
Head works as owner of business (0/1)	0.625	0.484
Head works as unpaid family worker (0/1)	0.097	0.296
Divorced head (0/1)	0.043	0.202
Married head (0/1)	0.725	0.446
Never married head (0/1)	0.004	0.061
Separated head (0/1)	0.051	0.219
Widowed head (0/1)	0.178	0.382
Household size	4.552	1.527
Number of male age 0-5	0.132	0.374
Number of male age 6-15	0.565	0.671
Number of male age 16-20	0.244	0.483
Number of male age 21-59	0.884	0.722
Number of male age 60 and over	0.332	0.472
Number of female age 0-5	0.126	0.356
Number of female age 6-15	0.549	0.650
Number of female age 16-20	0.241	0.459
Number of female age 21-59	1.060	0.641
Number of female age 60 and over	0.439	0.511
Agricultural household (0/1)	0.793	0.405
Amount of land cultivated (rai)	16.804	24.773
Rainfall (millimeters)	130.077	31.741
Deviations of annual rainfall from the 20-year average	16.190	12.261
Squares of deviations of annual rainfall from the 20-year average	412.399	546.473
Number of households	840	
Number of observations	2,944	

Table 2 Descriptive Statistics of Key Variables Used in Child Schooling Regressions

Variable	Mean	SD
Dependent variables		
Currently enrolled (0/1)	0.926	0.263
Log of household annual education expenditure per child	8.481	2.070
Years of school delay	0.628	0.997
Child characteristics		
Girl (0/1)	0.496	0.500
Son or daughter of the household head (0/1)	0.443	0.497
Grandchild of the household head (0/1)	0.519	0.500
Other relative of the household head (0/1)	0.038	0.191
Child's age	12.191	3.723
Household characteristics		
Number of children aged 6 to 18 years	1.817	0.908
Borrowing-constrained household (0/1)	0.545	0.498
Household's total savings	37,129.7	131,670.3
The ratio of total savings to annual income	0.149	0.342
Annual household total expenditure	96,815.9	88,350.0
Total education expenditure per household	16,379.1	15,125.9
Total education expenditure per child	10,087.1	10,275.5
Household budget share of education expenditure	0.174	0.117
Number of children	1,511	
Number of observations	4,298	

Table 3 Estimates of the Determinants of Household Income

Variable	Coeff.	Robust SE
Constant	10.700***	(0.506)
Household Head Characteristics		
Completed lower secondary	0.022	(0.106)
Completed upper secondary	0.485***	(0.127)
Completed post-secondary	-0.031	(0.325)
Age	0.044**	(0.017)
Age squared	-0.0004***	(0.0002)
Female (0/1)	-0.110*	(0.066)
Works as government worker (0/1)	-0.025	(0.221)
Works as owner of business (0/1)	-0.088**	(0.039)
Works as unpaid family worker (0/1)	-0.102*	(0.053)
Married (0/1)	-0.190**	(0.092)
Never married (0/1)	0.244	(0.477)
Separated (0/1)	-0.038	(0.087)
Widowed (0/1)	-0.044	(0.077)
Household Characteristics		
Household size	0.031	(0.025)
Number of male age 0-5	0.046	(0.047)
Number of male age 6-15	0.002	(0.045)
Number of male age 16-20	-0.012	(0.046)
Number of male age 21-59	0.222***	(0.042)
Number of male age 60 and over	0.187***	(0.063)
Number of female age 0-5	0.043	(0.049)
Number of female age 6-15	0.046	(0.044)
Number of female age 16-20	-0.004	(0.042)
Number of female age 21-59	0.061*	(0.037)
Log of the amount of land cultivated	0.086***	(0.013)
Transitory shock variables		
Deviations of annual rainfall	0.007***	(0.002)
Squares of deviations of annual rainfall	-0.0001*	(0.0001)
Year dummy for 2014	-0.017	(0.028)
Year dummy for 2015	0.083***	(0.028)
Year dummy for 2016	0.009	(0.030)
Year dummy for 2017	0.031	(0.034)
Number of observations	2,944	
Number of households	840	
R-squared	0.24	

Note: * significant at the 0.10 level, ** significant at the 0.05 level, and *** significant at the 0.01 level. Robust standard errors are shown in parentheses.

Table 4 Random Effect Logit Results for School Attendance

Variable	Mean marginal effect (1)	(2)
Girl (0/1)	0.036***	0.036***
	(0.013)	(0.012)
Son or daughter of the household head (0/1)	0.065***	0.061***
	(0.025)	(0.023)
Grandchild of the household head (0/1)	0.139***	0.116***
	(0.027)	(0.027)
Number of children aged 6-18	-0.022***	-0.012*
	(0.007)	(0.007)
Permanent income	0.081***	0.048**
	(0.020)	(0.025)
Transitory income	-0.132*	-0.100*
	(0.080)	(0.061)
Residual income	0.009	0.007
	(0.010)	(0.008)
Borrowing-constrained household (0/1)	-0.033***	-0.023***
	(0.009)	(0.008)
Child's age dummies	Yes	Yes
Household's head and household controls	No	Yes
Observations	4,298	4,298
Log pseudo-likelihood	-829.51	-766.29
Wald chi-square statistic	59.83	107.01

Notes: *significant at the 0.10 level, ** significant at the 0.05 level, and *** significant at the 0.01 level. Robust standard errors are shown in parentheses. Additional explanatory variables included but not reported in Column 2 are household size and age and its squared term, gender, work status, educational level, and marital status of the household head.

Table 5 OLS Estimates of Household Education Expenditure per Child

	Coefficient	
Variable	**(1)**	**(2)**
Constant	7.112***	10.348***
	(1.086)	(3.076)
Girl (0/1)	0.0003	0.028
	(0.028)	(0.028)
Son or daughter of the household head (0/1)	0.035	0.009
	(0.075)	(0.072)
Grandchild of the household head (0/1)	-0.092	-0.027
	(0.079)	(0.082)
Number of Children aged 6-18	-0.302***	-0.450***
	(0.035)	(0.074)
Permanent income	0.140*	-0.112
	(0.087)	(0.275)
Transitory income	1.624***	1.617***
	(0.505)	(0.502)
Residual income	0.083*	0.076
	(0.050)	(0.049)
borrowing-constrained household (0/1)	-0.001	0.002
	(0.053)	(0.056)
Child's age dummies	Yes	Yes
Year dummies	Yes	Yes
Village dummies	Yes	Yes
Household's head and household controls	No	Yes
Number of observations	3,976	3,976
R-squared	0.28	0.31

Notes: *significant at the 0.10 level, ** significant at the 0.05 level, and *** significant at the 0.01 level. Robust standard errors are shown in parentheses. Head and household controls included but not reported are household size and age and its squared term, gender, work status, educational level, and marital status of the household head.

Table 6 Tobit Estimates of the Number of Years of School Delay

Variable	Coeff.	Marginal effect
Constant	6.426**	
	(2.920)	
Girl (0/1)	-0.037	-0.016
	(0.071)	(0.031)
Son or daughter of the household head (0/1)	-0.009	-0.004
	(0.172)	(0.075)
Grandchild of the household head (0/1)	-0.885***	-0.388***
	(0.178)	(0.079)
Number of Children aged 6-18	0.447***	0.194***
	(0.084)	(0.037)
Permanent income	-0.493**	-0.214**
	(0.251)	(0.109)
Transitory income	0.688	0.299
	(0.471)	(0.205)
Residual income	0.069	0.030
	(0.064)	(0.028)
Borrowing-constrained household (0/1)	0.129*	0.056*
	(0.068)	(0.030)
Household head's years of education	-0.077***	-0.034***
	(0.021)	(0.009)
Household's head gender (=1 if female)	-0.103	-0.045
	(0.121)	(0.052)
Head and household controls	Yes	
Log likelihood	-4,601.7	
Censored observations	2,384	
Uncensored observations	1,914	
N	4,298	

Notes: * significant at the 0.10 level, ** significant at the 0.05 level, and *** significant at the 0.01 level. Marginal effects presented are left-censored at zero reporting the change in actual years of a school delayed for children both being in the age-appropriate grade and those with school delay in response to a specific covariate change. Robust standard errors are shown in parentheses. Head and household controls included but not reported are household size and age and its squared term, work status, and marital status of the household head.

Appendix: Additional Results

Figure A1 School Enrollment Rates by Age

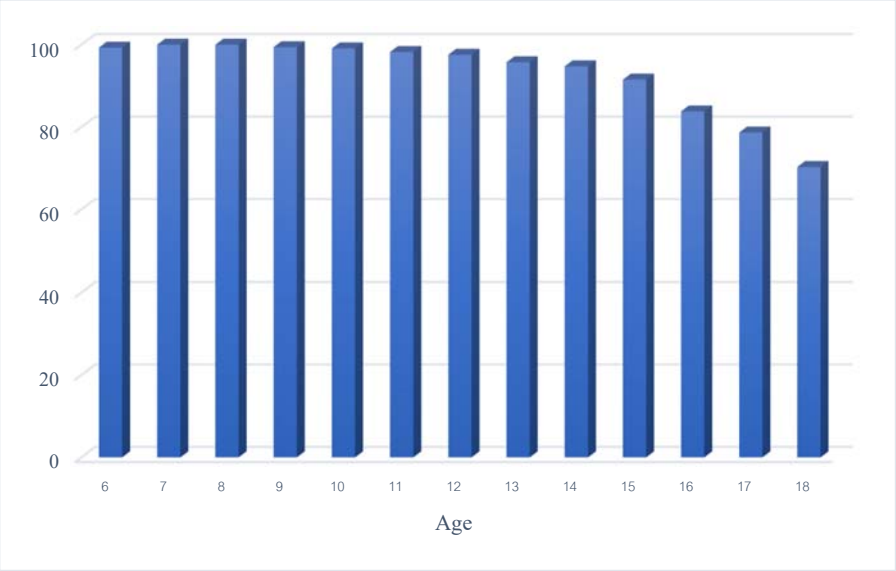

Table A1 Fixed Effects Estimates of Household Savings Equation

Variable	Coeff.	Robust SE
Constant	-16.048***	(5.715)
Permanent income	1.625***	(0.500)
Transitory income	4.579***	(0.876)
Residual income	2.876***	(0.164)
Household's head and household controls	Yes	
Number of observations	2,944	
Number of households	840	
R-squared	0.29	

Notes: *** significant at the 0.01 level. Robust standard errors are shown in parentheses. Additional explanatory variables included but not reported are household size and age and its squared term, gender, work status, educational level, and marital status of the household head.

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