Essays on Poverty, Education and Food Price Increases in Developing Countries

A DISSERTATION
SUBMITTED TO THE FACULTY OF THE GRADUATE SCHOOL
OF THE UNIVERSITY OF MINNESOTA
BY

Shinya Takamatsu

IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR THE DEGREE OF
DOCTOR OF PHILOSOPHY

Paul Glewwe, Advisor

August, 2011

Acknowledgments

I would like to thank my adviser Professor Paul Glewwe for his thoughtful comments, advice, endless patience and his wonderful encouragement throughout my Ph.D. program. Without his understanding and encouragement, this dissertation would not have been possible. I would also like to thank Professors Elizabeth Davis, Terry Roe, and Sanford Weisbergh for serving as my committee members, whose generous suggestions and comments were extremely invaluable to this dissertation. I would not have been able to complete my dissertation without Professor Burt Sundquist who provided his English writing and speaking support throughout my doctoral program.

I would also like to thank the faculty of the Department of Applied Economics for their instruction, conversations, and ideas. I am also grateful to the department staff and invaluable friends in the department for their kind help and friendship. I worked with a great boss, Dr. Matthew Sobek, as a research assistant at the Minnesota Population Center for two years and had opportunities to learn data management skills and teamwork, and to see more friends from other research backgrounds. I would like to thank the Foundation for Advanced Studies on International Development for financial support during my first two years of graduate studies. I would like to thank Professor Seiichi Fukui who encouraged me to pursue a Ph.D. degree in the United States when I was a master's student at the Graduate School of International Cooperation Studies, Kobe University.

I would like to thank Dr. Magnus Lindelow and Dr. Nina Fenton in the World Bank Vientiane office for providing the opportunities to work as a consultant for the last two years, and to visit Lao PDR, and allowing me to access the data which is used in Chapter 3. I also thank Professor Phouphet Kyophilavong at National University of Laos for helping me to obtain valuable data, literature and surveys, and connections in Laos. I would like to thank the International Food Policy Institute for maintaining a useful database from which the data set used in Chapter 2 was obtained.

Finally, but not the least, my thanks go to my beloved parents and sister in Japan for their love and continuous encouragement in my endeavors, and to my fiancé whose support has always been my source of strength and inspiration. Without their encouragement, my graduate study would have been infeasible.

Abstract

My dissertation is composed of two essays that investigate whether conditional cash transfer (CCT) programs affect the educational outcomes of non-targeted children in targeted households and the impacts of the global food crisis on household welfare and poverty. In the first essay, to investigate this issue, panel data are used from a randomized experiment conducted in Nicaragua to evaluate the *Red de Proteccion Social* program. Spillover effects on school enrollment are estimated separately for three types of non-target siblings: older, less-educated siblings; younger siblings; and older, more-educated siblings. Large, positive spillover effects are found for enrollment rates (27.1 and 29.3 percentage points in the first and second years, respectively) only for older, less-educated non-target children. Surprisingly, the estimated effects on enrollment rates are as large as the estimated increases in enrollment rates for target siblings (24.5 and 20.6 percentage points), although they are not directly comparable because of differences in initial enrollment rates. These empirical results are consistent with the predictions from a simple model of the demand for education. It also suggests that an accompanying supply-side intervention could raise schooling outcomes for non-target siblings although the data did not support this hypothesis. The main policy implication of this study is that neglecting spillover effects for non-target siblings underestimates the actual benefits of CCT programs. The second essay evaluates the impacts of the 2007-2008 food price crisis, especially price increases of rice, on household welfare and poverty in Lao PDR (Laos). Households benefit from an increase in the price of rice if they are net sellers of rice, and they suffer reduced welfare from a price increase if they are net buyers of rice. Laos is atypical in that glutinous rice is the main staple, while ordinary (non-glutinous)

rice, which is predominately consumed, and traded internationally, in the rest of Southeast Asia, is much less important in the Lao diet. The impact on household welfare in Laos of increases in the price of ordinary rice, the price of which was strongly affected by the food price crisis in 2007-2008, was negligible. This is mainly because the role of ordinary rice in sales and purchases in Laos is not as significant as in other Southeast Asian countries. In addition, during the crisis, price increases for ordinary rice in Laos were lower than those for other countries in Southeast Asia. The estimated effects of the growth rates of glutinous rice prices were not significant, mostly because the price increase in glutinous rice in 2008 was not as large as that of ordinary rice and of those of glutinous rice in the previous years. With (hypothetical) higher price increases of glutinous rice, the change in household welfare for the average Lao household is neutral, yet this average hides the fact that welfare changes are positive in rural areas and negative in urban areas. The sizes of the negative welfare changes among urban households do not vary much by expenditure quintiles or regions, but the size of the positive welfare increases in rural areas are concentrated in Vientiane and the Central region, which have relatively wealthy households. The increases in the national poverty rates due to a sharp hypothetical increase in the price of glutinous rice (40 percent) are less than about 0.5 percentage points. The changes in poverty rates are larger in the Vientiane region, where the poverty rates increase by 1.3 percentage points in urban areas and decrease by 1.8 percentage points in rural areas.

Table of Centents

List of Tables

List of Figures

Chapter 1

Introduction

The reduction of hunger and poverty and universal completion of primary education in developing countries are two of the eight Millennium Development Goals for the year 2015, which were adopted in 1990 by the international community and the world's leading development institutions (United Nations (2011)). Both scholars and development institutions have debated how to achieve these goals. Policies to stabilize food prices are important tools to reduce poverty, and investing in education is not only a goal in its own right but is also a means to reduce poverty in the future (Dercon and Shapiro (2007); Khandker and Haughton (2009)).

Conditional cash transfer (CCT) programs have become one of the most popular programs to improve health and education outcomes in developing countries.[1] Fiszbein and Schady (2009) provide a comprehensive description of CCT programs in developing countries, and review the impacts of these programs on consumption, poverty, education and health. Their definition of a CCT programs is "one that transfers cash to poor households if they make prespecified investments in the human capital of their children (p.31)". One of their findings is that, in general, CCT programs have large impacts on the use of services. These impacts are captured by higher rates of enrollment and daily

[1]CCT programs have been widely adopted in several middle-income countries (mainly in Latin America) since the mid-1990s, and low-income countries thereafter, and future adoptions are likely in Sub-Saharan Africa (de la Brire and Rawlings (2006)).

attendance in school and more frequent health center visits for pre-school age children. In addition to straightforward evaluations of whether CCT programs attain their intended outcomes, researchers have examined other, unintended impacts of CCT programs on education. Examples in estimation of the impact on test scores (Ponce and Bedi (2010); Behrman et al. (2011)), heterogenous impacts by gender and income levels (Dammert (2009)) and unintended spillover effects of CCT programs (Ferreira et al. (2009); Lalive and Cattaneo (2009)). Chapter 2 provides new evidence on the understanding of unintended impacts of CCT programs.

Chapter 3 analyzes the impacts of food price increases on household welfare and poverty in Laos due to the food price increases in 2007 and 2008. Food prices are one of the most important economic issues in any country, especially in developing countries, since those countries have more poor households, which tend to spend a relatively large proportion of their incomes on food consumption. Wodon and Zaman (2010) categorize the policies intended to mitigate the impacts of food price increases into three sets: (1) stabilizing rising prices by altering the aggregate supply and demand of food stuffs by reducing tax on food grains (import tariffs and sales taxes); (2) using existing safety net instruments to either increase benefit levels or increase beneficiary coverage; and (3) supporting domestic food production. In order to evaluate the effectiveness of these policies for reducing the impact of a future food price increases on household welfare, the impacts of previous food price increases on welfare and poverty should be understood. Chapter 3 contributes to this by providing empirical evidence on the impacts of the food price increases in 2008 on household welfare in Lao PDR (Laos).

Nicaragua is a lower middle income country, and Laos is a low income country, by World Bank income level categories. Per capita gross national incomes (GNI) in 2008 were USD 864.7 and 429.9 in constant 2000 USD for Nicaragua and Laos, respectively

(World Bank (2010)). Thus, Nicaragua is much wealthier than Laos. But Nicaragua's income level is much lower than those of other developing countries in Latin America and the Caribbean, whose average per capita GNI was 4687.9 in 2008. Given its higher GNI, it is not surprising that the poverty rate is lower in Nicaragua than in Laos. The poverty headcount ratio, using an USD1.25 per day expenditure poverty line (PPP exchange rates) was 15.8 percent in Nicaragua in 2005 and 33.9 percent in Laos in 2008. Both countries have much higher poverty rates than other developing countries in their regions (8.2 and 16.8 percent in the Latin America and the Caribbean region, and the East Asia and the Pacific region, respectively, in 2005). Although Nicaragua has a higher income and a lower poverty than Laos, the levels of educational attainment in the two countries are almost the same. The primary school completion rate in Nicaragua was 74.5 percent in 2008, and that in Laos was 74.7 percent, while the average rates in the Latin America and the Caribbean region, and in the East Asia and the Pacific region, were almost 100 (World Bank (2010)).

Chapter 2

Conditional Cash Transfer Programs and Educational Spillover Effects: An Analysis of Nicaragua's *Red de Proteccion Social* Program

2.1 Introduction

Although conditional cash transfer (CCT) programs have become a very popular intervention for raising health and education outcomes in developing countries, and many studies have documented positive effects for targeted children, research on the presence of unintended effects has been very limited. Damon and Glewwe (2009) evaluated three CCT programs in Latin America using cost-benefit analysis. However, their study could not take spillover effects into account when calculating the benefits since almost no studies had been conducted to estimate the size and existence of spillover effects in CCT programs. Cost-benefit evaluations of CCT programs would change if they have either negative or positive spillover effects.

Educational spillovers from gender specific education programs have been investigated by Khandker, Pitt, and Fuwa (2003) and Kremer, Miguel, and Thornton (2009). Khandker, Pitt, and Fuwa (2003) analyzed the effects of Bangladesh's nation-wide rural stipend program for girls on the secondary school enrollment of both girls and boys using both household and school survey data. Using the household survey data, they found an increase in the enrollment rate for girls, but no discernable effect on boys' enrollment. In addition, using school-level survey data, they found a decrease in boys' enrollment rates, which indicates a negative spillover. Kremer, Miguel, and Thornton (2009) investigated the effect of a merit scholarship program in Kenya using a randomized field experiment. This program targeted grade 6 girls, who were rewarded for high scores on their matriculation exam and received a grant to pay for the next two years' school fees (which is paid directly to schools) and for the costs of school supplies (which is paid to parents). The authors found an increase in test scores not only for girls (0.25 standard deviation increase) but also for boys (0.15 standard deviation increase). They also found a statistically significant increase in teacher attendance in the district where parental monitoring existed. But no increase was found in the other district, for which there was no evidence that parents monitored teachers. This study of Kenya is one example where an educational subsidy produced spillover effects.

Two empirical studies have shown that Mexico's CCT program, *Progresa*, had positive spillover effects on non-eligible households within eligible communities. Angelucci and Giorgi (2009) found an increase in per capita household consumption for non-targeted households by comparing four groups, eligible and non-eligible households in treatment and in control villages, which they attribute to within-village risk-sharing behavior. In addition, Bobonis and Finan (2009) calculated peer effects using the same comparison structure as Angelucci and Giorgi (2009), and found that an increase in enrollment rates for the eligible children in a community raised the likelihood of attending secondary school among non-eligible children in better-off households in the same community. These two studies show that limiting attention to targeted children may underestimate CCT programs' effects. While these two empirical studies quantify spillover effects of

CCT programs *across* households, spillover effects *within* households have not yet been considered.

In this chapter, panel data from a randomized experiment conducted in Nicaragua are used to investigate whether CCT programs affect the educational outcomes of non-targeted children in targeted households. Spillover effects in enrollment are estimated separately for three types of non-target siblings: older, less-educated siblings; younger siblings; and older, more-educated siblings, and heterogeneous effects are also investigated in terms of the gender. Lastly, in order to understand the changes resulting from spillover effects on education, estimates are presented of the impact of the program on educational expenditures.

The organization of this chapter is as follows. Section 2.2 provides the theoretical framework for spillover effects within a household on education for non-target siblings. Section 2.3 discusses the background and the data. Section 2.4 describes the empirical specification. Section 2.5 presents empirical results, and a final section provides conclusions.

2.2 Program Description, Data and Non-target Siblings

2.2.1 Nicaragua's *Red de Proteccion Social* (RPS)

Nicaragua's Social Safety Net (RPS) CCT program operated from 2001 to 2006. It consisted of two phases. Phase I was the pilot phase, and Phase II was conducted on a larger scale after the evaluation of Phase I. The International Food Policy Research Institute (IFPRI) conducted a quantitative impact evaluation based on a household survey implemented from 2000 to 2002. Henceforth, these three years of the survey will be called year 0 (or base year), year 1 and year 2. This study uses the database collected by IFPRI.

IFPRI (2005) documented that the RPS was implemented in selected areas that were geographically targeted in the following way:

1. The Departments of Modriz and Matagalpa, from the northern part of the Central Region, were selected on the basis of their high poverty rates, their capacity to implement the program, easy physical access to and communication with Managua, the capital and headquarter of the RPS, and relatively strong institutional capacity and local coordination.[1] In the Central region, poverty increased between 1998 and 2001, although during that time period both urban and rural poverty rates declined nationally.

2. A total of six municipalities were selected from these two Departments because these municipalities had a participatory development program and sufficient capacity to implement the program.

3. The 42 poorest *comarcas* were chosen from the 52 *comarcas* in these six municipalities, using a marginality index.[2] *Comarcas* are administrative areas

[1]The administrative strata in Nicaragua are : Nicaragua-Department-Municipality-*Comarca*.

[2]That index is a weighted average of a set of poverty indicators (family size, the percentage of households

within municipalities that include between one and five small communities that have, on average, 100 households each. One half of the 42 *comarcas* were randomly selected to be eligible for the program. All of the households living in the those 21 *comarcas* were eligible except households that were excluded because they are deemed to be too wealthy.

The RPS program provided poor households in rural Nicaragua with money transfers if they satisfied the following three conditions that apply to them (IFPRI (2005)):

(1) They enroll in grades 1 to 4, and maintain regular attendance (85%, i.e., no more than 5 absences every two months without a valid excuse), all children 7 to 13 years old who have not yet completed the 4th grade,[3]

(2) They bring their preschool age children to monthly (0 to less than 2 years old) or bimonthly (2-5 years old) healthcare appointments, and keep vaccinations up-to-date for all children under 5 years of age, and

(3) They attend a bimonthly health education workshop.[4]

The number of requirements for each household depended on whether it had children within the specific age ranges. All of the applicable requirements had to be satisfied to receive full cash transfers. For example, a household with only one 8-year-old child needed to satisfy both conditions (1) and (3) for cash transfers. On the other hand, households with 4- and 8-year-old children were provided full cash transfers if they satisfied all of the conditions (1), (2) and (3), but still received partial cash transfers even if they could not satisfy either the condition (1) or (2).

---

without piped water or latrine, and the percentage of households with at least one illiterate member over five years of age), at the *comarca* level.

[3]Successful promotion in grades (i.e., no grade repetition) was included in condition (1), but according to IFPRI (2005) it was not implemented in practice.

[4]This is only one condition that applies to households without children.

The amount of cash transfers received by each household depended on the number of children in the household and the number of conditions satisfied. IFPRI (2005) reports the annual amount, although cash transfers are given every two months. All households could receive C$2,880 (US$224) per year by satisfying condition (3).[5] For satisfying the education requirement (1), households receive C$1,440 (US$112) per year plus C$275 (US$21) per child at the beginning of the school year. Children received various health care services without charge. The mean of total household expenditures for the households in the IFPRI data was C$ 23,073 ($1,794) in 2000. Thus, a rough calculation shows that the cash transfers were equivalent to 21 percent of total household expenditures for households with two children eligible for the education subsidies.[6] This suggests that the incentive to satisfy the conditions to receive cash transfers was very high.[7]

2.2.2 Data and Sampling Scheme

The data were obtained from IFPRI (2005). The sample design for the data has the following characteristics:

1. The 42 *comarcas*[8] were ordered by a marginality index and grouped into seven strata, each with six comarcas, based on the marginality index. Within each stratum, three comarcas were randomly assigned to the control group and the other three were assigned to the treatment group. From each *comarca*, 42 households were

[5]U.S. dollars are converted into Nicaraguan córdobas (C$) using the September 2000 exchange rate.

[6]$\{2,880 + 1,440 + (2 * 275)\}/23,073 = 4870/23,073 = 0.21$

[7]In addition to the benefits for households, teachers or schools received C$80 (US$6) per child per year to "provide incentives to the teachers, who have some additional reporting duties and were likely to have larger classes after the introduction of the RPS, and to increase resources available to schools"(IFPRI (2005),p.6-7). Furthermore, for the health services provided free of charge to households, RPS paid approximately US$50 per beneficiary per year to service providers for the health education workshops cost and US$110 per year for the costs of healthcare services including vaccines and medicines (p.8).

[8]*Comarcas* are administrative areas within municipalities that include between one and five small communities that have, on average, 100 households each.

randomly sampled.

2. The survey was implemented each year from 2000 to 2002. In 2000, neither the treatment nor the control group had access to the program; and this year is used as a baseline for the treatment and control groups (and is called year 0 in this study). In 2001 and 2002, households in the treatment group were given access to the program while households in the control group had no access. (These years are called year 1 and year 2, respectively, in this study.) These households were surveyed in September or October, once per year, for three consecutive years.

Starting in 2003, households in the control groups were incorporated into Phase II of the RPS and became eligible for the program. One possible issue is that households in the control group changed their behavior based on the knowledge and expectation of their future inclusion to the program. Maluccio and Flores (2005) discuss this issue for program effects for target siblings.[9] The authors speculated that the "contamination of the control group due to expectations in a real possibility, although it may be limited to only a fraction of the households (p.23)". The issue in this study is whether the information on future incorporation in the control group could have changed the educational decisions for non-target siblings. One could argue that the educational choices for non-target siblings could be affected indirectly through changes in education choices for target siblings that were made in anticipation of the program. It is hard to assign the direction of the bias because the direction of the bias for the target siblings is ambiguous. Although contamination is possible, it may be less severe in the second year of the program. Caldes

[9] The authors mentioned that about half of the households in the control group answered that they did not know about future inclusion, and that about one-third were aware of specific program features according to the questions asked in year 2. Further, they point out that, in theory, there are two possible sources of contamination in the control group. First, households may postpone their children's dropping out from school if non-financial cost to return to school in the future is high once their children dropped out. Second, households had an incentive to delay the completion of the 4th grade until they are incorporated into the program and would be able to receive cash transfers. Therefore, these two biases are in opposite directions.

and Maluccio (2005) mention that the households in the control group were originally scheduled to be incorporated into the program in 2001, however the inclusion was delayed because of a delay in the financial approval of the Nicaraguan government. Perhaps this delay lowered the expectation of the inclusion in the future, which would reduce this type of bias for year 2.

2.2.3 Target and Non-target Siblings in Nicaragua's RPS

Given the age- and education-based targeting explained above, 7- to 13-year-old children who have not yet completed the fourth grade of primary school are the target children of the program. These children are referred to as target siblings in this study. ”Siblings” in this study do not exclude the children who live in the same househeold as the target children but are not brothers or sisters of the target children. There are also three types of non-target siblings, which are likely to have different characteristics: older (14 to 16 years old) less-educated (Not completed grade 4); younger (9 to 13) more-educated (completed grade 4);[10] and older, more-educated (14 to 16 years old who have completed grade 4).

Whether a given child is targeted is determined by his or her age and education. The relevant age is the age at the beginning of the school year (February) rather than age at the time of the survey (August to October), since the age at the beginning of the school year is the age used when enrollment (and program eligibility) decisions are made. Likewise, completed education levels at the beginning of school years are used. This avoids considering as non-target siblings some children who are eligible at the beginning of the school year, but are not at the time of the survey. For example, a child who is 7 years old at the period of the survey (October) and whose birth day is in May is not yet 7 years old at the beginning of the school year (February). Therefore, if the age at the survey period is

[10]Since no children who are less than 9 years old completed the 4th grade, this category starts from 9 year old.

used, a non-eligible child can be mistakenly considered eligible. Analogously, for older children, an eligible child can be considered non-eligible.

Special care is necessary regarding selection of the sample because of the design of the experiment. Table 2.1 shows the four possible transitions of both target and non-target siblings during the survey. Case 2 children are targeted in years 0 and 1 but not in year 2, but the status in year 2 could be due to both program effects in year 1 and spillover effects in year 2. This may cause overestimation of spillover effects in year 2 because although they were not targeted year 2, they were targeted in year 1. At the same time, since being non-target siblings in year 2 is due to children either completing the 4th grade or becoming older than 13 years old, it is likely that those who are more likely to enroll in school in year 1 were more likely to become non-target children in year 2 and those who are less likely to enroll in year 1 were more likely to be remain targeted children in year 2. If this is the case, the estimated program effects in year 2 would be underestimated. To address these biases, this study presents two separate sets of estimates, the first uses data from years 0 and 1, and the second uses data from years 0 and 2. The first set of estimates are free from the above-mentioned bias. The second set may suffer from this bias. Therefore, it should be noted that the estimates in year 2 include the cumulative effects in years 1 and 2, but may be biased.

Since this study focuses on parental choices in education between siblings, only households with both target and non-target siblings should be used for estimation. Table 2.2 shows the sample sizes of households and children who are 7 to 16 years old, and the subset of households with *both* target and non-target siblings; only the latter are used for the analysis in this study.[11] The numbers of households in the constructed data sets are slightly less than half of the full sample and those of children are slightly more

[11]The full sample in the table excludes households which have no child or only pre-school age or over-16-year-old children from the original data set.

than half. The numerical balance between the treatment and control groups is still maintained after deleting the households that do not have both target and non-target siblings; however, the characteristics of households have been changed. As seen in Table 2.2, the mean value of household expenditures decreases from C$ 3366 to 2875 after the selection. Because households with higher expenditures tend to have a smaller number of children, it is likely that richer households are more likely to be dropped from the constructed sample. The mean values in the expenditure level between the treatment and control groups are still very close after the selection.

Table 2.2 also shows the sample sizes for the target siblings and the three types of non-target siblings over the three years for the treatment and control groups. As seen in the table, the sample sizes of the target siblings are slightly larger than the sum of the non-target siblings over the three years. Among the non-target siblings in year 0, about 45 percent are older, less-educated siblings, and 23 percent are younger siblings, and 33 percent are older, more-educated non-target siblings.

The relative frequency of the three types of non-target siblings varies according to household characteristics. For example, Table 2.3 shows the combinations of non-target siblings and target siblings in the data, as well as mean per capita expenditures in year 0. As seen in the table, about 80 percent of the total households have distinct types of non-target siblings. Among these siblings, older, less-educated non-target siblings constitute more than half, and among the rest there are slightly more older, more-educated siblings than younger non-target siblings. In addition, the mean per capita expenditures for households with only older, less-educated non-target siblings is C$2,532, and those with the other two types of non-target siblings are C$3,427 and C$3,246. Thus, households with older, less-educated non-target siblings are poorer than those with older, more-educated siblings or younger non-target siblings.

2.3 Conceptual Framework of Spillover Effects in Education for Non-target Siblings

At the beginning of this section, spillover effects are explained by the demand-side of households and the supply-side of a CCT program. Each explanation follows.

2.3.1 Demand-side Explanation -A Model with Spillover Effects-

This section presents an economic model of households' education decisions. The model treats education as a consumption good. Of course, the investment aspect of education is responsible for some, and perhaps much, of this demand. Basic demand theory can be used to predict households' responses to CCT programs regarding the education of non-target siblings. To do this, a CCT program is considered that provides cash transfers to households if they keep their target child in school. Recall that the Nicaraguan CCT program targeted 7 to 13 year old children who have not yet completed the 4th grade of primary school. Therefore, the model has two types of children, target and non-target siblings.[12]

The model is based on the following assumptions. First, a unitary decision maker, a parent, chooses an allocation of total household consumption, and time for leisure, labor and education for his or her target and non-target children. For simplicity, leisure and labor for the parent are assumed to be fixed. Second, a CCT program provides cash transfers (t) in proportion to schooling allocated for the target sibling (S_1), but there is a targeted education level ($\overline{S}$) beyond which there are no further cash transfers. The parameters t and $\overline{S}$ are determined by a policy maker. For example, $\overline{S}$ is the fourth grade

[12]To my knowledge, no study has modeled the educational decisions parents make for non-target siblings within a household in the context of a CCT education program. However, several studies have discussed the intra-household allocation of the resources for CCT programs due to changes in income (Das, Do, and Ozler (2005)) and price (Ravallion and Wodon (2000)).

for the Nicaraguan CCT program and t is the corresponding amount of money a household can receive. The household does not obtain cash transfers by increasing a non-target child's education. Third, leisure and education are assumed to be normal goods. Fourth, the amount of cash transfers is large enough to have all of parents choose S_1 such that $S_1 \geq \overline{S}$. This assumption is reasonable since the relative size of cash transfers to per capita household expenditures for the RPS was larger than for other CCT programs in Latin America (Fiszbein and Schady (2009)). Fourth, assume that education costs and wages (or reservation wages for those who are not working) are fixed. Lastly, non-labor income, $Y(z)$, is exogenously determined and depends on household characteristics (z).

Under these assumptions, the parent maximizes his/her household utility function given his/her budget and time constraints by choosing values for five variables: household total consumption (C), and allocations for schooling (S_1, S_2) and leisure (H_1, H_2) for the two types of children. Subscript 1 indicates the target child and subscript 2 indicates the non-target child. All five of these variables are assumed to be continuous and positive. Actually, S_1 and S_2 can be discrete, but they are treated as continuous variables in order to simplify the analysis. The utility function is $U = U(C, H_1, H_2, S_1, S_2)$, where U is twice continuously differentiable and strictly quasi-concave on (C, H_1, H_2, S_1, S_2).

The budget constraint is:

$$\begin{aligned} C + b_1S_1 + b_2S_2 = w_1L_1 + w_2L_2 + CT + Y(z) \text{ where } CT &= tS_1 \quad \text{if } S_1 \leq \overline{S} \\ &= t\overline{S} \quad S_1 > \overline{S} \end{aligned} \tag{2.1}$$

where w_i and b_i are the wage rate and the cost of schooling for child i, respectively, and L_i is the labor time of child i. The price of C is normalized to 1. The amount of cash transfers received is bounded by $t\overline{S}$, the largest amount of cash transfers available. Since t is a constant, tS_1 is the amount of cash transfer if a household chooses schooling for the target child (S_1) such that $S_1 \leq \overline{S}$. The household can choose to provide its target sibling with schooling greater than $\overline{S}$, but it cannot receive cash transfers more than $t\overline{S}$. All of the parameters (w, b, Y, t and $\overline{S}$) are assumed to be positive.

The time constraint for each child is $T = H_i + L_i + S_i$, for i=1,2, where T is the time endowment for each child. The full-income budget constraint is derived by substituting the time constraints into (2.1):

$$C + w_1 H_1 + w_2 H_2 + (b_1 + w_1 - t)S_1 + (b_2 + w_2)S_2 = (w_1 + w_2)T + Y(z) \text{ if } 0 \leq S_1 \leq \overline{S} \tag{2.2a}$$

$$C + w_1 H_1 + w_2 H_2 + (b_1 + w_1)S_1 + (b_2 + w_2)S_2 = (w_1 + w_2)T + Y(z) + t\overline{S} \text{ if } S_1 > \overline{S} \tag{2.2b}$$

Two distinct cases are considered for the education level of the target sibling in the absence of the program: (1)$S_1^0 < \overline{S}$, and (2)$S_1^0 \geq \overline{S}$. For the allocations with the program, two distinct cases are considered: (1)$S_1^* = \overline{S}$, and (2)$S_1^* > \overline{S}$. $S_1^* < \overline{S}$ is excluded since it is assumed that the size of cash transfers is designed to be large enough to achieve the targeted education level. Technically, there are four possible scenarios regarding the values of S_1^0 and S_1^*. However, only three cases are actually possible for the following reason. If $S_1^0 \geq \overline{S}, S_1^* > \overline{S}$ since education is assumed to be normal goods and cash transfers always increase the demand of S_1. Each of these cases are discussed in the following subsections.

I. Initial Education Level for Target Sibling is Lower than Targeted Education Level ($S_1^0 < \overline{S}$). First, consider the case where the initial (pre-program) education level for the target sibling (S_1^0) is lower than the targeted education level. In this case, Figure 2.1 shows the two dimensional choice set between a composite commodity ($\mathbb{C}$) that includes C,

H_1,H_2 and S_2, and education for a target child (S_1).[13] Without a CCT program, the budget line is the straight line AB, and the optimal allocation is point D, at which the indifference curve IC_0 is tangent to AB. The optimal education for the target sibling is S_1^0, and the optimal amount for the composite commodity is $\mathbb{C}_0$ which includes S_2^0.

Without the program, the demand functions of the education for target and non-target siblings are:

$$S_1^0 = S_1(b_1, b_2, w_1, w_2, (w_1 + w_2)T + Y(z) | t = 0) \tag{2.3a}$$

$$S_2^0 = S_2(b_1, b_2, w_1, w_2, (w_1 + w_2)T + Y(z) | t = 0) \tag{2.3b}$$

where $|\, t = 0$ indicates that variables are those without the program. These are the Marshallian demand functions; which are the functions of the prices of each item and of full-income.

After the introduction of a CCT program, the budget line is no longer straight. Equation (2.2a) implies that the price of schooling for the target child is $b_1 + w_1 - t$ with a CCT program when education is lower than $\overline{S}$. As a result, line AB shifts upwards with the program since the price of schooling decreases until education increases up to $\overline{S}$. Once schooling for the target sibling becomes larger than $\overline{S}$, the slope of the budget line becomes parallel to AB. In the figure, lines AGH and AIJ are drawn to have the different rates of cash transfer (t) such that $t_{AGH} < t_{AIJ}$.

For Case 1, of which G is an example in Figure 2.1, education for the target sibling is fixed at $\overline{S}$, and the other variables are optimally solved. With the program, the education

[13] In Figure 2.1, the price for total household consumption, wage for a target child, and wage and schooling cost for a non-target child are assumed to move in parallel. Then, Hick's Composite Commodity Theorem permits one to treat C, H_1, S_2, and H_2 as one composite commodity ($\mathbb{C}$). This assumption holds temporarily in order for us to explain the results of this section graphically and concisely.

for target and non-target siblings (S_1^1 and S_2^1) are obtained using (2.2a) as follows:

$$S_1^1 = \overline{S} \tag{2.4a}$$

$$S_2^1 = S_2(b_1, b_2, w_1, w_2, (w_1+w_2)T + Y(z) + t\overline{S}|\, t > 0, S_1^1 = \overline{S}) \tag{2.4b}$$

where $|\, t > 0$ indicates that a variable is that with the program (as opposed to $t = 0$), and $S_1^1 = \overline{S}$ indicates that a variable is optimally chosen with S_1^1 fixed at $\overline{S}$.

Program effects are calculated by subtracting (2.3a) from the demand with the program (2.4a):

$$S_1^1 - S_1^0 = \overline{S} - S_1(b_1, b_2, w_1, w_2, (w_1+w_2)T + Y(z)|\, t > 0) > 0 \tag{2.5}$$

Since $S_1^0 < \overline{S}$ in this case, program effects are always positive. In addition, the size of the program effects is negatively correlated with parental income, Y(z) since education is a normal good and $\frac{\partial S_1^0}{\partial Y} > 0$.

Spillover effects are calculated by subtracting (2.3b) from the demand with the program (2.4b):

$$\begin{aligned} S_2^1 - S_2^0 =& S_2(b_1, b_2, w_1, w_2, (w_1+w_2)T + Y(z) + t\overline{S}|\, S_1^1 = \overline{S}, t > 0) \\ & - S_2(b_1, b_2, w_1, w_2, (w_1+w_2)T + Y(z)|\, t = 0) \\ =& S_2(, (w_1+w_2)T + Y(z) + t\overline{S}|\, t > 0) - S_2(, (w_1+w_2)T + Y(z)|\, t = 0) \\ & - \{S_2(, (w_1+w_2)T + Y(z) + t\overline{S}|\, t > 0) \\ & - S_2(, (w_1+w_2)T + Y(z) + t\overline{S}|\, S_1^1 = \overline{S}, t > 0)\} \\ =& \Delta S_2(\text{income effect}) - \Delta S_2(\text{conditionality effect}) \gtreqless 0. \end{aligned} \tag{2.6}$$

Although program effects are always positive, the existence and direction of spillover effects are indeterminate. The second line indicates that spillover effects can be decomposed into two differences. The first difference is the change in S_2 due to the income increase from $(w_1+w_2)T+Y(z)$ to $(w_1+w_2)T+Y(z)+t\overline{S}$, and the second difference is the change due to the conditionality that $S_1^1=\overline{S}$).[14] The first difference is positive since the income effect is positive, but the second difference is subtracted since this household has to choose $S_1^1=\overline{S}$ and this conditionality to receive cash transfers decreases education for the non-target sibling. The relative size of the two differences cannot be determined a priori, thus, spillover effects can be positive, zero or negative.

For Case 2, of which K is an example in Figure 2.1 and education for the target sibling is larger than $\overline{S}$, education for target and non-target siblings is obtained using budget constraint (2.2b), the optimal education for target and non-target siblings is chosen with income including full cash transfer, $t\overline{S}$. Program effects are calculated as in Case 1:

$$\begin{aligned} S_1^2-S_1^0 = {} & S_1(b_1,b_2,w_1,w_2,(w_1+w_2)T+Y(z)+t\overline{S}|\,t>0) \\ & -S_1(b_1,b_2,w_1,w_2,(w_1+w_2)T+Y(z)|\,t=0)>0. \end{aligned} \tag{2.7}$$

Spillover effects are:

$$\begin{aligned} S_2^2-S_2^0 = {} & S_2(b_1,b_2,w_1,w_2,(w_1+w_2)T+Y(z)+t\overline{S}|\,t>0) \\ & -S_2(b_1,b_2,w_1,w_2,(w_1+w_2)T+Y(z)|\,t=0)>0. \end{aligned} \tag{2.8}$$

Both effects are positive since education is a normal good, and only an income effect exists (no conditionality (price) effect exists).

II. Initial Education Level for Target Sibling is Equal or Larger than Targeted Education Level ($S_1^0\geq\overline{S}$). In Case 3, the formulas for program and spillover effects are equal to (2.7) and (2.8), respectively. So, both effects are always positive.

[14]Notice that the second term is equivalent to a standard price effect in Slutsky equation. But the term "conditionality" is used in the context of a CCT program.

Summary of Model Predictions Table 2.4 summarizes the existence and direction of program and spillover effects. Positive program effects always occur for target siblings, but spillover effects for non-target siblings are indeterminate in Case 1 but are positive in Cases 2 and 3.

Model Using Cobb-Douglas Utility Function

In this subsection, a Cobb-Douglas utility function is used to derive more concrete predictions and validate the predictions from the above-mentioned economic model using a more general utility function.

The Cobb-Douglas utility function is specified by:

$$U = U(C, H_1, H_2, S_1, S_2) = C^{\alpha} S_1^{\beta_1} S_2^{\beta_2} H_1^{\gamma_1} H_2^{\gamma_2} \tag{2.9}$$

where $\alpha, \beta_1, \beta_2, \gamma_1, \gamma_2 > 0$. For simplicity, assume that $\alpha + \beta_1 + \beta_2 + \gamma_1 + \gamma_2 = 1$, which is just a normalization that does not change the results of this section. Additionally, assume that preferences for target and non-target siblings are the same, so $\beta_1 = \beta_2$ and $\gamma_1 = \gamma_2$. With this assumption, the education for the target and non-target siblings are the same without the program, and so are the schooling costs for the two siblings.[15] The full-income budget constraint is the same as (2.2).

The dotted line in Figure 2.2 shows the optimal allocations of S_1 and S_2 without and with a program using a Cobb-Douglas utility function. The two axes in the figure are the same as those in Figure 2.1.[16]

[15]This assumption is used to make the model simpler, but is not indispensable.
[16]The parameter conditions for each case below are shown in Appendix A.1

I. Cases 1 and 2: The Initial Education Level for the Target Sibling is Lower than the Targeted Education Level ($S_1 < \overline{S}$). Equations (2.3a) and (2.3b) for the allocation *without* the program correspond to (2.10b) and (2.10d), respectively:

$$C^0 = \alpha\{(w_1 + w_2)T + Y(z)\} \tag{2.10a}$$

$$S_1^0 = \frac{\beta_1}{(w_1 + b_1)}\{(w_1 + w_2)T + Y(z)\} \tag{2.10b}$$

$$H_1^0 = \frac{\gamma_1}{w_1}\{(w_1 + w_2)T + Y(z)\} \tag{2.10c}$$

$$S_2^0 = \frac{\beta_2}{(w_2 + b_2)}\{(w_1 + w_2)T + Y(z)\} \tag{2.10d}$$

$$H_2^0 = \frac{\gamma_2}{w_2}\{(w_1 + w_2)T + Y(z)\} \tag{2.10e}$$

With the Cobb-Douglas utility function, the full income $(w_1 + w_2)T + Y(z)$ is allocated based on the preference and cost of each item, more specifically, in proportion of the ratio of preference parameters $(\alpha, \beta_1, \gamma_1, \beta_2, \gamma_2)$ to the price or cost $(1, w_1 + b_1, w_1, W - 2 + b_2, w_1 + w_2$, respectively).

Recall that the case in which $S_1^1 < \overline{S}$ is excluded by assuming that the amount of cash transfers is large enough to have $S_1^1 \geq \overline{S}$. Therefore, the allocations which are tangent to the budget line (e.g., point N in Figure 2.2) should be excluded.[17]

For Case 1, of which G is an example in Figure 2.2, education for the target sibling is fixed at $\overline{S}$, and the other variables are optimally solved. The mathematical solution is

[17] See Appendix A.2 for the mathematical derivation.

obtained using (2.2a) as:

$$C^1 = \frac{\alpha}{1-\beta_1}\{(w_1+w_2)T + Y(z) + \{t-(w_1+b_1)\}\overline{S}\} \tag{2.11a}$$

$$S_1^1 = \overline{S} \tag{2.11b}$$

$$H_1^1 = \frac{\gamma_1}{w_1(1-\beta_1)}\{(w_1+w_2)T + Y(z) + \{t-(w_1+b_1)\}\overline{S}\} \tag{2.11c}$$

$$S_2^1 = \frac{\beta_2}{(w_2+b_2)(1-\beta_1)}\{(w_1+w_2)T + Y(z) + \{t-(w_1+b_1)\}\overline{S}\} \tag{2.11d}$$

$$H_2^1 = \frac{\gamma_2}{w_2(1-\beta_1)}\{(w_1+w_2)T + Y(z) + \{t-(w_1+b_1)\}\overline{S}\} \tag{2.11e}$$

Program effects are calculated by subtracting (2.10b) from (2.11b): $S_1^1 - S_1^0 = \overline{S} - \frac{\beta_1}{(w_1+b_1)}\{(w_1+w_2)T + Y(z)\} > 0$. So, the size of the program effects is negatively correlated with parental income, Y. Spillover effects are calculated by subtracting (2.10d) from (2.11d):

$$\begin{aligned} S_2^1 - S_2^0 =& \frac{\beta_2}{(w_2+b_2)(1-\beta_1)}[(w_1+w_2)T + Y(z) + \{t-(w_1+b_1)\}\overline{S}] \\ &- \frac{\beta_2}{(w_2+b_2)}\{(w_1+w_2)T + Y(z)\} \\ =& \frac{\beta_2}{(w_2+b_2)(1-\beta_1)}\{t\overline{S} - (w_1+b_1)(\overline{S} - S_1^0)\} \\ =& \Delta S_2(\text{income effect}) - \Delta S_2(\text{conditionality effect}) \end{aligned} \tag{2.12}$$

$$\Rightarrow 0 \le S_2^1 - S_2^0 \le \frac{\beta_2 t\overline{S}}{(w_2+b_2)} \tag{2.13}$$

Although program effects are positive in this case, spillover effects can be positive or zero. Equation (2.12) indicates that spillover effects can be decomposed into two terms in terms of the education levels for target siblings. Although the first term in the last equality is negative (since $S_1^0 < \overline{S}$ by assumption) and the second is positive, the parameter condition (A.6) for Case 1 above implies that the total cannot be negative and is bounded as in (2.13). Thus, spillover effects are positive or zero in this case. This result indicates the effects cannot be negative, in contrast to (2.6), because of the Cobb-Douglas utility function.

For Case 2, of which K is an example in Figure 2.2, the mathematical solution is obtained using the budget constraint (2.2b):

$$\begin{aligned} &C^2 = C^0 + \alpha t\overline{S},\ S_1^2 = S_1^0 + \frac{\beta_1}{(w_1+b_1)}t\overline{S},\ H_1^2 = H_1^0 + \frac{\gamma_1}{w_1}t\overline{S}, \\ &S_2^2 = S_2^0 + \frac{\beta_2}{(w_2+b_2)}t\overline{S},\ H_2^2 = H_2^0 + \frac{\gamma_2}{w_2}t\overline{S} \end{aligned} \tag{2.14}$$

As seen in the equations, all of the variables are strictly larger than those without the program. Program and spillover effects respectively are:

$$\begin{aligned} S_1^2 - S_1^0 &= \frac{\beta_1}{(w_1+b_1)}\{(w_1+w_2)T + Y(z) + t\overline{S}\} - \frac{\beta_1}{(w_1+b_1)}\{(w_1+w_2)T + Y(z)\} \\ &= \frac{\beta_1 t\overline{S}}{(w_1+b_1)} > 0, \end{aligned} \tag{2.15}$$

$$\begin{aligned} S_2^2 - S_2^0 &= \frac{\beta_2}{(w_2+b_2)}\{(w_1+w_2)T + Y(z) + t\overline{S}\} - \frac{\beta_2}{(w_2+b_2)}\{(w_1+w_2)T + Y(z)\} \\ &= \frac{\beta_2 t\overline{S}}{(w_2+b_2)} > 0 \end{aligned} \tag{2.16}$$

In this case, spillover effects are always positive since only income effects exist. Equations (2.15) and (2.16) correspond to (2.7) and (2.8), respectively. Thus, spillover effects are always positive in this case and this finding using a Cobb-Douglas utility function is consistent with that using a general utility function.

II. Case 3: The Initial Education Level for the Target Sibling is Equal or Larger than the Targeted Education Level ($S_1^0 \geq \overline{S}$). In Case 3, the formulas for the allocations without the program are equal to (2.10), but $S_1^0 \geq \overline{S}$. The allocation with the program is tangent to the budget line in this case, so the formulas for the solution are equal to (2.14). Thus, program effects are equal to (2.15), and spillover effects are equal to (2.16), so both program and spillover effects are positive in this case as in Case 2. In this case, only income effects exist as in Case 2. This result using a Cobb-Douglas utility function is consistent with that using a general utility function.

Summary of the Model Prediction The summary of the results using a Cobb-Douglas utility is in Table 2.4 by replacing $\gtreqless$ with $>$ for spillover effects in Case 1. Positive program effects always occur, so do spillover effects.

2.3.2 Supply-side Explanations for Spillover Effects: Improved School Quality Caused by the Supply-side Intervention

If a CCT program has a supply-side intervention, such as a teacher subsidy, this intervention could lead to spillover effects for non-target siblings. In the RPS, as documented in Maluccio and Flores (2005), Supply-side Education Transfers[18] were given to teachers to provide them with incentives to work harder since "teacher absenteeism is a significant problem in rural Nicaragua"(Moore, 2009, p.9). In addition, bi-monthly training sessions for teachers were provided to schools in the treatment communities. These kinds of supply-side interventions can affect the quality of school for non-target siblings, but it is uncertain whether this will benefit non-target siblings. Schools may be more attractive to non-target siblings because teachers are more motivated and schools are better equipped by cash transfers. On the other hand, schools could become congested, and non-targeted children could be treated unfairly by teachers or

[18]US$ 4.75 per student per year, and either half of the transfers goes to teachers' salary or the allocation was decided by local school associations (Moore, 2009).

schools since their attendance do not bring cash transfers to teachers or schools.

To test this supply-side effect indirectly, its existence is tested by examining the change in enrollment rates for non-target siblings whose households have no target siblings and who have not yet completed primary school. The households for those non-target children do not receive cash transfers, but their children can go to the same schools where target children in the other households go; thus the change in education for them is due only to the change in the schools, namely, the supply-side effects of the CCT program.[19]

2.3.3 Other Explanations for Spillover Effects

Other mechanisms for spillover effects are possible. They are hard to distinguish from demand-side and supply-side spillovers. This subsection discusses four possible mechanisms, examining both their plausibility and whether they can be tested.

Decrease in Care Time for Younger Siblings by Older Non-target Siblings

The increase in schooling for young target siblings can provide older non-target siblings opportunities for more schooling. If older children, especially girls, have to leave school in order to take care of younger children at home, younger children's being at school caused by a CCT program will give older siblings an additional opportunity to go to school. One way to test this hypothesis is to exploit the fact that girls are much more likely to take care of younger siblings, which implies that spillover effects would be larger for girls than for boys.[20] This can be tested indirectly by interacting the spillover effect with gender.

[19] Although this estimation is promising for testing the supply-side effects, it is impossible to exclude the possibility that this change could be due to other factors, such as the community effects and family network effects observed in the Mexican CCT program (Angelucci and Giorgi (2009); Angelucci, Giorgi, Rangel, and Rasul (2009)).

[20] The data in year 0 indicate that 23.9 percent of 14-to-16-year-old girls chose domestic labor as the main reason of no enrollment in school, while 0.5 percent of 14-to-16-year-old boys did.

Economies of Scale in Education Expenditures

The increase in educational expenditures for target children due to cash transfers would lower educational costs for non-target children if there are economies of scale for expenditures on education. First, school supplies such as uniforms and textbooks used by older children could be used again by younger children. Second, additional recurrent costs such as lunch could be less if a household already has a child in school. If economies of scale exist, so that the additional per capita educational costs for non-target children decrease when the program is introduced, then more non-target children can go to school. This hypothesis can be tested by observing the change in individual educational expenditures for target and non-target children.

Arbitrary Implementation of Program Rules

An alternative explanation of spillover effects is that age and education criterion for target siblings were not followed, so that children who were not eligible to participate were allowed into the program regardless of what the official rules indicated. Specifically for the RPS, Moore (2009) describes the implementation of the program rule as follows:

> RPS-I had an extensive monitoring system, with checks and balances to ensure that all those involved were discharging their duties. Health service providers and school councils used official forms to record whether households had fulfilled their co-responsibilities in health and education. Information on co-responsibilities was given to local RPS employees, who passed it to the central office, or it was submitted directly to the central office. Once the information was received in Managua, workers entered it into RPS's information system(p.13).

Therefore, for the RPS, given this centrally controlled system, the likelihood of arbitrary implementation of the program rule appears low. In addition, “beneficiaries knew the requirement very well” (Maluccio and Flores (2005), p.23); therefore, parents are not likely to be manipulated. Of course, this is not sufficient evidence to rule out this possibility, but at least there is no evidence of arbitrary implementation of program rules.

Change in Development Programs and Services Caused by the RPS

If a CCT program can increase or decrease similar development programs and services for non-target children, such a change could change the education outcomes for non-target children. For the RPS in terms of target siblings, Maluccio and Flores (2005) concluded that there were changes in development programs, but no changes in the control group that would cause bias. They found some changes in the number of households that benefited from other development programs, but the changes were similar in the treatment and control groups. Therefore, for the RPS, it is unlikely that the estimates presented in the next section will be biased due to changes in development programs and services resulting from implementation of the RPS.

2.4 Empirical Specification

The main objective of this chapter is to estimate intra-household spillover effects, which are the impacts of the RPS program on the educational outcomes of children who are not targeted by the program rules but who have siblings that are targeted. This study will estimate both intention to treat (ITT) effects and spillover effects. ITT effects are the average effects of being *offered* the treatment,[21] and thus by definition apply only to target siblings. Note that ITT effects for target siblings have already been estimated by Maluccio and Flores (2005). The ITT and spillover effects estimated in this chapter use the same specification but a subset of the sample. Spillover effects are defined only for non-target siblings. As explained in Subsection 2.2.3, 7 to 16 year old children are divided into target and non-target children based on the RPS program's eligibility rules.

2.4.1 Spillover and Intention to Treat Effects

ITT and spillover effects may vary by covariates such as household, child and village characteristics, which can be denoted by the vector X. Mathematically, ITT effects conditional on X are defined as:

$$ITT(X) \equiv E[Y^{(1)}|TG=1,X] - E[Y^{(0)}|TG=1,X] \tag{2.17}$$

where $Y^{(1)}$ indicates an educational outcome of a child if the household of the child is offered the treatment, $Y^{(0)}$ is that outcome if the household was not offered the treatment, and TG=1 if the child was targeted by a CCT program. Thus, the first term in the equation

[21] ITT effects are different from average treatment effects since those who are offered are not necessarily treated by the program (Duflo, Glennerster, and Kremer (2008)). It is possible that households that were offered the treatment were not treated either because they chose not to participate or because they failed to satisfy the requirements.

is the outcome for a target child whose household was offered the treatment, and the second term is the outcome for the target child if the household did not receive the offer.

In the same way, spillover effects are defined as:

$$SP(X) \equiv E[Y^{(1)}|ST=1,X] - E[Y^{(0)}|ST=1,X] \tag{2.18}$$

where ST=1 denotes that a child had a sibling who was targeted although the child was not targeted. So, the first term indicates the outcome for non-target children whose household received an offer of the treatment (for target siblings), and the second term signifies the outcome for non-target children if the household did not receive the offer.

2.4.2 Econometric Models

In this study, binary (enrollment) and continuous (individual education expenditures) variables are used as dependent variables to test the existence and size of spillover effects. For binary dependent variables, non-linear estimates of ITT and spillover effects are not constant but instead depend on the values of the RHS variables (Cameron and Trivedi, 2005; Wooldridge, 2002). Although results from OLS estimation are easier to interpret, the probit model is often used since the predictions produced by the probit (or logit) model are more accurate than those produced by the linear probability model when the probability is close to one or zero (Amemiya, 1981; Cameron and Trivedi, 2005). As seen in Table 2.5, the enrollment rates for target and younger non-target children are close to one in years 1 and 2; thus, the probit model is used in this study.[22] Ai and Norton (2003) and Norton, Wang, and Ai (2004) point out that, in non-linear models including binary response models, interaction effects and their statistical significance cannot be determined

[22] The results using the linear probability models are also shown in the tables with the results of the probit estimation.

using only the coefficients and standard errors of the interaction terms; instead, the delta or bootstrap method should be used for the significance test. Therefore, in this study, the sample means of the predicted probabilities are calculated using estimated coefficients from the probit estimations, as opposed to using a linear model, and the bootstrapping method is used for their significance tests.

Econometric Specification for Spillover Effects

With a binary dependent variable, enrollment, the probit model is used. The difference-in-difference specification used to estimate ITT as defined in equation (2.17) is:

$$P_{itjc} = F[\beta_O O_{ij} + \beta_t t + \beta_{Ot} O_{ij} \times t + \beta_{\mathbf{x}} \mathbf{X_{itj}}], i \in I_1, \tag{2.19}$$

where P_{itjc} is the probability that child i in household j in comarca c is enrolled in school at time t, F is the normal cumulative function, and $i \in I_1$ indicates that the child is targeted by the program.[23] In equation (2.19), $O_{ij} = 1$ indicates that household j with child i received the offer, and $t = 1$ if the observation is from a year in which the project was implemented. Finally, $\mathbf{X_{itj}}$ is the vector of other attributes of child i in household j at time t and community (comarca) dummy variables. For the standard errors, the linearized variance estimator is used that allows for clustering at the comarca level.

The same specification as in (2.19) can be used to estimate spillover effects by replacing $i \in I_1$ with $i \in I_2$, which indicates that the children in the sample are not targeted by the program but their siblings are targeted.[24] By stacking this and the above specification for the target siblings, one regression can be used to estimate both effects at

[23] An index set I includes all of the children in the sample such that $I \equiv \{1, \cdots, N\}$, $I_1 = \{i \in I | TG = 1\}$, and $TG = 1$ corresponds to that in (2.17).

[24] $I_2 \equiv \{i \in I | ST = 1\}$ where $ST = 1$ corresponds to that in (2.18).

the same time by:

$$P_{itjc} = F[\beta_O^1 O_{ij}^1 + \beta_t^1 t^1 + \beta_{Ot}^1 O_{ij}^1 \times t^1 \\ + \beta_O^2 O_{ij}^2 + \beta_t^2 t^2 + \beta_{Ot}^2 O_{ij}^2 \times t^2 \\ + \beta_{\mathbf{x}} \mathbf{X_{itj}}], i \in I. \tag{2.20}$$

In order to distinguish the explanatory variables for each group, superscript 1 is used for variables concerning target siblings, and 2 for those concerning non-target siblings. Notice that the elements of $\beta_{\mathbf{x}}$ are assumed to be common for both types of children.[25] With this specification, ITT and spillover effects are calculated respectively by:

$$ITT(X) = [P_{itjc}|O^1 = 1, t^1 = 1] - [P_{itjc}|O^1 = 1, t^1 = 0] \\ - [P_{itjc}|O^1 = 0, t^1 = 1] + [P_{itjc}|O^1 = 0, t^1 = 0] \tag{2.21}$$

$$SP(X) = [P_{itjc}|O^2 = 1, t^2 = 1] - [P_{itjc}|O^2 = 1, t^2 = 0] \\ - [P_{itjc}|O^2 = 0, t^2 = 1] + [P_{itjc}|O^2 = 0, t^2 = 0] \tag{2.22}$$

Finally, note that three different sets of estimates corresponding to the second line in (2.20) are used to estimate spillover effects for three different types of non-target siblings.

Specification to Identify Gender Heterogeneity

Heterogenous spillover effects by gender are estimated to investigate whether spillover effects are caused by the decrease in care time for younger siblings by older non-target siblings, as discussed in 2.3.3. The binary variable, G, equals one for boys and zero for girls. For the probit model, adding an interaction term, G, to the specification (2.20)

[25] A robustness check of this assumption is presented in the following section.

yields:

$$
\begin{aligned}
P_{itjc} = F[&\beta_O^1 O^1 + \beta_t^1 t^1 + \beta_{Ot}^1 O_{ij}^1 \times t^1 \\
&+ \beta_{Oc}^1 O^1 \times G + \beta_{tc}^1 t^1 \times G + \beta_{Otc}^1 O_{ij}^1 \times t^1 \times G \\
&+ \beta_O^2 O_{ij}^2 + \beta_t^2 t^2 + \beta_{Ot}^2 O_{ij}^2 \times t^2 \\
&+ \beta_{Oc}^2 O_{ij}^2 \times G + \beta_{tc}^2 t^2 \times G + \beta_{Otc}^2 O^2 \times t^2 \times G \\
&+ \beta_{\mathbf{x}} \mathbf{X_{itj}}], i \in I.
\end{aligned}
\tag{2.23}
$$

Notice that the interaction term G is not added above for the X_{itj} variables since it is assumed that the coefficients of age dummy variables for boys are the same as those for girls. The differences in ITT and spillover effects by gender are calculated using the estimate above by $[ITT(X)|G=1] - [ITT(X)|G=0]$ and $[SP(X)|G=1] - [SP(X)|G=0]$, respectively, where each term is defined by conditioning (2.21) and (2.22) on G.

Specification for Individual Educational Expenditures

To understand better the behavior that underlies any spillover effects, it is useful to estimate the change in annual educational expenditures for non-target siblings, excluding transportation costs.[26] Individual education expenditures are recorded only for those who enrolled in school. Since changes in education expenditures for those who enrolled in school are the outcome of interest, only children who were enrolled in school were used for the estimation. Analogous estimations that use the entire sample were produced to check for sample selection bias. Quantile regressions were also used to investigate the

[26]The expenditures include the payment for quotas, enrollment, uniforms, educational supplies or materials, and books. Transportation costs are excluded since they mainly reflect the distance from home to school. The results in the next section are very similar to those including transportation costs, which are shown in Table 2.14.

change in education expenditures over the different levels of education expenditures. Since zero expenditures are not common (10 percent), the censored regression methods such as Tobit and Trimmed LAD are not necessary. The standard errors are obtained using bootstrapping.

2.5 Results

2.5.1 Variables and Descriptive Statistics

Table 2.5 shows the enrollment rates and mean individual education expenditures for the three types of non-target siblings and for target siblings, for all three years. Non-target siblings are divided into three groups: older, less-educated; younger; and older, more-educated. There are two child-specific dependent variables: enrollment rates and education expenditures. The first variable is binary, and the other is continuous. Focusing on the numbers in year 0, there are large variations in the values of the two dependent variables among the three groups of non-target siblings, these differences are not surprising given the definitions of the three groups. Among non-target siblings, enrollment is highest for the younger group, followed by the older, more-educated group, then the older, less-educated group. Individual educational expenditures are the highest for the older, more-educated group, followed by the younger group, then the older, less-educated siblings.

Table 2.6 shows descriptive statistics for the explanatory variables. Non-target siblings are about 14 years old on average, and the ratio of males and females is about equal. Per capita household expenditures in the control group declined in years 1 and 2, relative to year 0, while those in the treatment group increased, presumably due to the cash transfers. Seventy-four percent of households had one or more 1- to 5-year old infants in year 0 and so needed to satisfy the health requirement mentioned in Subsection 2.2.1.[27] Also, half of the sample children do not have a mother who completed at least one grade of primary education. Finally, the percentage of households that lived in coffee cropping regions in year 2 declined from 41 in year 1 to 37 which seems to be caused by the coffee price crisis

[27] If households satisfy the education requirement but not the health requirement, then they received not full but partial cash transfers.

during the period (Maluccio (2005)).

2.5.2 Spillover Effects on Enrollment

Spillover Effects for Full Sample

The results of the probit regressions are shown in Columns (3) and (4) in Table 2.7 along with the results of OLS regressions in Columns (1) and (2), which indicate that the statistical significance for the coefficients which identify ITT and spillover effects using probit estimations are the same as that using OLS estimations. For the standard errors, the linearized variance estimation is used that allows for clustering at the comarca level. For a robustness check, the assumption that the elements of $\beta_{\mathbf{x}}$ in Specification (2.20) are assumed to be common for both types of children was tested by estimating Specification (2.19) separately for target and non-target siblings, as seen in Table 2.8. Compared with the results which use a common $\beta_{\mathbf{x}}$ for both types of children, as shown in Table 2.7, the sizes and statistical significance for the coefficients which identify ITT and spillover effects do not change very much; therefore, this assumption seems to hold. To test the robustness of the clustering in standard errors, the same estimations as in Table 2.7 were obtained using households as clusters for the standard errors, and the results are shown in Table 2.9. Again, the sizes of standard errors and their statistical significance for the coefficients which identify ITT and spillover effects do not change very much. These findings are evidence that the estimation results in Table 2.7 are reliable.

Table 2.10 shows the predicted enrollment rates, before and after the program for the control and treatment groups, separately for the three types of non-target siblings (which measure spillover effects) and for target siblings (which measure ITT effects), with bootstrapped standard errors for the differences. As seen in that table, the spillover effects for older, less-educated non-target siblings are 27.1 and 29.3 percentage point increases in enrollment rates in years 1 and 2, respectively. The ITT effects for target siblings are 24.5 and 20.6 percentage point increases in years 1 and 2, respectively. These estimates of the ITT effects are somewhat larger than the 18.5 and 12.8 percentage point effects estimated by Maluccio and Flores (2005). It is reasonable to have larger ITT effects in this study since the mean of household expenditure in the sample used here is smaller than that in the entire sample, as shown in Subsection 2.2.3, and poorer households tend to have higher ITT effects, as shown by Maluccio and Flores (2005). These ITT effects are statistically significant using the bootstrap method. Spillover effects for the two other types of non-target siblings are much smaller and statistically insignificant. It may seem surprising that spillover effects are even larger than the ITT effects, but they are not directly comparable since the average education levels for the older, less-educated non-target siblings in the base year are much lower than for the target siblings, as seen in Table 2.10 (25.0 and 75.1 percent, respectively). Nevertheless, these 27.1 and 29.3 percentage point increases in enrollment are very large spillover effects, increasing enrollment rates to 53.9 percent in year 1 and 61.0 in year 2.[28]

Why are statistically significant spillover effects found only for older, less-educated non-target siblings in years 1 and 2? Can this result be explained by the model presented in subsection 2.3.1? Households with younger or older, more-educated non-target siblings are likely to be in Case 2 or 3 in the model, since the education level of those children is higher or equal to the targeted children's education level. Households with older, less-educated non-target siblings are more likely to belong to Case 1, since the education level of those children is lower than the targeted education level. This explanation is consistent with the data in Table 2.3. As seen in Table 2.4, the model always predicted positive program effects, and the empirical results matched this prediction. For spillover effects, the model predicted ambiguous effects in Case 1, so positive spillover effects for

[28]It should be recalled that the numbers in year 2 may be overstated, as pointed out in Section 2.2.3.

older, less-educated non-target siblings are consistent with the model. Although the model predicts positive spillover effects for Cases 2 and 3, to which younger and older, more-educated non-target siblings are likely to belong, it is possible that the effects are too small to be identified in the empirical estimation.

Suppose that the income effect of education is positive but decreasing over initial income. Since Y(z) in Cases 2 and 3 are larger than in Case 1, the income effects in Equation (2.8) can be very small. Intuitively, older, less-educated non-target siblings are more likely to benefit from the income effect since their initial education level is lower and so their parents have a greater incentive to allocate income to this type of non-target sibling than to the other types. Therefore, the empirical finding that spillover effects are observed only for a specific type of non-target siblings is completely consistent with the demand-side explanation of spillover effects.[29]

Heterogeneity in Spillover Effects by Gender

Table 2.11 shows the predicted difference in enrollment by gender, which were calculated using the coefficients from the probit regressions shown in Table 2.12. No statistically significant effects are found. Therefore, there is no difference in ITT and spillover effects between boys and girls. As explained in Subsection 2.3.3, this estimation was used to investigate the possibility that a decrease in the need for older siblings to care for younger target siblings caused spillover effects for older non-target siblings. However, the

[29]Comparing Cases 2 and 3, both the program and the spillover effects in Case 2 are larger than those for Case 3 due to the decreasing income effect. Turning to program effects in Case 1, they should be larger than those of Cases 2 and 3 since they are positive and decreasing in the initial income level. Previous studies of the RPS program showed heterogeneous ITT effects on enrollment rates in terms of quintiles of per capita household expenditures (Maluccio and Flores (2005); Dammert (2009)), and found that the size of ITT effects is inversely proportional to per capita household expenditures. The same result were obtained using the subset of the data which is used in this study (the result is not shown for brevity). This result, that ITT effects are negatively correlated with per capita household expenditures, also demonstrates that the empirical result is consistent with the prediction from the economic model.

empirical finding does not match the prediction that spillover effects are different by gender.

2.5.3 Spillover Effects on Individual Education Expenditures

Table 2.13 presents the results from regressions of individual education expenditures on the variables for target and non-target siblings. The sample for Columns (1) to (6) is the children who were enrolled in school. Columns (1) to (3) and (4) to (6) show changes in the 0.25, 0.50 and 0.75 quantiles of individual education expenditures in years 1 and 2, respectively. The (bolded) coefficients for the older, less-educated non-target siblings are positive and statistically significant for the 0.50 quantile (i.e., the median) in year 1 and for all three quantiles in year 2, and those for the target siblings are also positive and statistically significant for the 0.50 and 0.75 quantiles in year 1 and for all three quantiles in year 2. This means that the ITT and spillover effects on enrollment that were found in the previous section are accompanied by increases in educational expenditures for those children. The relative sizes of these impacts of the program on education expenditures to their educational expenditures in the base year are large. More specifically, expenditures of older, less-educated non-target siblings increased by C$ 40.6, 143.5, 55.7 for the 0.25, 0.50 and 0.75 quantiles in year 1 and 120.6, 181.6 and 136.8 in year 2. These numbers are equal to 0.4, 1.5, 0.6, 1.3, 1.9 and 1.4 times as large as their mean educational expenditures in year 0. For target siblings, the sizes are C$ 19.2, 106.8 and 62.4 in year 1 and 144.4, 137.3 and 67.8 in year 2. These numbers are 0.2 1.1, 0.6, 1.4, 1.4 and 0.7 times as large as their mean educational expenditures in year 0. Therefore, the sizes of the impacts are large and those sizes for older, less-educated non-target siblings are comparable to those for target siblings.

To test sample selection bias, Columns (7) to (12) estimated the same changes in education expenditures but used the entire sample, including those who did not enroll in school (and thus whose school expenditures equal zero). As seen in the table, statistically significant coefficients for older, less-educated non-target siblings shifted to those in the 0.75 quantile expenditures since the sample includes those who did not enroll in school and whose education expenditures were zero. For target siblings, statistically significant coefficients were found in the same quantiles as in Columns (1) to (6), which is not surprising since their enrollment rates were much higher than those for older, less-educated non-target siblings. The consistency of the findings of the estimates based on the subset and the estimates based on the entire sample indicates that the impact of the sample selection does not seem large. In summary, the findings in this section suggest that economies of scale in educational expenditures do not explain the existence of spillover effects since almost the same amounts of educational expenditures are incurred for both target and non-target siblings.[30]

2.5.4 Testing the Existence of Supply-side Effects

As explained in Section 2.3.2, the existence of supply-side effects on non-target children's enrollment can be tested using the change in enrollment rates for non-target siblings who have not yet completed primary school and whose households have no target siblings. The concern is that the supply side effect increased the quality of primary schools, so the non-target children are limited to those who have not yet finished primary school. The sample includes children who had not completed primary schools but were not targeted by the program because of their age, and who had no targeted siblings in their households, and so are affected by the supply-side effects. These children turn out to be older,

[30] The same specifications were estimated using individual education expenditures that do not exclude transportation costs. These are shown in Table 2.14. The significant coefficients in Table 2.14 are consistent with those in Table 2.13, which indicates that excluding transportation costs does not affect the results.

less-educated non-target siblings, and only this type of siblings was included in the estimations. To test the change in year 2, additional children whose siblings were targeted by the program in year 1 were excluded from the sample. Table 2.15 presents results from OLS regressions for years 1 and 2, respectively, and Table 2.16 presents those from probit regressions. In some of the estimations, the X variables are not included since the sample sizes are too small to include these variables. As seen in Columns (1), (2) and (5) in Table 2.15 and (7), (8), (10) and (11) in Tables 2.16, the coefficients of "treat=1*type=1" become statistically significant when X variables were included in the specifications. This means that the control and treatment groups are initially different in terms of enrollment rates after controlling for X variables and this difference biases the estimation of the supply-side effects (the coefficient on treat=1*year=1*type=1). Thus, the results from Columns (3) and (6) in Table 2.15 which are the estimations without the X variables, are preferred.[31] As seen in the table, spillover effects through the supply-side effects are not evident in years 1 and 2 since the bolded coefficients are not statistically significant. In addition, as seen in Columns (3) and (6), the sizes of the coefficients are almost zero in year 1; they are small but positive, namely 0.02 and 0.13, respectively, yet they are all statistically insignificant.

[31]The results from the probit estimation were not used simply because the coefficients from the OLS estimations were easier to interpret.

2.6 Summary and Conclusion

This chapter has analyzed whether CCT programs affect the educational outcomes of non-targeted children in targeted households, using panel data from a randomized experiment conducted in Nicaragua to evaluate the RPS program. First, it estimated spillover effects in enrollment for three types of non-target siblings: older, less-educated siblings; younger siblings; and older, more-educated siblings. Once the existence of spillover effects in education was empirically established, heterogeneity in those effects by gender was investigated. Finally, in order to understand changes associated with spillover effects in education, the changes in individual education expenditures were reported and tested for significance.

Empirical results show large, positive within-household spillover effects only for older, less-educated non-target siblings in both years of the program. In terms of percentage point increases in enrollment rates, the estimated impacts are slightly larger than the estimated ITT effects for target siblings, although the two effects are not directly comparable because of large differences in initial education levels. In addition, the chapter shows that these spillover effects also take the form of higher parental spending on education, and the size of this impact is the same as the size of the increases for target siblings. The similar sizes of the effects appear reasonable since the spillover occurred for older, less-educated children who had the same level of educational attainment as target siblings.

It is not possible to identify decisively the mechanisms of spillover effects, but the empirical findings can shed light on each of the possible reasons discussed in Section 2.3. The first two explanations of spillover effects are both consistent with the empirical findings. The first explanation, based on the demand model of CCT programs, predicted both program and spillover effects. The empirical results were consistent with this model's prediction. The second hypothesis, that spillover effects reflect increased school quality due to the supply-side intervention, is not consistent with the finding of no increase in enrollment for ineligible children who went to the same school as target siblings but who did not have a target sibling in their households.

A third possibility, that a decrease in care time for younger target siblings affected schooling for older non-target siblings, is also not supported by the empirical findings, since no heterogeneous spillover effects by gender are detected, assuming that girls have a larger role in taking care of younger siblings. Finally, whether arbitrary implementation of program rules took place, and changes in development programs and services caused by the program affected school environment for non-target siblings cannot be tested using the data, but there is no indirect evidence to support them, as explained in Sections 2.3.3 and 2.3.3.

Given these large, unintended effects of the RPS program, an important policy implication is that the evaluation of CCT programs should not be limited to targeted groups since such evaluations could under- or over-estimate the real benefits of CCT programs. The spillover effects in enrollment found in the RPS are positive, so the benefit would be underestimated if spillover effects are not taken into account.

In order to evaluate the benefit of spillover effects, benefit-cost ratios are calculated following the method used by Damon and Glewwe (2009). In their calculation, the increase in enrollment is transformed to an increase in future wages. ITT and spillover effects are 24.5 and 27.1 percentage point enrollment rate increases, respectively, as obtained above. The effects in year 1 are used for this calculation since the estimates in year 2 are less reliable, as explained in Section 2.2.3. The rates at which enrolled target and older, less-educated non-target siblings completed their grades were 0.991 and 0.947, respectively, using the data in year 0.[32] Thus, the actual increases in years of schooling are 0.243(=0.245*0.989) and 0.257(=0.271*0.947) for target and non-target siblings, respectively. An increase of 0.243 and 0.257 years of schooling for target and non-target siblings implies an income increase from the program, assuming that one additional year of schooling increases wages by 5 percent, or US$ 29.8(=0.243*2,461*0.05) and 31.6(=0.257*2,461*0.05), respectively.[33] Discounting these increases in income for 45 years by a 3 percent discount rate implies a present discounted value of US$751 and US$798, respectively (using a 6 percent discount rate leads to lower figures, US$488 and US$518).

The benefit-cost ratio is calculated for an "average household" since the cost is calculated for a household. On average, one household had 2.27 target children and 1.64 non-target siblings in year 0. Recall that spillover effects were found only for older, less-educated non-target siblings, and note that the fraction of them with respect to all non-target siblings is 0.43. So the benefit for the non-target siblings should be applied to 0.71(=1.64*0.43). Thus, the discounted benefit for an average household is equal to the sum of the benefits for 2.27 target siblings and 0.71 older, less-educated non-target siblings, which equals US$ 2,277(=2.27*751+0.71*798) using a 3 percent discount rate and 1,477(=2.27*488+0.71*518) using a 6 percent discount rate. The cash transfer to an average household is 384(=224+112+21*2.27), as explained in Subsection 2.2.1. Therefore, the benefit-cost ratio is 5.93(=2277/384) using a 3 percent discount rate, and 3.85(=1477/384) using a 6 percent discount rate. On the other hand, for a 3 percent discount rate the benefit-cost ratio is 4.44(=2.27*751/384) for target siblings only and

[32]Those ratios were approximated by those of children in the treated households who were enrolled in school in year 1 and did not miss more than 5 days of class in the month of the middle of school year in year 1.

[33]Wage income for a worker in Nicaragua is US$2,461, which is estimated in Damon and Glewwe (2009) using the rough approximation that labor income equals 60 percent of GDP per worker. Five percent is a rather conservative estimate since Psacharopoulos and Patrinos (2004) cite a 1998 study for Nicaragua that estimates that a one year increase in education raises wages by 12.1 percent.

2.88(=2.27*488/384) using a 6 percent discount rate. Thus, the benefit-cost ratio increases by 33 percent after taking spillover effects into consideration. This is a sizable increase compared to the situation where spillover effects are ignored, although it is not a 100 percent increase because the average household only has 0.71 older, less-educated non-target siblings, while it has 2.27 children who are eligible for the program. Therefore, these calculations indicate that neglecting spillover effects results in substantial under-estimation of the real benefit of CCT programs. In addition, this study has shed light on the fact that a CCT program could help disadvantaged children who were left out of the program in addition to the original targeted group.[34]

[34]This preceding estimation is based on the numbers in the first year of the program. Although the RPS program continued for six years, the dynamic change during the six years cannot be captured given the available data. One possibility is that these spillover effects were likely to become weaker over the six years since the fraction of older, less-educated non-target siblings in 7 to 16 year old children should be decreasing over the six years. Such a decrease is likely because (1) the supply of older, less-educated non-target siblings became smaller because of the direct impact of the program, and (2) the stock of this kind of non-target siblings becomes smaller thanks to the spillover effects.

Tables and Figures

Table 2.1: The Transition of Target and Non-target Siblings during the Survey

Case	Year 0 (No program)	Year 1 (Program)	Year 2 (Program)
1	T	T	T
2	T	T	N
3	T	N	N
4	N	N	N

T and N indicate target and non-target siblings, respectively.

Table 2.2: Sample Selection: Sample Size and Per Capita Household Expenditures

		Sample Size						PC HH Exp.
		Household			Children			
Year		0	1	2	0	1	2	0
Full sample - HH with at least one 7-16 year old child:								
	C	522	476	482	1341	1212	1208	3305
	T	548	529	501	1365	1315	1245	3425
	All	1070	1005	983	2706	2527	2453	3366
Constructed sample - HH with both target and non-target siblings:								
	C	236	228	221	850	774	762	2851
	T	239	242	245	848	835	818	2899
	All	475	470	466	1698	1609	1580	2875
Non-target:								
Older, less-educated	C				157	136	132	
	T				157	141	126	
Younger	C				95	95	87	
	T				75	119	130	
Older, more-educated	C				122	100	117	
	T				118	115	114	
Target:								
	C				475	443	426	
	T				496	457	448	

Note: All the sample are 7-16 years old. C and T signify control and treatment groups, respectively.

Table 2.3: Sibling Compositions within Households

Non-target sibling type in HH in addition to target siblings	Freq.	PC HH Exp.
type 1 alone	209	2532
type 2 alone	58	3427
type 3 alone	102	3246
types 1 & 2	14	2407
types 2 & 3	66	3194
types 1 & 3	23	2224
All types	3	3748

Note: Type 1, 2 and 3 indicates older, less-educated;
younger; older, and more-educated non-target siblings, respectively.

Table 2.4: Model Prediction: Signs of Effects

	Program Effect	Spillover Effect
Case 1	> 0	$\gtreqless 0$
Case 2	> 0	> 0
Case 3	> 0	> 0

Table 2.5: Descriptive Statistics for Dependent Variables

		Enroll			Ind. Edu. Expenditures*		
		Year 0	Year 1	Year 2	Year 0	Year 1	Year 2
Non-target:							
Older less-educated	C	0.255	0.279	0.333	103.1	127.5	122.3
	T	0.242	0.539	0.611	84.5	199.2	230.1
Younger	C	0.800	0.905	0.862	178.9	204.5	238.8
	T	0.880	0.933	0.915	204.4	266.0	288.2
Older more-educated	C	0.475	0.430	0.462	238.3	321.5	270.4
	T	0.492	0.522	0.623	236.0	304.5	295.0
Target:	C	0.781	0.795	0.829	87.1	138.0	145.0
	T	0.714	0.976	0.973	102.6	201.1	256.6

Note: C and T signify control and treatment groups, respectively.
* The numbers (individual education expenditures) are calculated for the children who enrolled in school.

Table 2.6: Descriptive Statistics for Explanatory Variables

			Year 0	Year 1	Year 2
Child-related variables:					
Age at the beginning of school year		Non-target	14.2	14.0	14.0
		Target	9.7	9.6	9.6
Boy		Non-target	0.48	0.50	0.52
		Target	0.56	0.54	0.53
Household-related variables:					
Per capita HH expenditures (C$)	C	Mean	2760.8	2537.1	2588.0
		SD	1614.6	1658.0	1555.8
	T	Mean	2777.2	3291.8	3227.3
		SD	1434.6	1458.7	1643.0
Have an infant (1-5 yr old)	C	Ratio	0.79	0.75	0.75
	T	Ratio	0.69	0.68	0.66
Mother's completed Education$^{(a)}$	C	Ratio	0.50	0.46	0.44
$>=$ primary 1th grade	T	Ratio	0.48	0.54	0.51
Regional variables:					
Coffee cultivating community $^{(b)}$	C	% of HH	(c)	0.41	0.26
	T		(c)	0.49	0.47
Dummy variables for stratum		Num. of strata	7	7	7
Dummy variables for comarcas		Num. of comarcas	42	42	42

Note: All the sample are 7-16 years old. C and T signify control and treatment groups, respectively.

(a) If mother's education is not available, father's education is used. If no parents are available, household head's education is used.

(b) The larger decline for the treatment group is found not only in the sub-data which is used by this study but also in the entire sample. In the entire sample, the ratios are 0.43 and 0.25 for the control group in years 1 and 2, respectively, and 0.49 and 0.46 for the treatment group. (c) No data are available.

Table 2.7: Regression of Spillover Effects in Enrollment

Dep. Var. Sample year	(1) Enroll (OLS) 0 and 1	(2) Enroll (OLS) 0 and 2	(3) Enroll (Probit) 0 and 1	(4) Enroll (Probit) 0 and 2
treat=1*type=1	-0.0692	-0.0933	-0.210	-0.372
	(0.0494)	(0.0983)	(0.172)	(0.393)
year=1*type=1	0.0394	0.0811*	0.131	0.259
	(0.0449)	(0.0474)	(0.160)	(0.158)
treat=1*year=1*type=1	0.236***	0.269***	0.729***	0.816***
	(0.0675)	(0.0652)	(0.238)	(0.217)
type=2:Young non-target siblings	0.613***	0.624***	1.868***	1.871***
	(0.0505)	(0.0648)	(0.184)	(0.247)
treat=1*type=2	-0.00306	-0.0261	0.0210	-0.0762
	(0.0517)	(0.102)	(0.233)	(0.426)
year=1*type=2	0.0863*	0.0671	0.440*	0.285
	(0.0457)	(0.0574)	(0.219)	(0.257)
treat=1*year=1*type=2	-0.00869	-0.00881	0.0259	0.0180
	(0.0631)	(0.0696)	(0.349)	(0.348)
type=3:Old more-educated non-target	0.150**	0.152**	0.403*	0.398**
	(0.0704)	(0.0621)	(0.209)	(0.191)
treat=1*type=3	-0.0391	-0.0808	-0.146	-0.349
	(0.0751)	(0.107)	(0.208)	(0.399)
year=1*type=3	-0.0333	-0.0194	-0.0881	-0.0656
	(0.0677)	(0.0692)	(0.184)	(0.197)
treat=1*year=1*type=3	0.0854	0.138	0.259	0.401
	(0.0843)	(0.0916)	(0.235)	(0.264)
target	0.591***	0.594***	1.741***	1.711***
	(0.0451)	(0.0487)	(0.160)	(0.177)
treat=1*target=1	-0.0975**	-0.117	-0.286**	-0.407
	(0.0399)	(0.0885)	(0.137)	(0.369)
year=1*target=1	0.0341	0.0607**	0.141	0.266**
	(0.0239)	(0.0261)	(0.0934)	(0.107)
treat=1*year=1*target=1	0.214***	0.175***	1.338***	1.145***
	(0.0521)	(0.0369)	(0.200)	(0.197)
Coffee cropped comarca in y1	-0.00875	0.0673	-0.0777	0.318
	(0.0174)	(0.0770)	(0.0824)	(0.372)
Age=8	0.0820***	0.0737***	0.375***	0.354***
	(0.0242)	(0.0275)	(0.121)	(0.132)
Age=9	0.0715***	0.0817***	0.323***	0.404***
	(0.0224)	(0.0244)	(0.0995)	(0.115)
Age=10	0.0722***	0.0895***	0.341***	0.425***
	(0.0243)	(0.0266)	(0.103)	(0.121)

Age=11	0.0423	0.0742***	0.173	0.353***
	(0.0322)	(0.0266)	(0.146)	(0.124)
Age=12	0.0204	0.0125	0.0629	0.0258
	(0.0288)	(0.0308)	(0.117)	(0.128)
Age=13	-0.0648**	-0.0778**	-0.316**	-0.323**
	(0.0315)	(0.0362)	(0.123)	(0.135)
Age=14	0.325***	0.300***	0.986***	0.912***
	(0.0431)	(0.0290)	(0.142)	(0.0963)
Age=15	0.0924***	0.170***	0.310***	0.540***
	(0.0309)	(0.0354)	(0.102)	(0.117)
2nd quintile of pc exp in y0	0.0250	0.0275	0.0955	0.0950
	(0.0304)	(0.0279)	(0.118)	(0.107)
3rd quintile of pc exp in y0	0.0520*	0.0649**	0.196*	0.253**
	(0.0268)	(0.0268)	(0.109)	(0.104)
4th quintile of pc exp in y0	0.121***	0.109***	0.505***	0.461***
	(0.0324)	(0.0310)	(0.135)	(0.128)
Richest quintile of pc exp in y0	0.0957**	0.0842**	0.387**	0.325**
	(0.0394)	(0.0381)	(0.181)	(0.159)
boy	-0.0351*	-0.0452***	-0.149**	-0.197***
	(0.0177)	(0.0150)	(0.0718)	(0.0607)
1 if have an infant (1-5 yr)	-0.00759	-0.0137	-0.0395	-0.0644
	(0.0197)	(0.0184)	(0.0773)	(0.0777)
1 if Parents completed	0.0505***	0.0820***	0.213***	0.345***
at least 1st grade of primary	(0.0177)	(0.0194)	(0.0703)	(0.0772)
comarca==El Kilan	0.101***	0.119*	0.409***	0.579*
	(0.0149)	(0.0628)	(0.0589)	(0.302)
comarca==El Mojon	0.104***	0.0645	0.426***	0.298
	(0.0196)	(0.0688)	(0.0830)	(0.319)
comarca==Las Chilcas	0.0289***	-0.0264	0.140***	-0.0765
	(0.00832)	(0.0869)	(0.0421)	(0.324)
comarca==Verapaz	-0.0437***	-0.0983	-0.128***	-0.330
	(0.00605)	(0.0908)	(0.0259)	(0.327)
comarca==Chaguite Grande	0.0643***	0.109	0.262***	0.563
	(0.00687)	(0.0680)	(0.0300)	(0.350)
comarca==La Esperanza	0.00554	0.00920	0.0180	0.0691
	(0.00976)	(0.0704)	(0.0402)	(0.329)
comarca==Salamasi	0.0689***	-0.0439	0.311***	-0.138
	(0.0116)	(0.0886)	(0.0529)	(0.330)
comarca==Casas Viejas	0.0796***	0.0354	0.444***	0.238
	(0.00811)	(0.0772)	(0.0437)	(0.384)
comarca==Hato La Virgen	0.0967***	0.101	0.456***	0.555
	(0.00640)	(0.0711)	(0.0377)	(0.364)
comarca==La Avellana	0.0924***	0.0810	0.477***	0.431
	(0.0113)	(0.0764)	(0.0472)	(0.311)
comarca==Las Calabazas	0.171***	0.146*	0.699***	0.654**

	(0.0108)	(0.0782)	(0.0437)	(0.324)
comarca==Las Pencas	0.0344***	0.00721	0.154***	0.0692
	(0.00954)	(0.0761)	(0.0429)	(0.338)
comarca==Llanos de Tamalapa	0.0913***	0.0431	0.380***	0.222
	(0.00677)	(0.0907)	(0.0371)	(0.395)
comarca==Pangual	0.107***	0.0877	0.482***	0.465
	(0.00813)	(0.0731)	(0.0392)	(0.358)
comarca==Puertas Viejas	0.0375***	-0.0294	0.169***	-0.0778
	(0.00993)	(0.0994)	(0.0416)	(0.366)
comarca==San Juanillo	0.155***	0.0787	0.913***	0.417
	(0.00734)	(0.0649)	(0.0422)	(0.339)
comarca==Totumbla	-0.0638***	-0.0562	-0.181***	-0.171
	(0.0122)	(0.0871)	(0.0550)	(0.321)
comarca==Aguas Amarillas	0.0442***	-0.0151	0.163***	-0.130
	(0.0138)	(0.0733)	(0.0535)	(0.351)
comarca==Bull Bull	-0.101***	-0.190	-0.235***	-0.684
	(0.0103)	(0.147)	(0.0579)	(0.548)
comarca==Bull Bull Arriba	-0.123***	-0.183**	-0.388***	-0.710**
	(0.0174)	(0.0857)	(0.0763)	(0.344)
comarca==Cuatro Esquinas	-0.123***	-0.220*	-0.371***	-0.857*
	(0.0153)	(0.125)	(0.0693)	(0.505)
comarca==El Castillo	-0.0529***	-0.149*	-0.199***	-0.580*
	(0.0176)	(0.0811)	(0.0722)	(0.335)
comarca==El Granadillo	0.0216	-0.0929	0.139**	-0.402
	(0.0136)	(0.0958)	(0.0582)	(0.396)
comarca==El Guapotal	-0.0906***	-0.165*	-0.365***	-0.657*
	(0.00765)	(0.0880)	(0.0371)	(0.356)
comarca==La Tronca	-0.113***	-0.239***	-0.436***	-0.919**
	(0.0115)	(0.0869)	(0.0557)	(0.362)
comarca==Piedra Luna	0.0595***	-0.0659	0.225***	-0.336
	(0.00752)	(0.0785)	(0.0324)	(0.355)
comarca==Quililito	-0.184***	-0.120	-0.536***	-0.491
	(0.0224)	(0.133)	(0.105)	(0.553)
comarca==Quililon	-0.136***	-0.358**	-0.396***	-1.290**
	(0.0188)	(0.171)	(0.0784)	(0.636)
comarca==Tayule	-0.384***	-0.369***	-1.158***	-1.311***
	(0.0173)	(0.128)	(0.0910)	(0.507)
comarca==Wasaka	-0.0186	-0.0958	-0.0621	-0.382
	(0.0151)	(0.0721)	(0.0678)	(0.328)
comarca==Wasaka Arriba	-0.0239*	-0.112	-0.0447	-0.476
	(0.0134)	(0.0773)	(0.0562)	(0.324)
comarca==Yasica Norte	-0.0464***	-0.183	-0.0486	-0.694
	(0.0131)	(0.125)	(0.0688)	(0.506)
comarca==Cerro El Padre	0.0407***	-0.0475	0.226***	-0.154
	(0.0118)	(0.0662)	(0.0556)	(0.320)

comarca==Coscuilo	-0.0750***	-0.0949	-0.228***	-0.288
	(0.00951)	(0.0951)	(0.0435)	(0.326)
comarca==Cumaica	-0.0185	-0.190	-0.0275	-0.784
	(0.0172)	(0.126)	(0.0734)	(0.511)
comarca==El Bacocan	-0.00485	-0.115	0.0598	-0.468
	(0.0190)	(0.117)	(0.0853)	(0.497)
comarca==La Rinconada	0.0112	-0.00118	0.104***	0.0299
	(0.00814)	(0.0992)	(0.0385)	(0.381)
comarca==Montana Grande	-0.00906	-0.122	0.0627	-0.475
	(0.0182)	(0.111)	(0.0807)	(0.472)
comarca==Ocotillo	-0.0243	-0.152	-0.0170	-0.590
	(0.0155)	(0.120)	(0.0710)	(0.495)
Constant	0.125***	0.141*	-1.210***	-1.116***
	(0.0367)	(0.0792)	(0.138)	(0.293)
Observations	3,301	3,275	3,301	3,275
R-squared	0.329	0.317		

Note: In the leftmost column, “type=1”, “type=2” and “type=3” indicate older, less-educated non-target; younger; and older more-educated non-target siblings, and “target=1” does target siblings. For standard errors, the linearized variance estimation is used with comarcas being clusters(Cameron and Trivedi (2005), p.843; Pendergast, Gange, Newton, Lindstrom, Palta, and Fisher (1996);Wooldridge (2010)) Standard errors in parentheses. *** $p < 0.01, **p < 0.05, *p < 0.1$

Table 2.8: Robustness Check of Same X Variables - Estimating Separately for Target and Non-target Siblings

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dep. Var.	Enroll (OLS)	Enroll (OLS)	Enroll (OLS)	Enroll (OLS)	Enroll (Probit)	Enroll (Probit)	Enroll (Probit)	Enroll (Probit)
Target	Yes	No	Yes	No	Yes	No	Yes	No
Sample year	0 and 1	0 and 1	0 and 2	0 and 2	0 and 1	0 and 1	0 and 2	0 and 2
treat=1*type=1		-0.139**		-0.146**		-0.469**		-0.508**
		(0.0534)		(0.0568)		(0.199)		(0.212)
year=1*type=1		0.0329		0.0761*		0.127		0.247*
		(0.0456)		(0.0403)		(0.160)		(0.134)
treat=1*year=1*type=1		0.249***		0.287***		0.732***		0.843***
		(0.0675)		(0.0752)		(0.231)		(0.248)
type=2:Young non-target siblings		0.738***		0.773***		1.524***		1.639***
		(0.0555)		(0.0601)		(0.248)		(0.269)
treat=1*type=2		-0.0622		-0.0570		-0.185		-0.159
		(0.0501)		(0.0485)		(0.223)		(0.213)
year=1*type=2		0.0806*		0.0463		0.484**		0.189
		(0.0432)		(0.0518)		(0.197)		(0.225)
treat=1*year=1*type=2		5.20e-05		0.0142		0.0636		0.152
		(0.0617)		(0.0614)		(0.351)		(0.297)
type=3:Old more-educated non-target		0.187**		0.186**		0.555**		0.555**
		(0.0737)		(0.0763)		(0.224)		(0.231)
treat=1*type=3		-0.0945		-0.111		-0.338		-0.412*
		(0.0685)		(0.0725)		(0.207)		(0.211)
year=1*type=3		-0.0435		-0.0240		-0.122		-0.0742
		(0.0694)		(0.0851)		(0.194)		(0.235)
treat=1*year=1*type=3		0.0896		0.123		0.257		0.332
		(0.0846)		(0.107)		(0.241)		(0.302)
target								

treat=1*target=1	-0.0381		-0.0829***		4.203***		-0.223*	
	(0.0319)		(0.0290)		(0.265)		(0.111)	
year=1*target=1	0.0445*		0.0689***		0.204*		0.335***	
	(0.0242)		(0.0239)		(0.104)		(0.105)	
treat=1*year=1*target=1	0.199***		0.161***		1.407***		1.177***	
	(0.0520)		(0.0497)		(0.233)		(0.254)	
Coffee cropped comarca in y1	-0.155***	0.182***	-0.0960***	0.287***	-5.020***	0.658***	-0.539***	1.081***
	(0.0173)	(0.0306)	(0.0165)	(0.0204)	(0.256)	(0.113)	(0.0935)	(0.102)
Age=8	0.0791***		0.0677**		0.378***		0.353**	
	(0.0240)		(0.0257)		(0.127)		(0.141)	
Age=9	0.0715***	-0.00411	0.0794***	0.0404	0.357***		0.429***	
	(0.0223)	(0.0483)	(0.0175)	(0.0366)	(0.110)		(0.106)	
Age=10	0.0712**		0.0861***		0.315**	1.351***	0.411***	1.387***
	(0.0265)		(0.0306)		(0.122)	(0.491)	(0.151)	(0.477)
Age=11	0.0352	-0.00997	0.0652**	-0.0128	0.123	1.215***	0.303*	1.228***
	(0.0376)	(0.0346)	(0.0294)	(0.0381)	(0.170)	(0.361)	(0.152)	(0.348)
Age=12	0.0213	-0.0650**	0.0329	-0.131***	0.0640	0.575***	0.118	0.272
	(0.0304)	(0.0292)	(0.0266)	(0.0392)	(0.127)	(0.193)	(0.121)	(0.208)
Age=13	-0.0462	-0.177***	-0.0901*	-0.192***	-0.238		-0.362**	
	(0.0350)	(0.0511)	(0.0449)	(0.0502)	(0.144)		(0.174)	
Age=14		0.329***		0.304***		1.004***		0.924***
		(0.0433)		(0.0309)		(0.146)		(0.106)
Age=15		0.0983***		0.171***		0.334***		0.539***
		(0.0316)		(0.0361)		(0.107)		(0.120)
2nd quintile of pc exp in y0	0.0180	0.0266	0.0325	0.0197	0.0604	0.0862	0.102	0.0464
	(0.0401)	(0.0393)	(0.0340)	(0.0303)	(0.175)	(0.143)	(0.158)	(0.107)
3rd quintile of pc exp in y0	0.0332	0.0680*	0.0630*	0.0588	0.103	0.225*	0.254	0.183
	(0.0332)	(0.0344)	(0.0359)	(0.0350)	(0.157)	(0.122)	(0.176)	(0.119)
4th quintile of pc exp in y0	0.0875**	0.130***	0.0889***	0.114***	0.419**	0.479***	0.411**	0.406***
	(0.0364)	(0.0424)	(0.0322)	(0.0389)	(0.183)	(0.156)	(0.165)	(0.137)
Richest quintile of pc exp in y0	0.0937**	0.0783	0.0679	0.0868	0.407	0.280	0.204	0.320
	(0.0462)	(0.0586)	(0.0416)	(0.0570)	(0.269)	(0.214)	(0.216)	(0.203)

boy	-0.0648***	0.00932	-0.0641***	-0.0130	-0.323***	0.0211	-0.332***	-0.0666
	(0.0210)	(0.0266)	(0.0213)	(0.0234)	(0.102)	(0.0950)	(0.104)	(0.0812)
1 if have an infant (1-5 yr)	-0.00545	-0.0180	-0.0230	-0.00915	-0.0836	-0.0599	-0.187	-0.0374
	(0.0236)	(0.0319)	(0.0234)	(0.0296)	(0.126)	(0.116)	(0.131)	(0.103)
1 if Parents completed	0.0587**	0.0376	0.0847***	0.0722***	0.291**	0.153*	0.441***	0.262***
at least 1st grade of primary	(0.0241)	(0.0234)	(0.0231)	(0.0233)	(0.117)	(0.0840)	(0.112)	(0.0783)
comarca==El Kilan	-0.00420	0.211***	0.0462***	0.179***	-4.151***	0.716***	0.342***	0.673***
	(0.0177)	(0.0177)	(0.0162)	(0.0189)	(0.233)	(0.0646)	(0.105)	(0.0757)
comarca==El Mojon	-0.0177	0.215***	0.0234	0.0627***	-4.294***	0.794***	0.0891	0.259***
	(0.0245)	(0.0218)	(0.0242)	(0.0209)	(0.240)	(0.0863)	(0.122)	(0.0812)
comarca==Las Chilcas	-0.0499***	0.100***	-0.0955***	0.0315*	-0.238***	0.427***	-0.470***	0.149***
	(0.00914)	(0.0126)	(0.0106)	(0.0158)	(0.0614)	(0.0560)	(0.0705)	(0.0537)
comarca==Verapaz	-0.0942***	-0.00907	-0.0872***	-0.129***	-0.449***	-0.0229	-0.521***	-0.397***
	(0.00915)	(0.0125)	(0.0115)	(0.0125)	(0.0510)	(0.0504)	(0.0670)	(0.0454)
comarca==Chaguite Grande	-0.0474***	0.184***	-0.0201*	0.227***	-4.369***	0.671***	-0.111	0.917***
	(0.0119)	(0.0112)	(0.0111)	(0.0133)	(0.271)	(0.0502)	(0.0887)	(0.0695)
comarca==La Esperanza	-0.0177	0.0446***	0.0225	-0.0213	-3.882***	0.121**	0.413***	-0.0597
	(0.0135)	(0.0133)	(0.0134)	(0.0154)	(0.255)	(0.0562)	(0.115)	(0.0582)
comarca==Salamasi	-0.0320*	0.168***	-0.103***	-0.000907	-0.119	0.596***	-0.509***	-0.0191
	(0.0164)	(0.0184)	(0.0142)	(0.0179)	(0.102)	(0.0805)	(0.0882)	(0.0637)
comarca==Casas Viejas	-0.112***	0.272***	-0.0797***	0.135***	-4.672***	1.106***	-0.374***	0.529***
	(0.00955)	(0.0143)	(0.00981)	(0.0143)	(0.275)	(0.0543)	(0.0908)	(0.0604)
comarca==Hato La Virgen	0.0288***	0.157***	0.0495***	0.126***		0.527***		0.450***
	(0.00803)	(0.0112)	(0.00663)	(0.0118)		(0.0585)		(0.0479)
comarca==La Avellana	0.0526***	0.118***	0.0245*	0.125***	0.496***	0.462***	0.345***	0.440***
	(0.0143)	(0.0141)	(0.0123)	(0.0154)	(0.0904)	(0.0495)	(0.0777)	(0.0583)
comarca==Las Calabazas	0.123***	0.193***	0.0892***	0.172***	1.093***	0.602***	0.953***	0.515***
	(0.0140)	(0.0162)	(0.0132)	(0.0154)	(0.0895)	(0.0645)	(0.101)	(0.0521)
comarca==Las Pencas	-0.0537***	0.101***	-0.0195	-0.00971	-4.428***	0.380***	-0.116	0.0305
	(0.0137)	(0.0112)	(0.0137)	(0.0151)	(0.247)	(0.0464)	(0.0881)	(0.0579)
comarca==Llanos de Tamalapa	-0.0912***	0.310***	-0.0650***	0.157***	-0.414***	1.210***	-0.327***	0.566***
	(0.00808)	(0.00856)	(0.0105)	(0.0132)	(0.0730)	(0.0450)	(0.0757)	(0.0548)

comarca==Pangual	-0.00761	0.229***	0.00624	0.165***	-3.906***	0.845***	0.418***	0.603***
	(0.0105)	(0.0160)	(0.0107)	(0.00972)	(0.246)	(0.0641)	(0.0895)	(0.0436)
comarca==Puertas Viejas	-0.0531***	0.131***	-0.0762***	0.00288	-0.228***	0.456***	-0.373***	0.0255
	(0.0125)	(0.0136)	(0.00899)	(0.0141)	(0.0753)	(0.0597)	(0.0596)	(0.0506)
comarca==San Juanillo	0.00120	0.290***	0.0212**	0.113***		1.126***		0.369***
	(0.0103)	(0.0127)	(0.00817)	(0.0113)		(0.0516)		(0.0473)
comarca==Totumbla	-0.113***	-0.0279**	-0.0875***	-0.0526**	-0.438***	-0.0707	-0.415***	-0.130*
	(0.0161)	(0.0134)	(0.0160)	(0.0207)	(0.0876)	(0.0569)	(0.0870)	(0.0737)
comarca==Aguas Amarillas	0.0786***	-0.0474*	0.0452***	-0.136***	0.276***	-0.150	0.0502	-0.523***
	(0.0164)	(0.0264)	(0.0136)	(0.0210)	(0.0933)	(0.0915)	(0.0887)	(0.0772)
comarca==Bull Bull	-0.118***	-0.0905***	-0.161***	-0.255***	4.102***	-0.287***	-0.421***	-0.912***
	(0.0157)	(0.0184)	(0.0136)	(0.0247)	(0.284)	(0.0779)	(0.0878)	(0.112)
comarca==Bull Bull Arriba	-0.189***	-0.00798	-0.182***	-0.182***	-0.545***	-0.0685	-0.706***	-0.704***
	(0.0197)	(0.0266)	(0.0151)	(0.0205)	(0.101)	(0.101)	(0.0821)	(0.0846)
comarca==Cuatro Esquinas	-0.116***	-0.145***	-0.159***	-0.336***	4.048***	-0.539***	-0.476***	-1.244***
	(0.0165)	(0.0238)	(0.0163)	(0.0247)	(0.266)	(0.0947)	(0.101)	(0.124)
comarca==El Castillo	-0.0460**	-0.0879***	-0.115***	-0.216***	-0.156*	-0.297***	-0.420***	-0.803***
	(0.0194)	(0.0303)	(0.0149)	(0.0265)	(0.0919)	(0.110)	(0.0777)	(0.0983)
comarca==El Granadillo	-0.0206	0.0755***	-0.127***	-0.0445**	-0.0607	0.248***	-0.544***	-0.203***
	(0.0170)	(0.0232)	(0.0180)	(0.0197)	(0.0929)	(0.0754)	(0.0980)	(0.0690)
comarca==El Guapotal	-0.128***	-0.0471**	-0.182***	-0.150***	-0.556***	-0.160**	-0.698***	-0.597***
	(0.0100)	(0.0183)	(0.0103)	(0.0157)	(0.0483)	(0.0684)	(0.0427)	(0.0622)
comarca==La Tronca	-0.159***	-0.0680***	-0.196***	-0.318***	-0.742***	-0.197**	-0.818***	-1.090***
	(0.0111)	(0.0250)	(0.0122)	(0.0185)	(0.0727)	(0.0901)	(0.0696)	(0.0808)
comarca==Piedra Luna	0.0766***	0.0147	0.0165*	-0.206***	0.297***	0.0309	-0.0985	-0.764***
	(0.0107)	(0.0158)	(0.00906)	(0.0106)	(0.0484)	(0.0516)	(0.0593)	(0.0609)
comarca==Quililito	-0.114***	-0.304***	0.00329	-0.356***	4.110***	-1.178***	0.0793	-1.264***
	(0.0231)	(0.0343)	(0.0263)	(0.0378)	(0.287)	(0.140)	(0.134)	(0.151)
comarca==Quililon	-0.137***	-0.120***	-0.334***	-0.397***	4.009***	-0.411***	-0.977***	-1.401***
	(0.0180)	(0.0336)	(0.0159)	(0.0416)	(0.252)	(0.134)	(0.0619)	(0.151)
comarca==Tayule	-0.372***	-0.386***	-0.310***	-0.456***	3.350***	-1.536***	-0.924***	-1.691***
	(0.0169)	(0.0311)	(0.0191)	(0.0348)	(0.251)	(0.130)	(0.104)	(0.137)

comarca==Wasaka	-0.00851	-0.0646**	-0.0434***	-0.202***	-0.0382	-0.276**	-0.215**	-0.740***
	(0.0193)	(0.0289)	(0.0142)	(0.0209)	(0.0953)	(0.116)	(0.0852)	(0.0896)
comarca==Wasaka Arriba	-0.122***	0.101***	-0.102***	-0.117***	-0.346***	0.328***	-0.424***	-0.484***
	(0.0199)	(0.0230)	(0.0147)	(0.0159)	(0.0886)	(0.0763)	(0.0647)	(0.0667)
comarca==Yasica Norte	-0.0763***	-0.0468*	-0.201***	-0.234***	4.205***	-0.148	-0.621***	-0.859***
	(0.0170)	(0.0252)	(0.0171)	(0.0210)	(0.289)	(0.105)	(0.107)	(0.107)
comarca==Cerro El Padre	0.0696***	-0.0330	0.0278**	-0.194***	0.450***	-0.114	0.196**	-0.701***
	(0.0147)	(0.0236)	(0.0130)	(0.0177)	(0.0891)	(0.0848)	(0.0898)	(0.0758)
comarca==Coscuilo	-0.173***	0.0382***	-0.166***	-0.0314**	-0.645***	0.141**	-0.663***	-0.0701
	(0.0128)	(0.0122)	(0.0116)	(0.0153)	(0.0717)	(0.0525)	(0.0734)	(0.0599)
comarca==Cumaica	0.0676***	-0.142***	-0.0736***	-0.376***	4.654***	-0.554***	-0.264**	-1.410***
	(0.0191)	(0.0258)	(0.0222)	(0.0252)	(0.256)	(0.101)	(0.0981)	(0.120)
comarca==El Bacocan	0.100***	-0.165***	-0.00363	-0.292***	4.810***	-0.660***	0.0847	-1.116***
	(0.0233)	(0.0297)	(0.0257)	(0.0260)	(0.251)	(0.104)	(0.112)	(0.118)
comarca==La Rinconada	-0.119***	0.127***	-0.142***	0.113***	-0.460***	0.502***	-0.658***	0.457***
	(0.0109)	(0.0127)	(0.0134)	(0.0178)	(0.0632)	(0.0691)	(0.0703)	(0.0755)
comarca==Montana Grande	0.204***	-0.280***	0.0989***	-0.433***	5.422***	-0.960***	0.670***	-1.500***
	(0.0220)	(0.0254)	(0.0226)	(0.0298)	(0.258)	(0.0986)	(0.0715)	(0.121)
comarca==Ocotillo	0.0446**	-0.134***	-0.0948***	-0.268***	4.546***	-0.465***	-0.291***	-0.967***
	(0.0179)	(0.0245)	(0.0164)	(0.0257)	(0.252)	(0.0923)	(0.0847)	(0.120)
Constant	0.816***	0.00526	0.822***	0.0534	1.005***	-1.597***	1.093***	-1.394***
	(0.0312)	(0.0477)	(0.0369)	(0.0476)	(0.153)	(0.182)	(0.183)	(0.171)
Observations	1,871	1,430	1,845	1,430	1,787	1,426	1,761	1,422
R-squared	0.205	0.340	0.212	0.314				

Note: In the leftmost column, “type=1”, “type=2” and “type=3” indicate older, less-educated non-target; younger; and older more-educated non-target siblings, and “target=1” does target siblings. For standard errors, the linearized variance estimation is used with comarcas being clusters(Cameron and Trivedi (2005), p.843;Pendergast et al. (1996);Wooldridge (2010)). Standard errors in parentheses. *** $p < 0.01, ** p < 0.05, * p < 0.1$

Table 2.9: Regression of Spillover Effects in Enrollment: Using Households as Clusters

	(1)	(2)	(3)	(4)
Dep. Var.	Enroll	Enroll	Enroll	Enroll
	(OLS)	(OLS)	(Probit)	(Probit)
Sample year	0 and 1	0 and 2	0 and 1	0 and 2
treat=1*type=1	-0.0692	-0.0933	-0.210	-0.372
	(0.0939)	(0.0983)	(0.352)	(0.393)
year=1*type=1	0.0394	0.0811*	0.131	0.259
	(0.0415)	(0.0474)	(0.145)	(0.158)
treat=1*year=1*type=1	0.236***	0.269***	0.729***	0.816***
	(0.0597)	(0.0652)	(0.206)	(0.217)
type=2:Young non-target siblings	0.613***	0.624***	1.868***	1.871***
	(0.0635)	(0.0648)	(0.239)	(0.247)
treat=1*type=2	-0.00306	-0.0261	0.0210	-0.0762
	(0.0990)	(0.102)	(0.397)	(0.426)
year=1*type=2	0.0863*	0.0671	0.440**	0.285
	(0.0467)	(0.0574)	(0.217)	(0.257)
treat=1*year=1*type=2	-0.00869	-0.00881	0.0259	0.0180
	(0.0634)	(0.0696)	(0.350)	(0.348)
type=3:Old more-educated non-target	0.150**	0.152**	0.403**	0.398**
	(0.0626)	(0.0621)	(0.193)	(0.191)
treat=1*type=3	-0.0391	-0.0808	-0.146	-0.349
	(0.102)	(0.107)	(0.356)	(0.399)
year=1*type=3	-0.0333	-0.0194	-0.0881	-0.0656
	(0.0586)	(0.0692)	(0.166)	(0.197)
treat=1*year=1*type=3	0.0854	0.138	0.259	0.401
	(0.0787)	(0.0916)	(0.224)	(0.264)
target	0.591***	0.594***	1.741***	1.711***
	(0.0471)	(0.0487)	(0.171)	(0.177)
treat=1*target=1	-0.0975	-0.117	-0.286	-0.407
	(0.0841)	(0.0885)	(0.322)	(0.369)
year=1*target=1	0.0341	0.0607**	0.141	0.266**
	(0.0247)	(0.0261)	(0.0944)	(0.107)
treat=1*year=1*target=1	0.214***	0.175***	1.338***	1.145***
	(0.0369)	(0.0369)	(0.179)	(0.197)
Coffee cropped comarca in y1	-0.00875	0.0673	-0.0777	0.318
	(0.104)	(0.0770)	(0.444)	(0.372)
Age=8	0.0820***	0.0737***	0.375***	0.354***
	(0.0253)	(0.0275)	(0.121)	(0.132)
Age=9	0.0715***	0.0817***	0.323***	0.404***
	(0.0262)	(0.0244)	(0.118)	(0.115)
Age=10	0.0722***	0.0895***	0.341***	0.425***
	(0.0270)	(0.0266)	(0.124)	(0.121)

Age=11	0.0423	0.0742***	0.173	0.353***
	(0.0292)	(0.0266)	(0.128)	(0.124)
Age=12	0.0204	0.0125	0.0629	0.0258
	(0.0315)	(0.0308)	(0.128)	(0.128)
Age=13	-0.0648*	-0.0778**	-0.316**	-0.323**
	(0.0346)	(0.0362)	(0.131)	(0.135)
Age=14	0.325***	0.300***	0.986***	0.912***
	(0.0324)	(0.0290)	(0.107)	(0.0963)
Age=15	0.0924***	0.170***	0.310***	0.540***
	(0.0278)	(0.0354)	(0.0930)	(0.117)
2nd quintile of pc exp in y0	0.0250	0.0275	0.0955	0.0950
	(0.0293)	(0.0279)	(0.110)	(0.107)
3rd quintile of pc exp in y0	0.0520*	0.0649**	0.196*	0.253**
	(0.0274)	(0.0268)	(0.107)	(0.104)
4th quintile of pc exp in y0	0.121***	0.109***	0.505***	0.461***
	(0.0320)	(0.0310)	(0.132)	(0.128)
Richest quintile of pc exp in y0	0.0957**	0.0842**	0.387**	0.325**
	(0.0390)	(0.0381)	(0.168)	(0.159)
boy	-0.0351**	-0.0452***	-0.149**	-0.197***
	(0.0159)	(0.0150)	(0.0636)	(0.0607)
1 if have an infant (1-5 yr)	-0.00759	-0.0137	-0.0395	-0.0644
	(0.0197)	(0.0184)	(0.0825)	(0.0777)
1 if Parents completed at	0.0505**	0.0820***	0.213***	0.345***
least 1st grade of primary	(0.0204)	(0.0194)	(0.0808)	(0.0772)
comarca==El Kilan	0.101*	0.119*	0.409	0.579*
	(0.0575)	(0.0628)	(0.255)	(0.302)
comarca==El Mojon	0.104*	0.0645	0.426	0.298
	(0.0613)	(0.0688)	(0.269)	(0.319)
comarca==Las Chilcas	0.0289	-0.0264	0.140	-0.0765
	(0.107)	(0.0869)	(0.391)	(0.324)
comarca==Verapaz	-0.0437	-0.0983	-0.128	-0.330
	(0.0850)	(0.0908)	(0.300)	(0.327)
comarca==Chaguite Grande	0.0643	0.109	0.262	0.563
	(0.0749)	(0.0680)	(0.334)	(0.350)
comarca==La Esperanza	0.00554	0.00920	0.0180	0.0691
	(0.0576)	(0.0704)	(0.245)	(0.329)
comarca==Salamasi	0.0689	-0.0439	0.311	-0.138
	(0.0813)	(0.0886)	(0.310)	(0.330)
comarca==Casas Viejas	0.0796	0.0354	0.444	0.238
	(0.0643)	(0.0772)	(0.332)	(0.384)
comarca==Hato La Virgen	0.0967	0.101	0.456	0.555
	(0.0634)	(0.0711)	(0.307)	(0.364)
comarca==La Avellana	0.0924	0.0810	0.477	0.431
	(0.0755)	(0.0764)	(0.299)	(0.311)
comarca==Las Calabazas	0.171**	0.146*	0.699**	0.654**

	(0.0802)	(0.0782)	(0.324)	(0.324)
comarca==Las Pencas	0.0344	0.00721	0.154	0.0692
	(0.0695)	(0.0761)	(0.288)	(0.338)
comarca==Llanos de Tamalapa	0.0913	0.0431	0.380	0.222
	(0.105)	(0.0907)	(0.464)	(0.395)
comarca==Pangual	0.107	0.0877	0.482	0.465
	(0.0685)	(0.0731)	(0.311)	(0.358)
comarca==Puertas Viejas	0.0375	-0.0294	0.169	-0.0778
	(0.0983)	(0.0994)	(0.368)	(0.366)
comarca==San Juanillo	0.155***	0.0787	0.913**	0.417
	(0.0590)	(0.0649)	(0.374)	(0.339)
comarca==Totumbla	-0.0638	-0.0562	-0.181	-0.171
	(0.0822)	(0.0871)	(0.294)	(0.321)
comarca==Aguas Amarillas	0.0442	-0.0151	0.163	-0.130
	(0.104)	(0.0733)	(0.451)	(0.351)
comarca==Bull Bull	-0.101	-0.190	-0.235	-0.684
	(0.157)	(0.147)	(0.585)	(0.548)
comarca==Bull Bull Arriba	-0.123	-0.183**	-0.388	-0.710**
	(0.118)	(0.0857)	(0.467)	(0.344)
comarca==Cuatro Esquinas	-0.123	-0.220*	-0.371	-0.857*
	(0.147)	(0.125)	(0.568)	(0.505)
comarca==El Castillo	-0.0529	-0.149*	-0.199	-0.580*
	(0.111)	(0.0811)	(0.447)	(0.335)
comarca==El Granadillo	0.0216	-0.0929	0.139	-0.402
	(0.109)	(0.0958)	(0.480)	(0.396)
comarca==El Guapotal	-0.0906	-0.165*	-0.365	-0.657*
	(0.112)	(0.0880)	(0.472)	(0.356)
comarca==La Tronca	-0.113	-0.239***	-0.436	-0.919**
	(0.116)	(0.0869)	(0.481)	(0.362)
comarca==Piedra Luna	0.0595	-0.0659	0.225	-0.336
	(0.109)	(0.0785)	(0.471)	(0.355)
comarca==Quililito	-0.184	-0.120	-0.536	-0.491
	(0.132)	(0.133)	(0.529)	(0.553)
comarca==Quililon	-0.136	-0.358**	-0.396	-1.290**
	(0.177)	(0.171)	(0.648)	(0.636)
comarca==Tayule	-0.384**	-0.369***	-1.158*	-1.311***
	(0.161)	(0.128)	(0.613)	(0.507)
comarca==Wasaka	-0.0186	-0.0958	-0.0621	-0.382
	(0.102)	(0.0721)	(0.438)	(0.328)
comarca==Wasaka Arriba	-0.0239	-0.112	-0.0447	-0.476
	(0.114)	(0.0773)	(0.457)	(0.324)
comarca==Yasica Norte	-0.0464	-0.183	-0.0486	-0.694
	(0.144)	(0.125)	(0.555)	(0.506)
comarca==Cerro El Padre	0.0407	-0.0475	0.226	-0.154
	(0.103)	(0.0662)	(0.448)	(0.320)

comarca==Coscuilo	-0.0750	-0.0949	-0.228	-0.288
	(0.0974)	(0.0951)	(0.327)	(0.326)
comarca==Cumaica	-0.0185	-0.190	-0.0275	-0.784
	(0.140)	(0.126)	(0.555)	(0.511)
comarca==El Bacocan	-0.00485	-0.115	0.0598	-0.468
	(0.135)	(0.117)	(0.547)	(0.497)
comarca==La Rinconada	0.0112	-0.00118	0.104	0.0299
	(0.0968)	(0.0992)	(0.361)	(0.381)
comarca==Montana Grande	-0.00906	-0.122	0.0627	-0.475
	(0.128)	(0.111)	(0.518)	(0.472)
comarca==Ocotillo	-0.0243	-0.152	-0.0170	-0.590
	(0.135)	(0.120)	(0.538)	(0.495)
Constant	0.125	0.141*	-1.210***	-1.116***
	(0.0782)	(0.0792)	(0.283)	(0.293)
Observations	3,301	3,275	3,301	3,275
R-squared	0.329	0.317		

Note: In the leftmost column, “type=1”, “type=2” and “type=3” indicate older, less-educated non-target; younger; and older more-educated non-target siblings, and “target=1” does target siblings. For standard errors, the linearized variance estimation is used with comarcas being clusters(Cameron and Trivedi (2005), p.843; Pendergast et al. (1996);Wooldridge (2010))

Standard errors in parentheses. *** $p < 0.01, **p < 0.05, *p < 0.1$

Table 2.10: Predicted Impact on Probability of Enrollment from Probit Model and Bootstrap SE

	Treat		Control			Bootstrap		
Category	Before	After	Before	After	Effect	se	t	p-val
Year 1								
Older Less-educated Non-target y1	0.242	0.539	0.257	0.282	0.271	0.072	3.787	0.000
Younger Non-target y1	0.880	0.933	0.802	0.908	-0.053	0.066	-0.797	0.425
Older More-educated Non-target y1	0.493	0.525	0.473	0.428	0.077	0.086	0.892	0.373
Target Siblings y1	0.718	0.974	0.783	0.795	0.245	0.055	4.486	0.000
Year2								
Older Less-educated Non-target y1	0.242	0.610	0.258	0.333	0.293	0.083	3.514	0.000
Younger Non-target y1	0.884	0.917	0.802	0.863	-0.028	0.066	-0.415	0.678
Older More-educated Non-target y1	0.491	0.618	0.477	0.460	0.144	0.113	1.279	0.201
Target Siblings y1	0.718	0.972	0.783	0.831	0.206	0.054	3.800	0.000

Note: The coefficients from the probit estimation in Columns (3) and (4) in Table 2.7 are used. Bootstrap replications =991 and 996 for years 1 and 2, respectively. For bootstrapping, *comarcas* are used as clusters.

Table 2.11: Difference between Boys and Girls in Spillover Effects on Enrollment and Bootstrap SE from Probit Model

Marginal effects for:	Coef.	Std. Err.	t	P>z
Year 1				
Older Less-educated Non-target	-0.099	0.111	-0.885	0.376
Older, more-educated non-target	0.139	0.169	0.819	0.413
Target siblings	0.047	0.069	0.685	0.493
Year 2				
Older Less-educated Non-target	0.098	0.166	0.590	0.555
Older, more-educated non-target	0.035	0.173	0.201	0.841
Target siblings	0.031	0.078	0.394	0.693

Note: The coefficients from the probit estimation in Columns (3) and (4) in Table 2.12 are used. Bootstrap replications =879 and 1000 for years 1 and 2, respectively. For bootstrapping, comarcas are used as clusters.

Table 2.12: Regression of Spillover Effects in Enrollment: Gender

	(1)	(2)	(3)	(4)
Dep. Var.	Enroll	Enroll	Enroll	Enroll
	(OLS)	(OLS)	(Probit)	(Probit)
Sample year	0 and 1	0 and 2	0 and 1	0 and 2
treat=1*type=1	-0.145*	-0.157**	-0.550**	-0.601**
	(0.0761)	(0.0719)	(0.261)	(0.243)
year=1*type=1	-0.0302	0.0892	-0.0976	0.272
	(0.0546)	(0.0891)	(0.181)	(0.275)
treat=1*year=1*type=1	0.326***	0.256**	0.996***	0.757**
	(0.0787)	(0.114)	(0.261)	(0.356)
type=2:Young non-target	0.619***	0.634***	1.899***	1.896***
	(0.0856)	(0.0897)	(0.309)	(0.328)
treat=1*type=2	0.0392	0.0151	0.377	0.298
	(0.0619)	(0.0619)	(0.431)	(0.422)
year=1*type=2	0.0296	0.00921	0.179	0.0717
	(0.0516)	(0.0716)	(0.260)	(0.327)
treat=1*year=1*type=2	-0.0661	0.0115	-0.573	-0.00488
	(0.0809)	(0.0868)	(0.557)	(0.594)
type=3:Old more-educated	0.119	0.117	0.270	0.256
non-target	(0.105)	(0.105)	(0.317)	(0.314)
treat=1*type=3	-0.0522	-0.0783	-0.274	-0.375
	(0.0929)	(0.0939)	(0.275)	(0.278)
year=1*type=3	-0.00674	0.000178	-0.00496	-0.00870
	(0.0947)	(0.105)	(0.266)	(0.287)
treat=1*year=1*type=3	0.0166	0.117	0.0455	0.329
	(0.116)	(0.125)	(0.328)	(0.346)
target	0.623***	0.625***	1.881***	1.834***
	(0.0752)	(0.0767)	(0.247)	(0.250)
treat=1*target=1	-0.150***	-0.161***	-0.606***	-0.638***
	(0.0540)	(0.0502)	(0.194)	(0.181)
year=1*target=1	0.0272	0.0466	0.148	0.269
	(0.0259)	(0.0323)	(0.127)	(0.166)
treat=1*year=1*target=1	0.201***	0.171**	1.211***	1.085***
	(0.0669)	(0.0692)	(0.300)	(0.369)
treat=1*type=1*G=1	0.122	0.122	0.405	0.388
	(0.108)	(0.107)	(0.394)	(0.389)
year=1*type=1*G=1	0.114	-0.0183	0.371	-0.0544
	(0.0840)	(0.125)	(0.291)	(0.410)
treat=1*year=1*type=1	-0.152	0.0129	-0.448	0.0700
*G=1	(0.111)	(0.150)	(0.383)	(0.495)
type=2:Young non-target	-0.0309	-0.0316	-0.120	-0.0945
*G=1	(0.133)	(0.133)	(0.486)	(0.484)

treat=1*type=2*G=1	-0.0873	-0.0693	-0.727	-0.616
	(0.103)	(0.102)	(0.521)	(0.499)
year=1*type=2*G=1	0.128*	0.121	0.634*	0.433
	(0.0647)	(0.132)	(0.328)	(0.604)
treat=1*year=1*type=2	0.101	-0.0393	1.121	-0.0209
***G=1**	(0.0968)	(0.150)	(0.673)	(0.809)
type=3:Old more-educated	0.0665	0.0951	0.272	0.384
non-target*G=1	(0.149)	(0.150)	(0.479)	(0.479)
treat=1*type=3*G=1	0.0133	-0.0105	0.0186	-0.0516
	(0.132)	(0.136)	(0.377)	(0.386)
year=1*type=3*G=1	-0.0720	-0.0657	-0.226	-0.211
	(0.131)	(0.119)	(0.390)	(0.342)
treat=1*year=1*type=3	0.174	0.0576	0.553	0.198
***G=1**	(0.160)	(0.151)	(0.470)	(0.431)
target=1*G=1	-0.0619	-0.0587	-0.238	-0.216
	(0.0948)	(0.0945)	(0.327)	(0.325)
treat=1*target=1*G=1	0.0887	0.0898	0.354	0.353
	(0.0639)	(0.0628)	(0.221)	(0.216)
year=1*target=1*G=1	0.0158	0.0205	0.0170	-0.0116
	(0.0383)	(0.0484)	(0.157)	(0.216)
treat=1*year=1*target=1	0.0216	0.00807	0.230	0.0806
***G=1**	(0.0654)	(0.0755)	(0.349)	(0.418)
Coffee cropped comarca in y1	-0.0478***	-0.0881***	-0.213***	-0.306***
	(0.00966)	(0.00848)	(0.0390)	(0.0356)
Age=8	0.0777***	0.0723**	0.360***	0.362**
	(0.0244)	(0.0271)	(0.122)	(0.137)
Age=9	0.0673***	0.0829***	0.313***	0.400***
	(0.0228)	(0.0182)	(0.104)	(0.0954)
Age=10	0.0705***	0.0914***	0.340***	0.446***
	(0.0243)	(0.0283)	(0.107)	(0.131)
Age=11	0.0415	0.0733***	0.166	0.347**
	(0.0324)	(0.0270)	(0.149)	(0.136)
Age=12	0.0204	0.0156	0.0673	0.0423
	(0.0287)	(0.0242)	(0.120)	(0.102)
Age=13	-0.0674**	-0.0801**	-0.339**	-0.334**
	(0.0321)	(0.0379)	(0.128)	(0.145)
Age=14	0.326***	0.300***	0.992***	0.911***
	(0.0422)	(0.0302)	(0.140)	(0.104)
Age=15	0.0947***	0.173***	0.323***	0.551***
	(0.0309)	(0.0374)	(0.102)	(0.129)
Per capita expenditures y0	4.15e-05***	3.23e-05***	0.000172***	0.000131***
	(1.04e-05)	(1.09e-05)	(4.95e-05)	(4.78e-05)
pexp02	-1.75e-09**	-1.13e-09	-7.11e-09	-4.23e-09
	(7.54e-10)	(8.23e-10)	(4.24e-09)	(4.02e-09)
boy	-0.0595	-0.0614	-0.234	-0.246

	(0.0911)	(0.0902)	(0.326)	(0.321)
1 if have an infant (1-5 yr)	-0.00425	-0.0152	-0.0293	-0.0722
	(0.0200)	(0.0201)	(0.0805)	(0.0845)
1 if Parents completed	0.0490***	0.0807***	0.213***	0.343***
at least 1st grade of primary	(0.0179)	(0.0192)	(0.0716)	(0.0725)
comarca==El Kilan	0.100***	0.110***	0.429***	0.551***
	(0.0110)	(0.0115)	(0.0463)	(0.0547)
comarca==El Mojon	0.101***	0.0583***	0.446***	0.282***
	(0.0150)	(0.0144)	(0.0673)	(0.0606)
comarca==Las Chilcas	0.0296**	-0.0234*	0.0716	-0.106**
	(0.0113)	(0.0127)	(0.0448)	(0.0484)
comarca==Verapaz	-0.0595***	-0.109***	-0.263***	-0.414***
	(0.00880)	(0.00938)	(0.0391)	(0.0404)
comarca==Chaguite Grande	0.0658***	0.113***	0.290***	0.568***
	(0.00841)	(0.00870)	(0.0450)	(0.0411)
comarca==La Esperanza	0.0151**	0.0111	0.105***	0.112***
	(0.00655)	(0.00736)	(0.0357)	(0.0406)
comarca==Salamasi	0.0536***	-0.0567***	0.178***	-0.249***
	(0.00953)	(0.0101)	(0.0445)	(0.0484)
comarca==Casas Viejas	0.0803***	0.0294***	0.472***	0.222***
	(0.00567)	(0.00532)	(0.0335)	(0.0277)
comarca==Hato La Virgen	0.103***	0.105***	0.528***	0.576***
	(0.00575)	(0.00478)	(0.0441)	(0.0361)
comarca==La Avellana	0.0890***	0.0879***	0.390***	0.424***
	(0.0111)	(0.0102)	(0.0472)	(0.0460)
comarca==Las Calabazas	0.165***	0.144***	0.629***	0.620***
	(0.0102)	(0.0103)	(0.0445)	(0.0462)
comarca==Las Pencas	0.0352***	0.00311	0.180***	0.0581
	(0.00885)	(0.00868)	(0.0415)	(0.0371)
comarca==Llanos de Tamalapa	0.0957***	0.0521***	0.333***	0.224***
	(0.0118)	(0.0111)	(0.0466)	(0.0431)
comarca==Pangual	0.122***	0.0999***	0.553***	0.505***
	(0.00744)	(0.00711)	(0.0355)	(0.0319)
comarca==Puertas Viejas	0.0378***	-0.0265***	0.120***	-0.0884**
	(0.0100)	(0.00813)	(0.0440)	(0.0350)
comarca==San Juanillo	0.153***	0.0785***	0.948***	0.434***
	(0.00765)	(0.00728)	(0.0558)	(0.0403)
comarca==Totumbla	-0.0758***	-0.0575***	-0.296***	-0.209***
	(0.0125)	(0.0122)	(0.0497)	(0.0470)
comarca==Aguas Amarillas	0.0753***	0.133***	0.281***	0.451***
	(0.0116)	(0.0106)	(0.0565)	(0.0543)
comarca==Bull Bull	-0.0806***	-0.0505***	-0.228***	-0.148***
	(0.00956)	(0.00984)	(0.0407)	(0.0429)
comarca==Bull Bull Arriba	-0.0804***	-0.0378***	-0.221**	-0.123*
	(0.0191)	(0.0140)	(0.0826)	(0.0628)

comarca==Cuatro Esquinas	-0.0870***	-0.0655***	-0.312***	-0.270***
	(0.00773)	(0.00688)	(0.0331)	(0.0364)
comarca==El Castillo	-0.00814	0.0101	-0.00742	0.0730
	(0.0189)	(0.0164)	(0.0873)	(0.0726)
comarca==El Granadillo	0.0731***	0.0725***	0.334***	0.243***
	(0.0103)	(0.0140)	(0.0581)	(0.0666)
comarca==El Guapotal	-0.0478***	-0.0102	-0.196***	-0.0277
	(0.0132)	(0.0129)	(0.0661)	(0.0561)
comarca==La Tronca	-0.0771***	-0.0851***	-0.278***	-0.288***
	(0.0124)	(0.0119)	(0.0630)	(0.0707)
comarca==Piedra Luna	0.0917***	0.0853***	0.370***	0.271***
	(0.0117)	(0.00830)	(0.0596)	(0.0448)
comarca==Quililito	-0.149***	0.0421***	-0.488***	0.108***
	(0.00942)	(0.0106)	(0.0377)	(0.0385)
comarca==Quililon	-0.103***	-0.200***	-0.368***	-0.717***
	(0.0136)	(0.0126)	(0.0597)	(0.0560)
comarca==Tayule	-0.353***	-0.217***	-1.146***	-0.763***
	(0.00832)	(0.00896)	(0.0455)	(0.0459)
comarca==Wasaka	0.00808	0.0423***	0.0349	0.183***
	(0.0129)	(0.0126)	(0.0598)	(0.0582)
comarca==Wasaka Arriba	0.0160	0.0362***	0.126*	0.138**
	(0.0144)	(0.0124)	(0.0663)	(0.0592)
comarca==Yale	0.0351**	0.151***	0.119*	0.588***
	(0.0146)	(0.0102)	(0.0655)	(0.0505)
comarca==Yasica Norte	-0.0273***	-0.0387***	-0.0589*	-0.144***
	(0.00748)	(0.00658)	(0.0299)	(0.0273)
comarca==Cerro El Padre	0.0682***	0.101***	0.319***	0.440***
	(0.0116)	(0.00801)	(0.0533)	(0.0390)
comarca==Coscuilo	-0.0766***	-0.0914***	-0.302***	-0.308***
	(0.00935)	(0.00880)	(0.0366)	(0.0359)
comarca==Cumaica	0.00810	-0.0335***	0.000284	-0.190***
	(0.00801)	(0.00765)	(0.0402)	(0.0393)
comarca==Piedra Grande	-0.00649	0.00198	-0.0914**	-0.0284
	(0.00983)	(0.0106)	(0.0377)	(0.0443)
comarca==El Bacocan	0.0285**	0.0391***	0.106***	0.126***
	(0.0109)	(0.0109)	(0.0391)	(0.0405)
comarca==Montana Grande	0.0229**	0.0323***	0.101***	0.102**
	(0.00895)	(0.0105)	(0.0372)	(0.0445)
Constant	0.0919	0.118*	-1.299***	-1.190***
	(0.0663)	(0.0681)	(0.222)	(0.225)
Observations	3,301	3,275	3,301	3,275
R-squared	0.335	0.321		

Note: In the leftmost column, "type=1", "type=2" and "type=3" indicate older, less-educated non-target; younger; and older more-educated non-target siblings, and "target=1" does target siblings. For standard errors, the linearized variance

estimation is used with comarcas being clusters(Cameron and Trivedi (2005), p.843; Pendergast et al. (1996);Wooldridge (2010))
"*G=1" indicates that the variables are interacted with a dummy variable which equals one when a child is a boy.
Standard errors in parentheses. *** $p < 0.01, **p < 0.05, *p < 0.1$

Table 2.13: Regression of Individual Education Expenditures - Excluding Transportation Costs

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Quantile	q25	q50	q75	q25	q50	q75	q25	q50	q75	q25	q50	q75
Sample	Enrolled	Enrolled	Enrolled	Enrolled	Enrolled	Enrolled	All	All	All	All	All	All
Sample year	0 and 1	0 and 1	0 and 1	0 and 2	0 and 2	0 and 2	0 and 1	0 and 1	0 and 1	0 and 2	0 and 2	0 and 2
treat=1*type=1	-145.6	-208.6**	-169.6	-41.32	-44.04	-81.15	-5.000	-145.5**	-183.8*	-4.014	-20.38	-101.3*
	(101.1)	(98.16)	(120.3)	(41.21)	(44.48)	(61.64)	(4.772)	(58.31)	(101.1)	(6.308)	(34.34)	(56.44)
year=1*type=1	21.97	14.31	62.28	7.520	18.18	32.19	-0	1.314	8.724	-7.17e-09	3.719	21.53**
	(20.15)	(22.26)	(58.82)	(10.57)	(20.95)	(54.48)	(0.177)	(2.486)	(7.098)	(0.418)	(3.078)	(10.97)
treat=1*year=1*type=1	40.64	143.5***	55.67	120.6***	181.6***	136.8**	0	11.96	172.4***	1.690	71.57	182.5***
	(44.29)	(36.30)	(74.55)	(46.53)	(31.36)	(60.66)	(0.297)	(9.710)	(27.08)	(1.811)	(49.86)	(23.97)
type=2:Young non-target	10.39	20.08	35.15	42.52*	70.34*	82.92	5	76.69***	160.3***	3.993	81.97***	153.1***
\;siblings	(29.05)	(37.02)	(58.18)	(22.58)	(35.91)	(67.34)	(6.775)	(22.06)	(47.89)	(7.106)	(23.63)	(38.18)
treat=1*type=2	-91.64	-138.1	-213.0*	0.400	9.480	-111.3*	35.00	-83.75	-165.6	34.42	26.58	-101.8
	(108.9)	(99.43)	(114.9)	(53.10)	(46.87)	(66.44)	(26.78)	(67.76)	(106.7)	(28.32)	(48.00)	(65.18)
year=1*type=2	2.242	13.92	-22.33	55.40**	58.75**	3.192	30.00*	2.928	1.737	52.24***	72.23**	30.25
	(25.47)	(48.97)	(70.90)	(26.21)	(26.88)	(49.70)	(15.42)	(47.45)	(72.27)	(19.17)	(28.58)	(39.65)
treat=1*year=1*type=2	85.91**	76.77	92.48	29.12	47.09	113.4*	75**	98.04*	88.31	54.42	45.26	102.1*
	(42.55)	(54.69)	(82.93)	(45.97)	(42.27)	(65.39)	(35.45)	(57.12)	(80.26)	(33.85)	(41.91)	(53.34)
type=3:Old more-educated	38.73	109.2***	187.6**	40.56*	67.71	161.7**	-0	6.536	80.02*	-0.775	7.388	55.46
\; non-target	(30.64)	(34.63)	(76.61)	(22.90)	(48.06)	(74.36)	(0.298)	(6.233)	(44.09)	(0.697)	(8.544)	(36.85)
treat=1*type=3	-108.8	-164.9	-162.3	-28.16	41.28	-19.35	-5.000	-139.1**	-146.6	-3.275	-20.98	-61.71
	(108.1)	(110.8)	(126.7)	(49.75)	(83.81)	(80.88)	(4.719)	(58.49)	(125.5)	(6.176)	(35.11)	(98.99)
year=1*type=3	104.1*	105.9**	76.72	36.40	88.09*	85.00	0	3.307	71.71	-0.141	1.967	75.01
	(53.49)	(52.78)	(82.13)	(47.41)	(48.10)	(85.11)	(0.444)	(7.334)	(67.07)	(1.088)	(13.85)	(51.14)
treat=1*year=1*type=3	-4.091	-25.31	-45.46	47.64	-38.37	-32.46	-0	5.869	63.47	1.162	80.14*	68.07
	(62.35)	(79.31)	(96.97)	(58.59)	(91.75)	(97.34)	(0.851)	(41.08)	(99.22)	(2.179)	(48.09)	(84.85)
target	-17.94	-33.31	-95.88**	6.400	-1.19e-06	-53.92	-0	11.48**	38.96***	0.563	11.97**	39.69***
	(17.37)	(26.24)	(43.64)	(14.66)	(27.62)	(46.96)	(0.754)	(5.721)	(13.32)	(1.105)	(6.087)	(13.02)
treat=1*target=1	-118.0	-186.5*	-175.8	-22.44	-17.79	-40.69	-5.000	-140.2**	-163.6	-2.923	-16.97	-84.95
	(102.3)	(96.38)	(107.1)	(38.57)	(35.37)	(47.17)	(4.588)	(58.58)	(100.8)	(6.151)	(34.09)	(55.83)
year=1*target=1	15.61**	30.23**	70.44***	22.12***	52.90***	89.81***	2.500	21.71**	58.04***	7.077	47.64**	86.51***
	(6.498)	(12.72)	(21.47)	(8.095)	(17.66)	(19.25)	(3.210)	(9.540)	(19.12)	(5.279)	(18.80)	(19.17)
treat=1*year=1*target=1	19.21	106.8***	62.42**	144.4***	137.3***	67.77**	32.50	173.6***	117.2***	181.8***	173.6***	104.0***
	(24.74)	(22.93)	(27.66)	(14.52)	(22.12)	(28.22)	(38.83)	(18.89)	(27.50)	(13.93)	(21.15)	(25.17)
Constant	92.76	173.0**	305.4***	-12.32	-2.811	157.0**	-0	108.6**	120.9	-0.493	-16.36	61.20
	(75.47)	(81.19)	(99.04)	(35.87)	(41.05)	(61.73)	(4.189)	(51.89)	(81.64)	(4.154)	(32.49)	(46.47)
Observations	2273	2273	2273	2290	2290	2290	3301	3301	3301	3275	3275	3275

Note: In the leftmost column, “type=1” indicates older, less-educated non-target siblings and “target=1” does target siblings. For standard errors, bootstrapping standard errors are used with comarcas being clusters. The number of bootstrapping replication =1,000. The coefficients of X variables are not shown.

Table 2.14: Regression of Individual Education Expenditures - Including Transportation Costs

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Quantile	q25	q50	q75	q25	q50	q75	q25	q50	q75	q25	q50	q75
Sample	Enrolled	Enrolled	Enrolled	Enrolled	Enrolled	Enrolled	All	All	All	All	All	All
Sample year	0 and 1	0 and 1	0 and 1	0 and 2	0 and 2	0 and 2	0 and 1	0 and 1	0 and 1	0 and 2	0 and 2	0 and 2
treat=1*type=1	-179.6	-184.3*	-97.42	-30.37	-71.61	-101.9	-3.000	-118.0**	-133.9	-3.625	-36.05	-137.1
	(110.0)	(105.3)	(123.1)	(59.32)	(65.20)	(101.2)	(4.850)	(56.87)	(87.19)	(12.58)	(66.21)	(90.72)
year=1*type=1	24.79	31.51	94.32	24.10*	11.29	27.06	-0	1.171	3.561	0.114	5.238	29.45**
	(22.02)	(40.98)	(88.58)	(12.80)	(23.34)	(62.93)	(0.195)	(3.026)	(8.560)	(0.407)	(3.944)	(13.53)
treat=1*year=1*type=1	36.17	135.4***	95.63	180.8***	243.4***	216.0**	0	10.89	196.2***	1.807	125.1*	245.2***
	(55.19)	(52.57)	(107.4)	(56.07)	(35.09)	(87.49)	(0.362)	(11.90)	(34.00)	(2.348)	(71.98)	(37.55)
type=2:Young non-target siblings	12.66	-12.59	8.737	47.10*	42.04	45.19	5	70.54***	199.0***	3.682	75.79***	168.2***
	(30.94)	(56.77)	(105.2)	(25.50)	(47.62)	(118.9)	(8.609)	(22.30)	(61.71)	(8.939)	(23.84)	(58.75)
treat=1*type=2	-114.3	-110.2	-156.9	-10.31	-6.286	-149.5	42.00	-29.91	-161.9	44.16	44.45	-146.5
	(118.0)	(107.7)	(127.6)	(66.82)	(66.65)	(113.2)	(29.27)	(68.00)	(108.4)	(31.73)	(75.46)	(105.5)
year=1*type=2	9.275	2.692	-1.105	83.36***	73.86**	110.8	42**	33.31	-4.049	55.33*	97.40***	71.03
	(30.91)	(53.80)	(103.5)	(27.85)	(35.78)	(120.3)	(18.04)	(52.75)	(102.0)	(33.12)	(30.82)	(85.93)
treat=1*year=1*type=2	95.64*	109.6*	215.6*	38.40	91.82	119.2	74*	102.3	235.8**	76.12*	65.26	185.3*
	(50.84)	(62.18)	(130.4)	(49.68)	(56.53)	(135.8)	(38.06)	(67.69)	(118.0)	(45.52)	(55.18)	(94.99)
type=3:Old more-educated non-target	83.35**	143.8*	471.8	76.19***	163.7**	517.0*	0	8.943	137.1	-0.648	9.857	137.3*
	(33.70)	(76.10)	(304.5)	(22.96)	(76.33)	(278.5)	(0.298)	(12.28)	(86.53)	(0.703)	(11.39)	(77.07)
treat=1*type=3	-166.3	-189.6	-231.7	-63.45	-54.89	-295.4	-3.000	-118.1**	-162.9	-3.125	-34.21	-192.5
	(115.3)	(137.4)	(320.2)	(65.11)	(123.7)	(293.5)	(4.778)	(57.18)	(141.4)	(12.49)	(66.46)	(142.3)
year=1*type=3	86.78**	67.62	-46.47	73.64	145.7	-96.19	-0	-0.371	48.02	-0.148	1.500	79.11
	(40.66)	(85.79)	(332.4)	(62.23)	(117.4)	(292.4)	(0.410)	(13.40)	(98.41)	(1.096)	(20.33)	(115.7)
treat=1*year=1*type=3	17.89	106.2	145.3	74.08	-30.36	163.6	0	8.600	154.2	1.341	147.4***	138.2
	(56.92)	(109.6)	(344.1)	(68.66)	(151.3)	(311.8)	(0.665)	(45.36)	(131.0)	(2.132)	(56.47)	(143.2)
target	-17.11	-75.62	-173.2**	3.837	-25.11	-82.65	0	11.06*	33.56**	0.170	10.57	42.58***
	(19.32)	(48.31)	(87.28)	(21.23)	(39.64)	(86.24)	(0.920)	(6.291)	(13.89)	(1.071)	(6.678)	(14.49)
treat=1*target=1	-148.8	-166.9	-61.84	-24.38	-33.68	-98.62	-3.000	-116.9**	-105.6	-2.295	-27.81	-122.6
	(111.1)	(103.9)	(99.00)	(56.24)	(58.16)	(75.21)	(4.716)	(56.97)	(86.86)	(12.46)	(66.25)	(89.20)
year=1*target=1	20.00**	39.23**	89.00***	31.59**	62.29***	85.62***	3	27.74**	87.59***	7.614	53.98**	110.7***
	(7.778)	(17.28)	(24.45)	(12.27)	(21.41)	(31.45)	(3.535)	(12.26)	(23.54)	(6.761)	(25.69)	(30.86)
treat=1*year=1*target=1	55.31**	128.7***	109.8***	179.9***	184.2***	193.4***	112.0***	189.6***	148.9***	216.5***	227.2***	211.5***
	(27.41)	(24.74)	(33.71)	(17.82)	(25.87)	(40.98)	(36.95)	(20.56)	(30.03)	(11.01)	(29.97)	(36.84)
Constant	121.7	204.2**	360.9***	-9.360	16.89	192.5*	-0	87.57*	118.8	-0.398	-21.05	47.29
	(83.50)	(98.71)	(117.8)	(50.04)	(63.07)	(106.2)	(4.073)	(49.79)	(73.49)	(6.493)	(59.13)	(75.93)
Observations	2273	2273	2273	2290	2290	2290	3301	3301	3301	3275	3275	3275

Note: In the leftmost column, "type=1" indicates older, less-educated non-target siblings and "target=1" does target siblings. For standard errors, bootstrapping standard errors are used with comarcas being clusters. The number of bootstrapping replication =1,000. The coefficients of X variables are not shown.

Table 2.15: Regression of Supply-side Effects in Enrollment: OLS

VARIABLES	(1) Enroll (OLS) 0 and 1	(2) Enroll (OLS) 0 and 1	(3) Enroll (OLS) 0 and 1	(4) Enroll (OLS) 0 and 2	(5) Enroll (OLS) 0 and 2	(6) Enroll (OLS) 0 and 2
treat=1*type=1	-0.729***	-0.168*	-0.116	-0.830***	-0.123	-0.116
	(0.180)	(0.0830)	(0.0840)	(0.230)	(0.0843)	(0.0840)
year=1*type=1	0.0893	0.121	0.129	0.0368	0.0334	0.0595
	(0.118)	(0.127)	(0.132)	(0.0904)	(0.0836)	(0.0815)
treat=1*year=1*type=1	0.0656	0.0339	0.0206	0.230	0.226	0.127
	(0.167)	(0.163)	(0.167)	(0.177)	(0.140)	(0.146)
Coffee cropped comarca in y1	-0.108	-0.0265		-0.272	-0.0461	
	(0.168)	(0.0726)		(0.218)	(0.0683)	
Age=14	0.341***	0.315***		0.266***	0.322***	
	(0.0902)	(0.0811)		(0.0979)	(0.0866)	
Age=15	0.106	0.0530		0.126	0.162	
	(0.0750)	(0.0713)		(0.136)	(0.114)	
2nd quintile of pc exp in y0	0.125	0.154		0.109	0.211*	
	(0.167)	(0.123)		(0.176)	(0.112)	
3rd quintile of pc exp in y0	0.260	0.0106		0.141	-0.00118	
	(0.166)	(0.107)		(0.108)	(0.103)	
4th quintile of pc exp in y0	0.0965	-0.0237		0.137	0.0996	
	(0.142)	(0.0879)		(0.116)	(0.0912)	
Richest quintile of pc exp in y0	0.0959	0.0883		0.219	0.258**	
	(0.162)	(0.105)		(0.145)	(0.103)	
boy	-0.0519	0.0833		-0.00737	0.0734	
	(0.129)	(0.0965)		(0.107)	(0.0876)	
1 if have an infant (1-5 yr)	-0.0697	-0.0554		0.0295	0.0575	
	(0.0723)	(0.0831)		(0.0833)	(0.0704)	
1 if Parents completed	0.0615	0.00481		0.0277	0.00495	
at least 1st grade of primary	(0.0866)	(0.0729)		(0.0932)	(0.0680)	
comarca==El Kilan	-0.211			-0.102		
	(0.162)			(0.116)		
comarca==El Mojon	-0.295**			-0.299***		
	(0.115)			(0.0947)		
comarca==Las Chilcas	-0.187			-0.303		
	(0.222)			(0.279)		
comarca==Verapaz	-0.625***			-0.831***		
	(0.135)			(0.253)		
comarca==Chaguite Grande	0.129			0.308**		
	(0.103)			(0.121)		
comarca==La Esperanza	-0.402**			-0.212*		
	(0.152)			(0.123)		
comarca==Salamasi	-1.041***			-0.984***		
	(0.0788)			(0.163)		
comarca==Hato La Virgen	0.700***			0.652***		
	(0.149)			(0.119)		
comarca==La Avellana	-0.775***			-0.952***		
	(0.118)			(0.166)		
comarca==Las Calabazas	-0.517**			-0.382		
	(0.237)			(0.248)		
comarca==Las Pencas	-0.329***			-0.188		
	(0.120)			(0.112)		
comarca==Llanos de Tamalapa	-0.422***			-0.543**		
	(0.154)			(0.227)		
comarca==Pangual	-0.0726			-0.0351		
	(0.111)			(0.0961)		
comarca==Puertas Viejas	-0.171***			-0.162		
	(0.0451)			(0.284)		
comarca==San Juanillo	0.549***			0.172		
	(0.106)			(0.113)		
comarca==Totumbla	-0.568***			-0.670***		

	(0.143)			(0.173)		
comarca==Aguas Amarillas	0.139			0.141		
	(0.181)			(0.248)		
comarca==Bull Bull Arriba	0.222			0.499**		
	(0.154)			(0.211)		
comarca==Cuatro Esquinas	-0.442*			-0.279		
	(0.241)			(0.332)		
comarca==El Castillo	0.111			0.130		
	(0.174)			(0.164)		
comarca==El Granadillo	-0.153			-0.0289		
	(0.159)			(0.268)		
comarca==El Guapotal	-0.140			0.253		
	(0.159)			(0.203)		
comarca==La Tronca	0.0402			0.311		
	(0.137)			(0.191)		
comarca==Quililito	-0.199			-0.372		
	(0.229)			(0.365)		
comarca==Quililon	-0.338			-0.116		
	(0.233)			(0.334)		
comarca==Tayule	-0.693***			-0.670*		
	(0.202)			(0.345)		
comarca==Wasaka	0.149			0.190		
	(0.170)			(0.229)		
comarca==Wasaka Arriba	0.624**			0.907***		
	(0.233)			(0.262)		
comarca==Yasica Norte	-0.318			-0.662*		
	(0.274)			(0.369)		
comarca==Cerro El Padre	0.0696			0.347		
	(0.143)			(0.215)		
comarca==Cumaica	-0.746***			-0.749**		
	(0.225)			(0.337)		
comarca==El Bacocan	0.428			-0.281		
	(0.307)			(0.378)		
comarca==Montana Grande	0.249					
	(0.269)					
comarca==Ocotillo	-0.800***			-0.674**		
	(0.210)			(0.310)		
comarca==Bull Bull				-0.834**		
				(0.368)		
Constant	0.644***	0.116	0.262***	0.700**	-0.0459	0.262***
	(0.226)	(0.149)	(0.0637)	(0.261)	(0.148)	(0.0637)
Observations	133	133	133	126	126	126
R-squared	0.470	0.184	0.038	0.445	0.193	0.030

Note: In the leftmost column, “type=1”, “type=2” and “type=3” indicate older, less-educated non-target; younger; and older more-educated non-target siblings, and “target=1” does target siblings. For standard errors, the linearized variance estimation is used with comarcas being clusters(Cameron and Trivedi (2005), p.843; Pendergast et al. (1996);Wooldridge (2010))
Standard errors in parentheses. *** $p < 0.01, **p < 0.05, *p < 0.1$

Table 2.16: Regression of Supply-side Effects in Enrollment: Probit

VARIABLES	(7) Enroll (Probit) 0 and 1	(8) Enroll (Probit) 0 and 1	(9) Enroll (Probit) 0 and 1	(10) Enroll (Probit) 0 and 2	(11) Enroll (Probit) 0 and 2	(12) Enroll (Probit) 0 and 2
treat=1*type=1	-8.727***	-0.772**	-0.415	-7.175***	-0.639*	-0.415
	(1.106)	(0.352)	(0.309)	(1.352)	(0.362)	(0.309)
year=1*type=1	0.506	0.373	0.362	-0.183	0.0182	0.174
	(0.590)	(0.404)	(0.358)	(0.463)	(0.295)	(0.230)
treat=1*year=1*type=1	0.853	0.233	0.156	2.276**	1.070**	0.448
	(0.772)	(0.571)	(0.500)	(0.928)	(0.502)	(0.458)
Coffee cropped comarca in y1	-2.364	-0.0714		-4.034***	-0.126	
	(1.994)	(0.287)		(1.121)	(0.269)	
Age=14	2.670***	1.127***		1.846***	1.271***	
	(0.714)	(0.269)		(0.551)	(0.330)	
Age=15	1.343**	0.274		1.062	0.732	
	(0.619)	(0.293)		(0.850)	(0.447)	
2nd quintile of pc exp in y0	0.633	0.610		0.864	0.843*	
	(0.951)	(0.433)		(1.119)	(0.451)	
3rd quintile of pc exp in y0	1.779*	0.148		1.597*	0.0860	
	(1.023)	(0.418)		(0.839)	(0.464)	
4th quintile of pc exp in y0	0.735	-0.0749		1.593*	0.466	
	(1.309)	(0.414)		(0.853)	(0.381)	
Richest quintile of pc exp in y0	0.192	0.333		1.311*	0.986**	
	(0.849)	(0.409)		(0.733)	(0.396)	
boy	-0.0323	0.307		0.0470	0.284	
	(0.739)	(0.365)		(0.622)	(0.345)	
1 if have an infant (1-5 yr)	-0.0537	-0.244		0.576	0.181	
	(0.451)	(0.310)		(0.646)	(0.258)	
1 if Parents completed	0.547	0.0583		0.243	0.0352	
at least 1st grade of primary	(0.574)	(0.264)		(0.648)	(0.270)	
comarca==El Kilan						
comarca==El Mojon						
comarca==Las Chilcas	-4.374***			-3.724**		
	(1.441)			(1.553)		
comarca==Verapaz	-6.138***					
	(1.151)					
comarca==Chaguite Grande	1.560			1.977**		
	(1.175)			(0.874)		
comarca==La Esperanza						
comarca==Salamasi						
comarca==Hato La Virgen						
comarca==La Avellana	-8.282***					
	(1.108)					
comarca==Las Calabazas	-6.735***			-4.302***		
	(1.348)			(1.415)		
comarca==Las Pencas						
comarca==Llanos de Tamalapa	-6.036***			-5.708***		
	(1.458)			(1.384)		
comarca==Pangual						
comarca==Puertas Viejas						
comarca==San Juanillo	3.285**			0.718		
	(1.567)			(1.084)		
comarca==Totumbla	-6.639***			-5.863***		

	(0.588)			(1.044)		
comarca==Aguas Amarillas	2.506					
	(1.548)					
comarca==Bull Bull Arriba	3.910***			5.744***		
	(0.931)			(1.091)		
comarca==Cuatro Esquinas	-4.027**			-1.249		
	(1.431)			(1.698)		
comarca==El Castillo	3.597***					
	(1.252)					
comarca==El Granadillo	1.652					
	(1.227)					
comarca==El Guapotal				3.406***		
				(1.115)		
comarca==La Tronca	3.209**			4.807***		
	(1.168)			(0.965)		
comarca==Quililito	-2.896*			-1.825		
	(1.532)			(1.787)		
comarca==Quililon	-3.825**			-1.265		
	(1.454)			(1.900)		
comarca==Tayule						
comarca==Wasaka						
comarca==Wasaka Arriba						
comarca==Yasica Norte	-3.933**					
	(1.695)					
comarca==Cerro El Padre	3.544***			5.194***		
	(1.224)			(1.231)		
comarca==Cumaica						
comarca==El Bacocan				-1.463		
				(2.114)		
comarca==Montana Grande						
comarca==Ocotillo						
comarca==Bull Bull						
Constant	3.769**	-1.311**	-0.637***	2.756*	-1.996***	-0.637***
	(1.645)	(0.548)	(0.196)	(1.483)	(0.617)	(0.196)
Observations	93	133	133	72	126	126

Note: In the leftmost column, "type=1", "type=2" and "type=3" indicate older, less-educated non-target; younger; and older more-educated non-target siblings, and "target=1" does target siblings. For standard errors, the linearized variance estimation is used with comarcas being clusters(Cameron and Trivedi (2005), p.843; Pendergast et al. (1996);Wooldridge (2010))
Standard errors in parentheses. *** $p < 0.01$, $** p < 0.05$, $* p < 0.1$

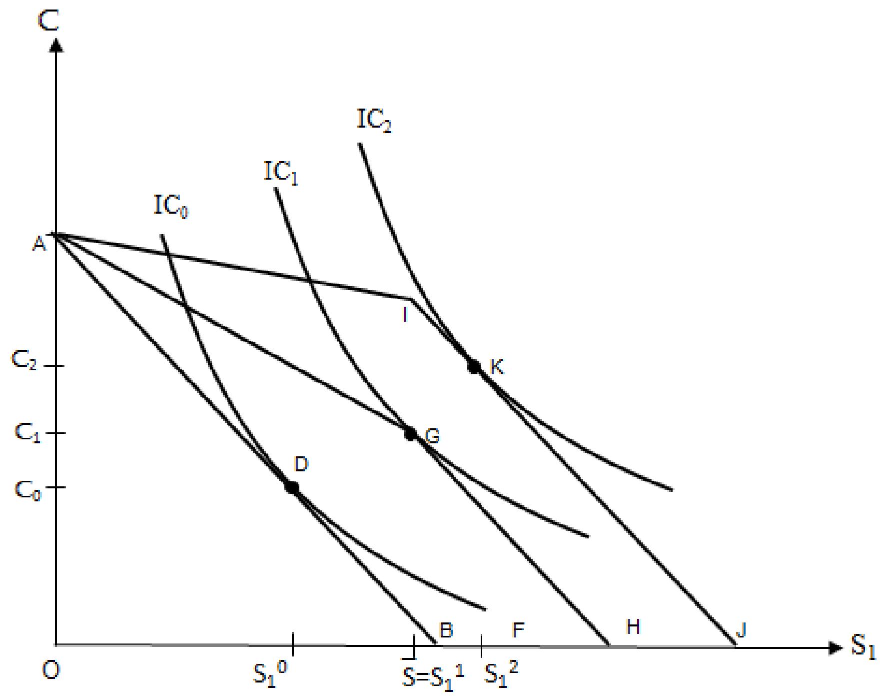


Figure 2.1: Budget Constraint and Allocations with and without Program

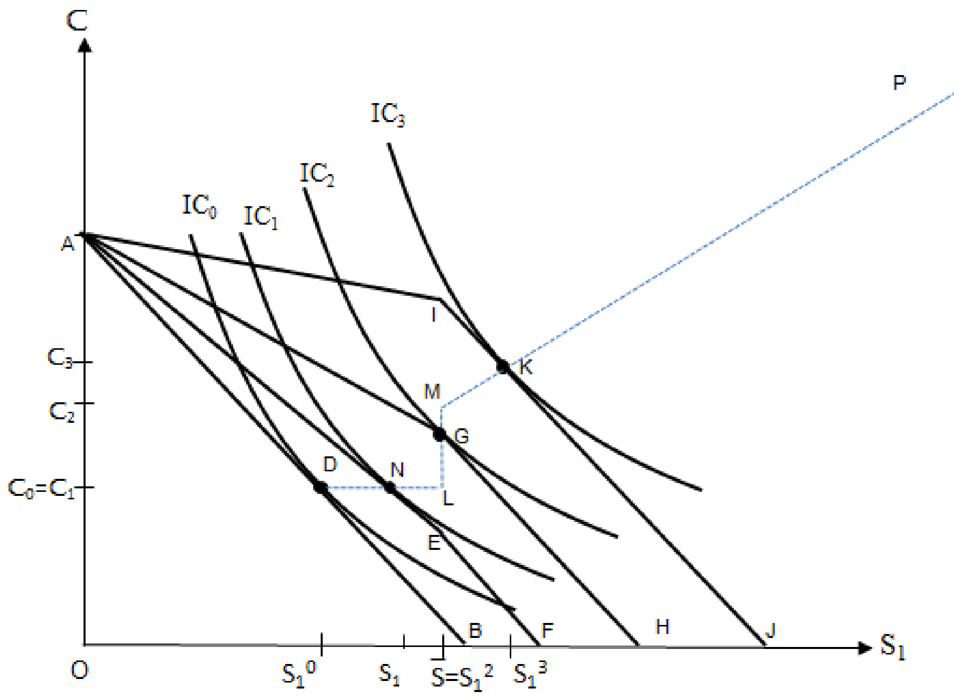


Figure 2.2: Budget Constraint and Allocations with and without Program - Cobb-Douglas Utility Function

Chapter 3

Impacts of the Global Food Price Crisis on Household Welfare and Poverty in Lao PDR

3.1 Introduction

Food prices are an important economic issue in any country, and are especially important in developing countries, since those countries have more poor households, which tend to spend a relatively large proportion of their incomes on food consumption and often production of food crops. FAO data show that international crop prices displayed extremely high price increases during the food price crisis that occurred from 2007 to 2008. From January, 2007 to their peak in 2008, international commodity prices increased about three-fold for rice, about two and a half times for wheat and two-fold for soybeans and maize (Piesse and Thirtle (2009)). These international commodity price increases are steeper than the increases that occurred in domestic markets, but domestic commodity prices also rose in many developing countries during this period. For example, in Vietnam, the consumer price of staple foods (mostly rice) increased by 15 percent in 2007 and 78 percent in 2008 (Vu and Glewwe (2011)). In Cambodia, the consumer price of rice doubled from 2007 to 2008 (Vu and Glewwe (2009)). In Thailand, the wholesale price of rice increased by 88 percent from 2007 to 2008 (Timmer (2010)).

The impact of the increase in rice prices on Southeast Asian countries has been documented in several studies. Ivanic and Martin (2008a) estimated the impact of the global food price increases from 2005 to 2007 on poverty rates in nine developing countries. They estimate that the poverty rate increased by 1.4 percentage points in Cambodia as a whole, and by 1.4 and 1.2 percentage points in rural and urban areas, respectively. In addition, the poverty rate decreased by 1.4 and 1.9 percentage points in Vietnam as a whole and rural Vietnam, respectively, but increased by 0.3 percentage points in urban Vietnam. In contrast to Ivanic and Martin (2008a), who used the growth rates in international food prices from 2005 to 2007, Vu and Glewwe (2009, 2011) used the domestic rice price changes from 2007 to September 2008 in Vietnam and cereal price changes in 2008 in Cambodia (an 88 percent increase) to estimate changes in welfare and poverty rates in those two countries. Their Vietnam study found that, on average, household welfare, as measured by household expenditures, increased by 5 percent, but they also found that the poverty rate increased by 0.3 percentage points. Household welfare increased by 7.6 percent and decreased by 2.8 percent in rural and urban areas, respectively, and the poverty rates decreased by 0.1 percentage points and increased by 1.3 percentage points in rural and urban areas, respectively. For Cambodia, they found that household welfare increased by 4 and 6 percent in Cambodia as a whole and rural Cambodia, respectively, and decreased by about 4 percent in urban areas. The poverty rates decreased by 0.3 percentage points in Cambodia as a whole, and by 0.9

percentage points in rural areas, but increased by about 1 percent in urban areas. These examples in Southeast Asian countries indicate that higher rice or cereal prices increase households' welfare to some extent, but the impact on poverty is not very large, and that the impacts on household welfare and poverty differ considerably between urban and rural areas.

When compared to analyses in neighboring countries, investigation of the impact of the food price crisis in Laos requires additional attention. First, Laos consumes and produces two varieties of rice: glutinous (sticky) and ordinary (non-glutinous) rice. Laos is atypical in that glutinous rice is the main staple, while ordinary rice is predominately consumed, and traded internationally, in the rest of Southeast Asia. The traded volume of glutinous rice is less than one percent in the world's trade in rice (Childs and Burdett (2000)), so it is hard even to find international prices for glutinous rice. One available approximation of international prices for glutinous rice is export prices in Thailand; the price of glutinous rice increased by 47 percent from January to September in 2008, while the price decreased by 8 percent for the two year period from January 2007 to December 2008 (TREA (2011)), as shown in Figure 3.4. The price growth in glutinous rice is not as high as that for ordinary rice, but the Thai export glutinous rice prices indicate a potential price increase in glutinous rice, which could have a large impact on household welfare and poverty in Laos. Therefore, since Laos has a unique pattern in crop consumption and production, it should merit particular attention when studying the impact of the food price crisis in 2008.

The causes of this food price crisis have been analyzed by Piesse and Thirtle (2009) and Timmer (2010). The fear of food price increases still persists because of the prospect of higher demand for grains from rapidly growing developing countries with large populations, such as China and India, and increasing demand of grain for bio-fuel production. Indeed, this fear is rapidly becoming a reality again; in March 2011, the World Bank's food price index was 36% above its level a year earlier and close to its 2008 peak (World Bank (2011)). That World Bank report estimated an additional 44 million more poor in low- and middle income countries due to the rise in food prices since June 2010.

In Laos, World Bank (2009) discussed the impact of the food price crisis in 2008 by presenting the percentages of households that buy rice, that consume own produced rice, and that sell rice in each household category, using data collected in 2007/08. It concluded that urban households are the most affected by a price increase, and that the urban poor should be provided with some support if the price continued to increase. One problem with this method is that it does not look at the percentages of *net* buyers and sellers, and *these* percentages will identify the real victims and beneficiaries, not the overall percentages of (gross) buyers and sellers. In addition, it is not possible to measure the *sizes* of the impact which is measured by household expenditures, using the simple analytical method in World Bank (2009). This paper overcomes the aforementioned issues and thus provides more insights into the possibility of a food price crisis in the future in Laos.

Though Laos has enjoyed significant economic growth in recent years (almost a five percent annual growth rate in real per capita GDP growth rate from 2005 to 2009), the role of the agricultural sector is still important. Although the current figure is almost certainly lower, 85 percent of the labor force was employed in agriculture in 1995 (World Bank (2010)). Laos is a land-locked country, as seen in Figure 3.1. The low level of integration of the domestic agricultural market due to a poor road network in rural areas, no national railroad systems and low population density, has been recognized as barriers to be overcome for agricultural development. In addition, the poor population is concentrated in rural areas; therefore, agricultural development is very important for Laos. In this context, analysis of the impact of global food price crises is important.

The rest of this chapter is organized as follows: Section 3.2 presents changes in consumer prices for two kinds of rice in Laos during the food price crisis, and the method to estimate the growth rates of producer prices. Section 3.3 presents the method used to estimate the impacts of a food price increase on household welfare and poverty, and describes the data used. Section 3.4 describes poverty in Laos and the patterns of consumption and production of two kinds of rice. Section 3.5 presents the results of the simulations using two hypothetical scenarios, and the actual price changes that occurred in 2008, in order to examine the impact of changing rice prices on household welfare, as measure by household expenditure, and on poverty. Section 3.6 summarizes the results and provides several conclusions.

3.2 Consumer and Producer Price Changes in Laos during the Food Crisis

This section describes the changes in consumer prices for rice in Laos, and explains the method used to estimate producer prices. Both types of price changes must be consired to obtain the changes in household welfare and in poverty. Table 3.1 shows the yearly growth rates for the consumer prices of glutinous and ordinary rice in Laos in 2006, 2007 and 2008. Vientiane province (including the Vientiane Capital) is in the Central region in the CPI statistics.[1] As seen in the table, the growth rate of the ordinary rice CPI for the entire country in 2008 (22.9 percent) was much higher than those in 2006 and 2007 (1.4 and 7.0 percent, respectively). The growth rate in the North region did not jump by as much as it did in the Central and South regions. The growth rates in 2008 in the Central and South regions are 29.3 and 20.3 percent, respectively, so the timing of these price increases corresponds to the price spike in international rice prices in 2008 (Asian Development Bank (2008), p.1). For Laos as a whole, the table also shows the growth rate of the price indices for food and non-food items. From 2006 to 2008, the prices of food and non-food commodities were stable, and the just-mentioned higher growth rates for glutinous and ordinary rice were much higher than the growth rates of the food and non-food price indices. Finally, note that although the increase in the price of ordinary rice in 2008 was much higher than in the previous two years, that growth rate was much smaller than the corresponding rate for the international market (as seen in Figure 3.3).

[1] As seen in Figure 3.2 (the map of four regions), Laos' 17 provinces can be aggregated into one province (Vientiane) and three regions (North, Central and South).

Compared with the high CPI growth rates in the price of ordinary rice, the growth rates of glutinous rice prices were much lower in 2008. This reflects the unusually high yields in glutinous rice in 2008.[2] The annual growth rates of glutinous rice prices in 2008 were 7.8 percent, 12.1 percent and 5.9 percent in the North, Central and South regions, respectively, as seen in Table 3.1. These growth rates were much lower than those in 2006 and 2007 in the Central and South regions, and than that in 2006 in the North. In spite of these smaller growth rates, the impact on household welfare and poverty could be large because of the importance of glutinous rice as both a consumption good and an income source in Laos, as described below.

Unfortunately, unlike the CPI data, the producer price index (PPI) data, which are based on a survey of farm-gate prices, are not collected regularly and are not published by the government of Laos.[3] Although one way to obtain a PPI is to borrow data from a neighbor country that is similar to Laos, this study uses the village-level farm-gate prices of glutinous and ordinary rice that were collected in the (nationally representative) Lao Expenditure and Consumption Surveys that were collected in 2002/03 and 2007/08. Assuming a strong correlation between consumer and producer prices, the percentage change of the PPI with a one percentage increase in the CPI is called the elasticity of the PPI with respect to the CPI. The following formula is used to calculate that elasticity:

$$\frac{d\ln(P_{P_i})}{d\ln(P_{C_i})} = \frac{\ln(\text{Farm-gate price for rice in } 07/08) - \ln(\text{Farm-gate price for rice in } 02/03)}{\ln(\textit{Food CPI in } 07/08) - \ln(\textit{Food CPI in } 02/03)}$$

[2] The slower growth rate in the price of glutinous rice in 2008 is considered to be due to supply-side factors. The most direct evidence to support this hypothesis is that the per capita production was much higher in 2008 (and 2009) than in 2006 and 2007 (445 kg/person in 2006 and 2007, 477 and 498 kg/person in 2008 and 2009, respectively). The growth rates of per capita production were 1.9, -0.1, 5.9 and 5.3 percent in 2006 to 2009, respectively. (See FAO (2010) for production, World Bank (2010) for population). Evidence to support the hypothesis that the slower price growth rate in 2008 is due to demand-side factors cannot be found in literature.

[3] Monthly farm-gate price data are available from the Ministry of Industry and Commerce, but this survey is not nationally representative, and those data are not used in this study.

The means over households of this elasticity are calculated for 11 sub-regions from 2002/03 to 2007/08. The elasticities are shown in the third and fourth columns of Table 3.2. As a result, the estimated PPI growth rates can be calculated as in the fifth and sixth columns of the table. For both types of rice, the numbers are very different across regions except for those between the Vientiane province and the rest of the Central region.

Although a different analysis is necessary in order to determine why this difference happens, this regional difference in the growth rates of the CPI and the PPI is not surprising since the lack of integration in agricultural markets in Laos has been documented in World Bank (2006) and in a slightly older analysis by Takamatsu (2002). The pattern that the growth rates of the CPI and the estimated PPI are very different except for between Vientiane province and the Central region, supports the findings that the rice markets in Vientiane province and the Central region are more integrated, and that the markets in the North and South regions are separated from each other and from Vientiane and the Central region.

Another plausible conjecture is that different regions are affected by different international markets. For example, since the border in the North region is with China, Vietnam and Myanmar, the influence of the agricultural markets in these countries on the North region can be stronger than that from the other parts of Laos as seen in Figure 3.1.[4] The Central region including Vientiane province, and the South region are more affected

[4] For some districts in the North region, the distance to Hanoi in Vietnam and southern large cities in China is less than that to the Vientiane.

by the agricultural markets in northern Thailand because the border of these areas faces Thailand.

An additional factor which is likely to explain the different patterns in regional price differences is the patterns in rice production (and demand). The Central region including Vientiane is the rice-surplus region, so rice from the Central region is distributed to the rice-deficit North and South regions. It is possible that the producer price is more responsive to a consumer price increase in those locations, where the demand for rice is both high and often not satisfied. As seen in Tables 3.3 and 3.4, the values of net production (=value produced – value consumed) of glutinous and ordinary rice are negative in the North and South regions. Thus, this study makes additional simulations using the estimated PPI given high regional variability in Laos.

Finally, the producer prices for rice could be influenced by the activities of the State Food Enterprise (SFE). "The SFE procures rice during harvest for government staff and sells rice stocks during rice shortages. … [T]he SFE is responsible for operating food procurement from farmers and traders in the central and Southern provinces in order to stabilize prices" (p.12 in Engvall et al. (2009)).

A variety of factors can be considered as to why the estimated PPI growth rates are different across regions. Identifying the true reason(s) is not the purpose of this study, but the important implication of this section for this study is that one should consider the possibility of different growth rates for increases in producer and consumer prices.

3.3 Methods and Data

3.3.1 Measurement of Welfare Change

The methodologies used by previous studies to estimate the impacts of a food price increase on poverty and welfare have varied according to the specific interests of these studies, the data available, and the types of impacts that were studied. For example, computable general equilibrium (CGE) analysis, such as the Global Trade Analysis Project (GTAP) model, considers many possible routes for the impact of a food price change. However, since CGE analysis alone has difficulties in analyzing the detailed distribution within a country, a more detailed prediction is made by others using information from individual households collected by nationally representative household surveys (Bourguignon et al. (2008); Chen and Ravallion (2004)).

To analyze the distribution of the impact of a price increase, only a household survey is necessary. Following the approach in Deaton (1989), the indirect utility function for an agricultural household h is defined by:

$$U_h = \varphi\left(\boldsymbol{P_c}, wT + b + \pi(\boldsymbol{P_p}, v, w)\right) \tag{3.1}$$

where the first argument, $\boldsymbol{P_c}$, is the vector of consumer or sales prices of food and non-food items, and the second argument is the full income of this household. In the expression for full income, w is the wage rate, T is the time endowment of the household, b is non-labor income, and π is the profit function for cultivation of agricultural products. The profit function is a function of the vector of: producer (farm-gate) prices, $\boldsymbol{P_p}$; fixed factors (such as land, management skills and any quasi-fixed inputs) that are used for the household farm production but not traded in the market,

v; and the wage rate, w. This specification is common for agricultural household models (Singh et al. (1986); Bardhan and Udry (1999))

The indirect utility function shows how the household's utility changes in response to changes in the prices of consumption goods, $\boldsymbol{P_c}$, producer prices, $\boldsymbol{P_p}$, and, possibly, the wage rate, w. One could assume that, the percentage change in the consumer price for one item equals the percentage change in the producer price for that item, and that the wage rate does not change with a price change of consumer items. These assumptions can be expressed as follows for good i:

$$\frac{\mathrm{d}\ln \mathrm{p_{pi}}}{\mathrm{d}\ln \mathrm{p_{ci}}} = 1, \frac{\mathrm{dw}}{\mathrm{dp_{ci}}} = 0,\ \forall i, \qquad (3.2)$$

Given this relationship between producer prices and the wage rate, on one hand, and changes in the consumer price, on the other hand, the marginal change in the indirect utility function in Equation (3.1) is from the first and second arguments of the function[5]. Changes in utility can be expressed in money terms using the expenditure function, e, and the profit function, π. If the price of an item increases, a household that is a net consumer of this item will decrease its consumption of that item and lose utility, while a household that is a net producer of this item increases its profit and thereby leads to an increase in utility. If a household both consumes and produces the item, then the net gain or loss of utility can be calculated conceptually. A useful measurement of a welfare change from such a price increase is the amount of money the household must receive, or give up, in order to stay at the same level of utility as before the price change. One can call this amount of money, dB_h, which implies that:

[5] Ivanic and Martin (2008) use a more general assumption that $\frac{\mathrm{dw}}{\mathrm{dp_{ci}}} \neq 0,\ \forall i,$. Their study estimates $\frac{\mathrm{dw}}{\mathrm{dp_{ci}}}$ using the GTAP model.

$$MMU_{new} + dB_h = MMU_{old} \tag{3.3}$$

$$\text{and; thus, } - dB_h = MMU_{new} - MMU_{old}, \tag{3.4}$$

Where MMU_{old} and MMU_{new} represent the money metric utilities before and after the price change, respectively. The first line defines dB_h, and the second line indicates that the negative of the change of B_h is the money metric measure of the change in utility.

The monetary value of the welfare change ($-dB_h$) equals the increased profits through higher prices from its agricultural production, π, minus the monetary value of its utility loss because of an increase in the consumer price. The monetary value of its utility loss is expressed by the expenditure function, $e(\boldsymbol{P_c}, w, u_h)$ where u_h is the utility in (3.1). The negative of this monetary value of the welfare change from a change in the consumer price of good i is given by:

$$dB_{hi} = (e_{P_c} - \pi_{P_p} \frac{dP_{pi}}{dP_{ci}}) \, dP_{ci}, \tag{3.5}$$

$$= (q_i - y_i \frac{dP_{pi}}{dP_{ci}}) dP_{ci} \tag{3.6}$$

In the first term, e_{P_c} is the first derivative of the expenditure function with respect to consumer prices, P_c, and π_{P_p} is the first derivative of the profit function with respect to produce prices, P_p. To obtain (3.6) from (3.5), Shephard's and Hotelling's lemmas are used, so the first derivative of the expenditure function equals the quantity demanded, q_i, and the first derivative of the profit function equals the output, y_i.[6]

[6] This quantity includes both the quantity sold and consumed by the household since, in agricultural models, the consumption which is produced by the household is considered as a sale to itself (Taylor and Adelman (2003)).

Dividing the monetary value of the welfare change by the total expenditure, X_h, which includes the value of consumption from own production, yields:

$$\frac{dB_{hi}}{X_h} = (\frac{q_i}{X_h} - \frac{y_i}{X_h}\frac{dP_{pi}}{dP_{ci}})\, dP_{ci}. \tag{3.7}$$

$$= \left(\frac{P_{ci}q_i}{X_h} - \frac{y_i}{X_h}\frac{P_{ci}\,P_{pi}\,dlnP_{pi}}{P_{ci}\,dln\,P_{ci}}\right) dlnP_{ci} \tag{3.8}$$

$$= \left(\frac{P_{ci}q_i}{X_h} - \frac{P_{pi}y_i}{X_h}\frac{dlnP_{pi}}{d\,ln\,P_{ci}}\right) dlnP_{ci} \tag{3.9}$$

$$= \left(\frac{P_{ci}q_i}{X_h} - \frac{P_{pi}y_i}{X_h}\right) dlnP_{ci} \tag{3.10}$$

The first equality in Assumption (3.2) is used to derive (3.10). In this equation, the first term in the parentheses is the weight (share) of the expenditure of good i in total household expenditures, and the second term is the value of agricultural sales and consumption from own-production i over the expenditure for household h. This formula was used by Deaton (1989) to estimate the change in welfare due to a price change. Since (3.10) is the welfare change due to the consumer price change of one item, the total welfare change for household h is obtained by summing over all items: $\frac{dB_h}{X_h} = \sum_{i=1}^{N}\frac{dB_{hi}}{X_h}$. The money metric welfare change in the country is obtained by summing this over all households.

The formula for the welfare change in (3.10) can be rewritten more explicitly as:

$$\frac{dB_{hi}}{X_h} = \left(\frac{P_{ci}q_i^p + P_{ci}q_i^o}{X_h} - \frac{P_{pi}y_i^s + P_{pi}y_i^o}{X_h}\right) dlnP_{ci}\ . \tag{3.11}$$

The total quantity of item i consumed (q_i) can be divided into the purchased (q_i^p) and the own-produced (q_i^o) amount such that $q_i = q_i^p + q_i^o$. The quantity produced (y_i) of item i can be divided into quantity for sales (y_i^s) and quantity consumed (y_i^o) such that $y^i = y_i^s + y_i^o$. $P_{ci}q_i^p$ and $P_{ci}q_i^o$ are the values of consumption from purchase and own-production, respectively. $P_{pi}y_i^s$ and $P_{pi}y_i^o$ are the values of production for sales and for own-consumption. Since $P_{ci}q_i^o = P_{pi}y_i^o$, it follows that:

$$\frac{dB_{hi}}{X_h} = \left(\frac{P_{ci}\, q_i^p}{X_h} - \frac{P_{pi}\, y_i^s}{X_h}\right) dlnP_{ci}\,. \qquad (3.12)$$

This is the formula of the welfare change used in Vu and Glewwe (2009, 2011) and de Janvry and Sadoulet (2010). This formula is different from (3.11) since it does not take into consideration the consumption and production which are not traded in a market. This approach is valid if agricultural markets work perfectly.

As shown above, Equation (3.11) equals (3.12) if $P_{ci}q_i^o = P_{pi}y_i^o$. Both (3.11) and (3.12) implicitly assume that the price change in a consumer price (P_{ci}) is perfectly transmitted to the markets where the households reside and that they can buy or sell their food items without restraint. Under this assumption, it is contradictory for the equality not to hold, which implies an imperfect agricultural market. Under competitive wholesale and retail markets, the equality should hold in equilibrium according to the following argument: If the equality does not hold, households have an incentive to change the volumes of sales and purchase and make more profit by selling or purchasing more or less of the item.

But it is not very plausible to claim that the above situation is found in Laos. One reason is that the role of the SFE in the rice market as explained in Section 3.2. (See p.87.) Also, the low provision and maintenance of transportation in rural areas have been an important constraint on agricultural development in Laos. However, at the same time, it is also extreme to claim that the government controls everything in the rice market, since the capacity of the government in Laos is limited. In addition, it is pointed out that the capacity of the SFE in Laos is weak (World Bank (2006)). Therefore, Equation (3.12) will be used hereafter in this study.

Another reason from the empirical point of view for using Equation (3.12) is that the trustworthy values of the consumption from own production and production for own consumption are not available. In Laos, a very large portion of households does not sell rice but consumes rice (in 2007/08, 25 and 13 percent of households sold glutinous and ordinary rice, respectively, while 90 and 26 percent of them consumed rice). In the survey, the values of the consumption from own production were evaluated by households with enumerators' help, and the values of the production for own consumption require approximate sale prices such as farm-gate prices for neighboring households.

Households whose values of sales of an item are larger than those of purchases of the item are called net sellers. By contrast, households whose values of sales of an item are smaller than those of purchases of the item are called net buyers (net purchasers). According to Equation (3.12), welfare of net sellers increases and that of net buyers decreases with a price increase. The fractions of net sellers and buyers represent the distribution of winners and losers from a price increase.

A so-called second-order effect of the welfare change due to a price change is not considered in this study. The second-order effect is the change in welfare which comes from the changes in the quantity demanded and the quantity produced due to a price change (Minot and Goletti (2000); Friedman and Levinsohn (2002); de Janvry and Sadoulet (2010); Vu and Glewwe (2011)). In these studies, the second-order effects, that is the price elasticities of demand and supply, are used. The two kinds of elasticities can be taken from conventional values as in de Janvry and Sadoulet (2010) or be estimated as in Vu and Glewwe (2011), Minot and Goletti (2000) and Friedman and Levinsohn (2002)).

To the best of my knowledge, the two elasticities in Laos are not available in previous studies.[7] As explained in Ivanic and Martin (2008a), the bias from not including the second-order effect should be small. Also, the price elasticity of demand should be small since rice is a staple food. Also, given the short-lived price shock, the elasticity of supply is not large since the adjustment from a price change tends to take time and so is likely to be small. For example, in Vu and Glewwe (2011), the sizes of welfare changes using the second-order effect using the price elasticity of demand are almost the same as those not using it.

[7] One possible source is the elasticities of demand used in the GTAP database (Badri and Walmsley (2008)), but the quality of these numbers is unclear, and so should be treated with caution.

3.3.2 Change in Poverty due to Change in Household Welfare

The methods used to obtain the change of poverty due to a price increase can be categorized into three types. The first type adjusts poverty lines to measure a short-term impact given the distribution of household expenditure or income. The change of poverty lines reflects the change of the purchasing power of poor and non-poor households. This approach considers only the impact on households in their roles as consumers (Dessus et al. (2008)). On the other hand, two other approaches consider the impact through an *income* change due to a change in food prices in addition to the effect as consumers. The first of these methods calculates the welfare change due to the price change using the equivalent variation, [8] while the second calculates the income change and the resulting welfare change (de Janvry and Sadoulet (2010)). The second and third methods are essentially the same since the second method quantifies the loss of utility due to a price increase and changes expenditures corresponding to the loss, and the third quantifies the loss of utility by adjusting poverty lines. Therefore, the loss of utility with a price increase yields a decrease in expenditures in the second method and higher poverty lines in the third method. Since the two approaches gives similar results, the second method is used in this study.

As in Vu and Glewwe (2009, 2011), new and old expenditure are related as follows:

---

[8] Both the equivalent variation (EV) and compensating variation (CV) measure the change in welfare due to a price change. EV can be thought as the dollar amount that a consumer would be indifferent about accepting in lieu of the price change. On the other hand, CV measures the compensation with which the consumer receives after it occurs (Mas-Colell, Whinston, et al (1995), p.82). The method used in this study measure EV since the new welfare and old welfare are measured with old prices rather than new prices.

$$X_h^{new} = X_h^{old} - dB_h \ . \tag{3.13}$$

As mentioned above, this welfare change is equivalent to a pre-paid cash transfer a household receives (or loses) to compensate for the future welfare loss (or gain) due to the price change as specified in (3.4). With a new level of household expenditure, the poverty under the new set of prices is defined by:

$$HC_h^{new} = \begin{Bmatrix} 1 & if & X_h^{new} < Z^{old} \\ 0 & if & X_h^{new} \geq Z^{old} \end{Bmatrix} \tag{3.14}$$

Note that poverty lines, Z^{old}, are not adjusted with the price change since the welfare change is measured using the equivalent variation, which uses the prices before the change.

3.3.3 Change in Growth Rates of PPI and CPI

Thus far, it is assumed that the growth rates of consumer prices are equal to those of producer prices, as in the first equation in Assumption (3.2). In order to consider the case in which this assumption does not hold, another formula to calculate welfare changes is introduced. Without this assumption, the formula to measure the welfare changes is obtained from (3.9):

$$\frac{dB_{hi}}{X_h} = \left(\frac{P_{ci}\, q_i^p}{X_h} - \frac{P_{pi}\, y_i^s}{X_h} \ \frac{dlnP_{pi}}{d\ ln\ P_{ci}} \right) dlnP_{ci} \ . \tag{3.15}$$

This formula implies that the extent to which net consumer households lose their welfare from a price increase, and net seller households gain from a price increase, must take into account the relationship between producer price changes and consumer price changes.

The term $\frac{d\ln(P_{P_i})}{d\ln(P_{C_i})}$ represents the percent change in the PPI that corresponds to a one percent change in the CPI, which is called the elasticity of PPI with CPI in this study. Note that this study does not claim that the change of CPI causes that of PPI, rather the relationship above is considered to be a correlation.

3.3.4 Data

In order to assess the impact of the sharp rice price increases on household welfare and poverty in Laos, this study mainly uses data from the 2007-2008 Lao Expenditure and Consumption Study (LECS), which was conducted from April, 2007 to March, 2008. The LECS is a nationally representative household survey with detailed data on household consumption, agricultural and economic activity, and on household and individual characteristics. The survey covered 8,926 households, of which 6,232 lived in rural areas and 2,064 lived in urban areas. The price data used in this study are from two sources: a monthly consumer price index which is collected by the Department of Statistics in Laos for three regions: the North, Central, and South regions; and a village level survey that collected, among other things, paddy rice prices for the LECS in 2002/03 and 2007/08.

The consumption and production data were collected at the household level in the LECS survey. The consumption from purchase and own production was recorded in diaries for thirty days. The values of households' consumption were recorded by households using daily diaries, and when households found it difficult to record the value of consumption, the enumerators helped them to fill in the values by providing a price per unit in the nearest market according to the instruction of the questionnaires. For the production data, the harvested volumes (in kg) of crops were recorded for both agricultural seasons (wet and dry). The harvested volumes of two kinds of paddy rice were transformed to the values using the farm-gate paddy prices which were collected from each village in the 2007/08 LECS, since the household data indicate that only 24 percent and 5 percent of households sold glutinous and ordinary rice, respectively. The sales values of crops were recorded only for the most recent agricultural season, so the sales values were recorded in either of the two agricultural seasons even though some households cultivated rice in both seasons. The percentages of households that did this were 6.7 and 0.49 percent for glutinous and ordinary rice, respectively. To remedy this problem, the sales were doubled if rice was cropped in both seasons.[9] A final complication regarding these data is that the values of consumption from own production are estimated by either the households or the enumerators. The values of purchase are more reliable since they are based on actual transactions of money.

The survey sample design is based on the following stratification: 1. urban villages, 2. rural villages with wet season road access and 3. rural villages without wet season road access. In the analysis, 17 provinces are aggregated into one province (Vientiane) and three regions (North, Central and South). The map of these four regions is shown in Figure 3.2. In the following analysis, eight sub-regions (four regions by urban or rural

[9] The data do not allow one to identify missing seasons since the questionnaire asked only the usage of crops including sales in the last season and did not record the season. The most ideal remedy to this issue is the use of seasonal weights which reflect the difference of the sales values between the two seasons rather than simply doubling the sales in one season. But the data do not allow one to do this.

areas) are used to avoid too much detail. An analysis using 50 sub-provinces (17*3-1) might be beneficial in capturing more diverse aspects, but the sample in each province is too small to obtain reliable results. The sample sizes of eight sub-regions are found in Table 3.3.

3.4 Rice Consumption and Production in Laos

3.4.1 Poverty, Farming and Food Consumption in Laos

Table 3.3 describes the distribution of some household characteristics, including the incidence of poverty and farming, by location and by per capita expenditure quintiles in 2007/8. As seen in the table, the poverty rate in Laos is 28 percent. Poverty is higher in rural areas, especially in rural areas without road access. Across regions, the poverty rate is the highest in the North region, slightly lower in the Central region, and much lower in Vientiane and the South region. A further locational disaggregation into 11 location categories reveals that the range in poverty rates across the location categories is rather large, from 11 to 55 percent. A more detailed discussion of poverty in 2007/08 is found in Engvall et al. (2009).

In Laos, 88 percent of households are engaged in agricultural activities, which include livestock production and fishing as seen in Table 3.3.[10] In urban areas, this figure is 63 percent, while it is almost 100 percent in rural areas. The involvement in agriculture declines as household expenditure increases. This indicates that, in general, the majority of households in Laos are engaged in agricultural activity, and even in urban areas the percentage is very high. The table also shows the share of food in total expenditures. On average, 72 percent of expenditures go to food. In urban areas, the number drops to 65 percent, but it is much higher in rural areas (about 75 percent). In addition, but not surprisingly, the food share declines as expenditures increase.

[10] The numbers in the table exclude agricultural wage labor, but the LECS data also show that 76.9 percent of persons who worked last seven days engaged in agricultural activities.

3.4.2 Glutinous Rice

Glutinous rice is the most important grain and staple food in Laos. In the entire country, the value of the consumption share for glutinous rice in food consumption is 37.9 percent[11], and only 21. 6 percent of the consumption comes from purchase, as seen in Table 3.4. Not only is the importance of glutinous rice in food consumption noteworthy, but the extremely low dependency on purchases, in other words the high self-sufficiency in glutinous rice, has important implications for the impact of food price changes on household welfare. These numbers vary across regions and urban or rural areas, as indicated in the table. Regarding the share of glutinous rice expenditure in food consumption, the North, Central and South regions have much higher consumption ratios (from 39.5 to 41.3 percent) than Vientiane (21.9). In addition, rural areas have higher consumption ratios than urban areas (about 40.5 vs 27.7 percent). Rural Vientiane has a slightly lower share of glutinous rice consumption in food consumption than other rural areas.

Similarly, the fraction of glutinous rice consumption that is purchased differs across regions and between urban and rural areas. Not surprisingly, urban areas have a much higher purchase share (49.1 percent) than rural areas (about 10 percent). Across regions, Vientiane has the largest purchase share (55.9 percent), the Central and South regions have the second largest share (about 20 percent), and the North has the lowest (12.5 percent). Between rural areas with and without wet season road access, rural areas

---

[11] Since the food consumption in total expenditures is 72.3 percent, this number also indicates the importance of glutinous rice in entire expenditures.

with road access have slightly higher shares of purchase than those without road access in the North and Central regions, but this difference is not found in the South. Between regions, the share of purchase is about 75 percent in Vientiane, the South region has the second largest share (55.8 percent), the Central has the third (41.8), and the urban areas in North have a considerably lower share (31.2 percent). Rural Vientiane has a slightly lower share (24.5 percent) than that in the urban North region. Obviously, glutinous rice consumption in urban areas relies more on the market than in rural areas, but both urban and rural Vientiane have higher dependency on the market than their counterparts in the other regions.

Glutinous rice is also important as an income source. The value of glutinous rice production is 47.2 percent of agricultural production including livestock and fishing in the entire country, as shown in Table 3.4. This ratio is higher in urban areas and rural areas with road access than in rural areas without road access. Across regions, Vientiane has the largest ratio and the Central region, where rice cropping is most suited, has the second highest ratio, followed by the South and North regions. Thus, in Laos, glutinous rice is the most important grain and food item in both consumption and production.

3.4.3 Ordinary Rice

Ordinary (or non-sticky) rice is also important in consumption and production in Laos, but to a much lesser extent than glutinous rice. As seen in Table 3.5, in the entire country, 6.3 percent of the food budget (including consumption from own-production) is devoted to ordinary rice, and 58.1 percent of that consumption comes from owner-produced rice. This means that, on average, the value of ordinary rice consumption is much smaller than that of glutinous rice, and that more than half of the consumption is from own production. Compared with glutinous rice, the dependency on the market is higher for ordinary rice. Looking across regions and urban or rural areas, the percentage of total consumption devoted to ordinary rice is higher in the North region, especially, in rural areas (10.6 and 12.4 percent, respectively), compared to the national average (6.3 percent). As seen in Table 3.5, wherever the share of ordinary rice production is higher, the share of ordinary rice in food consumption is higher. For example, in the rural North region where the role of ordinary rice in consumption is larger, the production of ordinary rice is more important (10.6 percent). In general, ordinary rice has a higher market dependency than glutinous rice, but its importance in consumption and production is much lower than for glutinous rice.

3.5 Results

3.5.1 Impacts of Rice Price Increases on Household Welfare and Poverty in Laos

Four hypothetical scenarios are used to examine the impact of changing rice prices on household welfare, as measure by real household expenditure, and poverty. Scenarios (1)-(2) and (3)-(4) assume that the growth rates in the consumer prices of glutinous and ordinary rice are 20 and 40 percent, respectively. For scenarios (1) and (3), the growth rates of producer prices are assumed to be those of consumer prices. For scenarios (2) and (4), the estimated growth rates of producer prices are used as presented in Table 3.2. The changes in household welfare and poverty using scenarios (1) - (2) and (3)-(4) are shown in Tables 3.6 and 3.7, respectively. The fractions of households that are positively and negatively affected by the price changes are shown in Table 3.8.

3.5.1.1 Impacts of Increases in the Price of Glutinous Rice

Tables 3.6 and 3.7 show the results of scenarios (1) through (4) for increases in the price of glutinous rice. Comparing the figures in these four columns, the results in scenarios (1) and (3) are very close to those in scenarios (2) and (4), respectively. This is because the estimated consumer-price elasticities of producer prices are close to one for glutinous rice except for the North region, as seen in Table 3.2. Therefore, the discussion here is limited to the results from scenarios (1) and (3).

The welfare of an average household increases by 0.1 and 0.2 percent with 20 and 40 percent increases in prices of glutinous rice, respectively, which means that, on average, households are unaffected by the price increases. Urban households are negatively affected by a price increase, as one would expect, while rural households enjoy an increase in welfare, but the sizes of both of these welfare changes are not very large. With a 40 percent price increase, urban households' welfare decreases by 1.6 percent while welfare increases by 1.0 and 0.7 percent for rural households with and without road access, respectively. The directions of these welfare changes are consistent with the fact that urban areas have fewer farmers than rural areas, and non-farmers are net buyers of rice.

The negative changes in welfare for urban households do not vary by quintiles. On the other hand, the positive change in welfare for rural households is larger for richer households, and it is largest for the 4th (richest) quintile, in contrast to being close to zero for the first and second quintiles. Therefore, the size of negative welfare changes is invariant over household wealth in urban areas, but the benefit of a price increase is skewed to richer households in rural areas. As seen in Table 3.4, the value of net production tends to be larger for richer households in rural areas, while it tends to be smaller for richer households in urban areas.

The percentage decrease in welfare in urban areas due to a price increase is slightly larger for poor households than for the non-poor. On the other hand, the percentage increase in welfare in rural areas is slightly larger for non-poor households than for poor households. With a 20 (40) percent price increase, household welfare decreased by 0.7 (1.5) percent of expenditures for non-poor households and 1.1 (1.4) percent for poor households in urban areas, and in rural areas it increased by 0.6 (1.2) percent for non-poor households and 0.2 (0.3) for poor households.

As seen above, urban households are negatively affected by a price increase, but the sizes of the impact on welfare are similar among urban regions except for the urban North region. A 40 percent price increase reduces welfare by 1.8, 0.4, 1.8 and 2.5 percent of expenditure in Vientiane, the North, Central and South regions, respectively. The small decrease in the urban North region reflects its lower dependency on the purchase of glutinous rice, even in urban areas, as seen in Table 3.4.

As seen above, rural households benefit from an increase in the price of rice, but the variation in the increase in welfare across rural regions is larger than it is across urban regions. With a 40 percent price increase, welfare increases by 5.4, 0.6, 1.1 and 0.3 percent in rural Vientiane, the rural North, Central and South regions, respectively. Rural households in Vientiane have a very large benefit, and the benefit in the Central region is noticeable, albeit much smaller than that in Vientiane. These areas have higher sales since Vientiane and the Central region are more suited for rice production than the North and South regions (World Bank (2006)).[12] The increases in welfare among rural households in the North and South regions are negligible even with a 40 percent price increase.

[12] The mean produced quantities per households for glutinous rice are 3.9, 2.0, 2.8 and 2.4 ton for rural Vientiane, the rural North, Central and South regions according to LECS data.

Thus, the change in household welfare for the average Lao household due to an increase in the price of glutinous rice is neutral, while it is positive in rural areas and negative in urban areas. The sizes of the negative welfare changes for urban households do not differ very much by expenditure quintiles and regions, but the size of the positive welfare increases in rural areas display more variation, which reflects the differences in rice sales across household wealth groups and regions.

Next, consider how the poverty rate changes when the price of glutinous rice increases. The poverty rate increases by 0.3 and 0.5 percentage points, from a base of 27.6 percent, with 20 and 40 percent price increases, respectively. Although average welfare slightly increases with a price increase, the poverty rate increases as well, about only slightly. The poverty rate can increase even though household welfare increases, as shown above, since the size of the welfare gain is small and the gain was an average. As seen in Table 3.8, the fractions of net buyers and net sellers are both 23 percent. The welfare of net buyers decreases with a price increase, while that of net sellers increases with a price increase. Thus, the number of households that move out of poverty because of their increase in welfare is less than that of households that fall into poverty because of their negative welfare changes.

The percentage point changes in the poverty rate are 0.5(0.7), 0.4(0.5), -0.5 (0.1) in urban areas, rural areas with road access, rural areas without road access, respectively, with a 20 (40) percent price increase. The poverty rate increases in urban areas with a price increase, and this is consistent with the decrease in welfare. In rural areas without road access, the poverty rate decreases by 0.5 percentage points with a 20 percent price increase, but the decrease in the poverty rate disappears with a higher (40 percent) price increase. In rural areas with road access, the poverty increases due to a 20 and 40 percent price increase. The poverty rates do not decrease in rural areas since the sizes of the increase in welfare for poorer households are close to zero, as shown above.

Across the four rural regions, the poverty rate decreases only in Vientiane, but it increases very slightly in the rest of rural regions. The poverty rate decreases by 1.0 (1.8) percentage points in rural Vientiane with a 20 (40) percent price increase. In the rest of rural regions, the poverty rates increase by about 0.5 percentage points. For urban regions, the increase in the poverty rate is larger in urban Vientiane since the fraction of net buyers is 47 percent, which is much larger than that of net sellers in Vientiane, although the difference of the fractions between net buyers and sellers is smaller in the other regions, as seen in Table 3.8. In summary, the changes in poverty rates due to a price change are smaller than one percentage point except for Vientiane.

3.5.1.2 Impacts of Increases in the Price of Ordinary Rice

Tables 3.6 and 3.7 show that the sizes of welfare changes are within plus or minus 0.2 in most household groups. Only a few household groups are worth noting. With a 20 and 40 percent price increase for ordinary rice, household welfare increases by 0.3 and 0.7 percent of total expenditures in rural Vientiane, decreases by 0.2 and 0.4 in urban Vientiane, and decreases by 0.2 and 0.5 percent for the urban poor, respectively. The sizes of the change in poverty rates are also negligible in all groups. These almost negligible changes in welfare and poverty for ordinary rice are due to the small scale of sales and purchases compared to total consumption. This finding indicates that the importance of ordinary rice is very limited in Laos, which is very different from the other countries in Southeast Asia.

3.5.2 Impact of Food Price Increases in 2008

3.5.2.1 Ordinary Rice

As mentioned in Subsection 3.3.3, the growth rates of the increase in the price of ordinary rice were much higher than for the previous two years except for the North region. This corresponds to the price trend in the international (non-glutinous) rice market prices during the food price crisis of 2008, although the sizes of the growth rates are not as high as those for neighboring Southeast Asian countries. As seen in the analysis of Subsection 3.5.1.2, the impact of increases in the price of ordinary rice is expected to be very limited. Tables 3.9 and 3.10 show the percentage changes in welfare and percentage point changes of the poverty rate due to the increase in the price of ordinary rice in 2008. The results in Tables 3.9 and 3.10 are almost the same although they used different growth rates for producer prices. The sizes of the changes in welfare and poverty with the price increase are extremely small except for a few household groups. Household welfare decreased by 0.3 percent for urban poor households, rural Vientiane and the rural South region, but the sizes of decreases are almost negligible. For the change in poverty, the rate changes are no more than 0.1 percentage points in all groups.

3.5.2.2 Glutinous rice

As mentioned above, the price growth rates of glutinous rice in 2008 were much lower than for the previous two years, and this price trend does not correspond to ordinary rice price increases during the food price crisis. The analysis of a price increase for glutinous rice in Subsection 3.5.1.1 implies a larger impact from a food price increase of glutinous rice, but the modest price increase in 2008 can reduce the expected impact during the food price crisis compared to a situation of higher price growth rates.

Tables 3.9 and 3.10 show the percentage changes of welfare change and percentage point changes in poverty rates due to the increase in the price of glutinous rice in 2008 although the difference in the numbers in the two tables are negligible. As seen in the tables, the change of household welfare in the entire country is a zero percent of total expenditures, a 0.2 percent increase in two rural areas, and a 0.5 percent decrease in urban areas. The corresponding changes in the poverty rates are less than one percentage point. For the other household categories, the sizes of the changes in welfare and poverty are less than one percent in all of the groups, so one cannot find noticeable changes in contrast to the findings in Subsection 3.5.1.1. After all, with the lower growth rates of prices in 2008, the impacts of the increases in prices of glutinous rice on welfare and poverty were negligible.

3.6 Conclusions

This chapter has studied the impacts of increases in the prices of two kinds of rice, glutinous and ordinary rice, in Laos. First, the potential impacts on household welfare and poverty were estimated using two different assumptions on size of the increases. Then, the impacts of the actual rice price increases that occurred in 2008 were examined. As seen above, the impact of increases in the price of ordinary rice, the price of which was strongly affected by the food price crisis in 2007-2008, was negligible. This is mainly because the role of ordinary rice in sales and purchases is not as significant in Laos as it is in other Southeast Asian countries. As mentioned above, the staple in Laos is not ordinary rice but glutinous rice.

The estimated effects of the growth rates of glutinous rice prices were not significant, mostly because the price increase in glutinous rice in 2008 was not as large as that of ordinary rice and of those of glutinous rice in the previous years. As discussed in the simulated price increases, if the price increase of glutinous rice had been higher than its actual growth rate in 2008, the changes in household welfare and poverty would not have been negligible.

This paper's contribution is that it shows that the possible impact to household welfare and poverty would not have been large if the price of glutinous rice had been much higher than was observed in 2008. The dependency on the market in Laos is still low on average, so an impact from the outside shock can be absorbed by consumption from internal production. As seen above, the changes in household welfare for the entire

Lao households are neutral, but are positive in rural areas to a price change of glutinous rice, but are negative in urban areas. The sizes of the negative welfare change for urban households do not change very much by expenditure quintiles and regions, but the size of the positive welfare increases in rural areas are concentrated in Vientiane and the Central region with more wealthy households. The resulting increase in the poverty rates with a high price growth rate of glutinous rice (a 40 percent) is less than about 0.5 percent except for Vientiane, where the poverty rates increase by 1.3 percentage points in urban areas and decrease by 1.8 percentage points in rural areas. These sizes of the changes in the poverty rates are close to those in the studies in Vietnam and Cambodia, although the sizes of the welfare changes are smaller in Laos.

As seen above, the role of ordinary rice is much smaller than that of glutinous rice in Laos. Since the price of ordinary rice in Laos is much more likely to be affected by the international rice market than that of glutinous rice, the impact of a global food price crisis such as that in 2008 and price shock from outside is likely to be small. Rather, households in Laos are more likely to be impacted by the price of glutinous rice which is more affected by domestic factors such as the success or failure of rice production. This prevents Laos from being affected too much by possibly highly fluctuating rice prices in the world rice market. If moderately high and stable rice prices help induce more investment in more efficient rice cropping technology like HYV seeds and irrigation in Laos, they are not an issue for concern (Timmer (2010)).   However, at the same time, the rice market in Laos can be isolated, and cannot profit from external demand.

The estimated impacts on household welfare and poverty are due to price increases which are not based on domestic supply or demand but are based on external shock. To analyze the impacts due to the price change which occurs because of domestic factors such as success or failure of rice production, a different approach is necessary. The change in rice production and resulting change in consumption is not assumed in this analysis, but a more complicated model such as the CGE model is necessary. Laos has experienced a food price increase recently. FAO (2010) recently announced that (glutinous) rice price has nearly doubled in last 12 months (but this extreme increase is mainly due to low rice production because of a slow beginning of the rainy season in 2010). But analysis of the impacts due to such internally induced price changes is beyond the scope of the analytical methodology in this chapter.

Tables and Figures

Table 3.1: Yearly Rate of Price Growth 2006-2008

	North		Central		South		All			
	GL	OR	GL	OR	GL	OR	GL	OR	Food	Non-food
2006	0.273	0.084	0.284	-0.011	0.218	0.016	0.268	0.014	0.089	0.045
2007	0.071	-0.010	0.208	0.049	0.227	0.174	0.186	0.070	0.077	0.015
2008	0.078	0.059	0.121	0.293	0.059	0.203	0.101	0.229	0.105	0.043

Note: GL: Glutinous rice. OR: Ordinary rice. The 12-month growth rates for each month were calculated, and the means of the 12-month growth rates are taken within each year.

Table 3.2: Percentage Change of PPI with One Percent Change in CPI and the Estimated PPI in 2008

2008	CPI (2008)		Elasticity of PPI with respect to CPI		Estimated PPI (2008)	
	Glutinous	Ordinary	Glutinous	Ordinary	Glutinous	Ordinary
Vientiane-urban	0.121	0.293	0.97	1.37	0.117	0.402
Vientiane-rural w/ road	0.121	0.293	0.95	1.37	0.115	0.400
North-urban	0.078	0.059	1.26	1.40	0.098	0.082
North-rural w/ road	0.078	0.059	1.25	1.46	0.097	0.086
North-rural w/o road	0.078	0.059	1.05	1.23	0.081	0.072
Central-urban	0.121	0.293	0.97	1.28	0.118	0.374
Central-rural w/ road	0.121	0.293	0.95	1.23	0.114	0.361
Central-rural w/o road	0.121	0.293	0.85	1.27	0.103	0.372
South-urban	0.059	0.203	1.09	1.47	0.065	0.298
South-rural w/ road	0.059	0.203	1.08	1.55	0.064	0.314
South-rural w/o road	0.059	0.203	1.11	1.64	0.066	0.332
All	0.101	0.229	1.06	1.38	0.107	0.315

Note: CPI(2008) is take from Table 3.1. Elasticity of PPI is calculated following the formula in Section 3.2 using LECS4 data. Estimated PPI is calculated by multiplying the second column by the third column.

Table 3.3: Sample, Poverty, Expenditures and Agricultural Producers in Laos

	Sample HH size	HH size	Poverty rates	PC tot exp	PC food exp	Food share	Farmer (producer)
All	8,296	6.53	0.276	282,899	177,399	0.723	0.879
Urban	2,064	6.10	0.174	386,656	216,282	0.654	0.633
Rural w/ road	5,135	6.68	0.299	248,068	165,161	0.747	0.975
Rural no road	1,097	6.90	0.426	196,908	140,191	0.775	0.999
Vientiane	768	5.77	0.152	432,149	231,547	0.632	0.473
North	3,136	6.85	0.325	241,166	155,223	0.734	0.960
Central	2,688	6.46	0.298	284,928	184,026	0.740	0.907
South	1,704	6.60	0.228	261,509	170,439	0.726	0.929
Vientiane-urban	528	5.92	0.153	463,103	239,870	0.619	0.304
Vientiane-rural w/ road	240	5.48	0.152	372,861	215,605	0.658	0.797
North-urban	592	6.06	0.146	342,315	193,428	0.651	0.828
North-rural w/ road	1,936	6.99	0.333	230,941	151,642	0.744	0.986
North-rural w/o road	608	7.16	0.495	168,854	126,766	0.786	1.000
Central-urban	624	6.26	0.222	374,347	214,896	0.675	0.735
Central-rural w/ road	1,856	6.52	0.317	247,651	172,108	0.766	0.988
Central-rural w/o road	208	7.00	0.547	178,428	135,598	0.829	1.000
South-urban	320	6.05	0.113	342,079	209,152	0.665	0.675
South-rural w/ road	1,103	6.80	0.260	239,331	160,202	0.745	0.988
South-rural w/o road	281	6.38	0.232	257,316	166,495	0.720	0.996
Exp. Quintile 1 (Lowest)	1,635	8.12	0.997	107,304	90,931	0.852	0.971
Exp. Quintile 2	1,621	7.05	0.372	162,858	129,234	0.795	0.935
Exp. Quintile 3	1,633	6.32	0.009	213,647	159,328	0.747	0.919
Exp. Quintile 4	1,698	5.87	0.000	295,196	201,678	0.686	0.840
Exp. Quintile 5 (Highest)	1,709	5.31	0.000	635,763	305,930	0.534	0.728

Table 3.4: Yearly Glutinous Rice Production, Consumption, Sales and Purchases, by Household Groups

Glutinous Rice	Cons. share in food	Share of purchase in cons.	Share of production	Sales	Food purchase	Value produced	Value consumed
All	0.379	0.216	0.472	747	784	4,600	4,428
Urban	0.277	0.491	0.484	421	1,438	3,101	3,658
Rural w/ road	0.422	0.111	0.480	930	552	5,397	4,868
Rural no road	0.405	0.070	0.407	566	321	4,042	3,951
Vientiane	0.219	0.559	0.596	1,515	1,154	3,949	2,794
North	0.396	0.125	0.409	510	488	3,947	4,202
Central	0.395	0.197	0.523	746	809	5,388	4,894
South	0.413	0.213	0.453	689	1,000	4,618	4,882
Vientiane, urban	0.164	0.748	0.488	355	1,418	1,391	2,203
Vientiane, rural	0.324	0.245	0.674	3,739	649	8,848	3,926
North, urban	0.355	0.312	0.434	543	906	3,329	4,163
North, rural	0.405	0.079	0.404	502	395	4,084	4,211
Central, urban	0.306	0.418	0.526	383	1,572	4,100	4,278
Central, rural	0.437	0.091	0.522	919	446	6,001	5,187
South, urban	0.292	0.558	0.437	477	1,872	3,126	3,884
South, rural	0.442	0.131	0.456	739	794	4,970	5,117

Note: The units of the numbers in columns 2 to 4 are the percentages, and in columns 5 to 8 are thousand kips.

Table 3.5: Yearly Ordinary Rice Production, Consumption, Sales and Purchases, by Household Groups

Ordinary Rice	Cons. share in food	Share of purchase in cons.	Share of production	Sales	Food purchase	Value produced	Value consumed
All	0.063	0.419	0.071	115	103	708	742
Urban	0.022	0.848	0.031	97	229	248	305
Rural w/ road	0.075	0.209	0.078	130	59	872	894
Rural no road	0.107	0.053	0.105	77	11	1,032	1,069
Vientiane	0.023	0.867	0.066	213	256	527	306
North	0.106	0.210	0.106	117	99	1,033	1,260
Central	0.049	0.435	0.059	103	68	686	554
South	0.043	0.397	0.039	79	86	340	498
Vientiane, urban	0.025	0.954	0.062	77	347	242	354
Vientiane, rural	0.019	0.580	0.068	473	81	1,072	215
North, urban	0.024	0.724	0.028	211	187	294	358
North, rural	0.124	0.120	0.120	96	80	1,197	1,461
Central, urban	0.016	0.835	0.022	64	159	229	229
Central, rural	0.065	0.168	0.073	122	24	903	709
South, urban	0.031	0.742	0.039	59	266	246	354
South, rural	0.046	0.246	0.038	83	44	363	532

Note: The units of the numbers in columns 2 to 4 are the percentages, and in columns 5 to 8 are thousand kips.

Table 3.6: Percentage Change in Household Welfare and Point Change in Poverty Impacts due to Simulated 20 Percent Rice Price Increases

Scenario	(1)				(2)			
CPI growth rate =	20				20			
PPI growth rate=	20				PPI≠CPI			
Rice	Glutinous		Ordinary		Glutinous		Ordinary	
	WF	Pov	WF	Pov	WF	Pov	WF	Pov
All	0.1	0.3	0.0	0.0	0.2	0.3	0.1	0.0
Urban	-0.8	0.5	-0.1	0.0	-0.8	0.5	-0.1	0.0
Rural w/ road	0.5	0.4	0.1	0.0	0.5	0.3	0.1	0.0
Rural no road	0.4	-0.5	0.1	0.0	0.4	-0.5	0.1	0.0
Quintile1-urban	-0.8		-0.1		-0.7		-0.1	
Quintile2-urban	-0.7		-0.1		-0.6		-0.1	
Quintile3-urban	-0.8		-0.1		-0.8		-0.1	
Quintile4-urban	-0.8		-0.1		-0.8		0.0	
Quintile5-urban	-0.8		-0.1		-0.8		-0.1	
Quintile1-rural	0.1		0.0		0.2		0.0	
Quintile2-rural	0.1		0.1		0.2		0.1	
Quintile3-rural	0.6		0.1		0.6		0.2	
Quintile4-rural	0.9		0.1		1.0		0.2	
Quintile5-rural	0.6		0.1		0.6		0.2	
Non-poor	0.2		0.0		0.2		0.1	
Poor	-0.1		0.0		0.0		0.0	
Urban non-poor	-0.7		-0.1		-0.7		0.0	
Urban poor	-1.1		-0.2		-1.0		-0.2	
Rural non-poor	0.6		0.1		0.7		0.2	
Rural poor	0.2		0.0		0.2		0.1	
Vientiane, urban	-0.9	0.7	-0.2	0.0	-0.9	0.7	-0.2	0.0
Vientiane, rural	2.7	-1.0	0.3	0.0	2.5	-1.0	0.5	0.0
North, urban	-0.2	0.4	0.0	0.0	0.0	0.4	0.1	0.0
North, rural	0.3	0.3	0.0	0.1	0.4	0.2	0.1	0.0
Central, urban	-0.9	0.4	-0.1	0.0	-0.9	0.4	-0.1	0.0
Central, rural	0.6	0.3	0.1	0.0	0.5	0.3	0.1	0.0
South, urban	-1.2	0.3	-0.2	0.1	-1.2	0.3	-0.2	0.1
South, rural	0.1	0.5	0.0	0.0	0.2	0.5	0.1	0.0

Note: WF: Percent change in household welfare (-B), Pov: Percentage point change in the poverty headcoutn ratio

Table 3.7: Percentage Change in Household Welfare and Point Change in Poverty Impacts due to Simulated 40 Percent Rice Price Increases

Scenario	(3)				(4)			
CPI growth rate =	40				40			
PPI growth rate=	40				PPI≠CPI			
	WF	Pov	WF	Pov	WF	Pov	WF	Pov
Rice	Glutinous		Ordinary		Glutinous		Ordinary	
All	0.2	0.5	0.1	0.0	0.3	0.4	0.1	-0.1
Urban	-1.6	0.7	-0.2	0.0	-1.5	0.6	-0.1	0.0
Rural w/ road	1.0	0.5	0.2	0.0	1.1	0.4	0.3	-0.1
Rural no road	0.7	0.1	0.2	0.0	0.8	0.1	0.2	0.0
Quintile1-urban	-1.7		-0.3		-1.4		-0.2	
Quintile2-urban	-1.3		-0.2		-1.2		-0.1	
Quintile3-urban	-1.6		-0.2		-1.6		-0.2	
Quintile4-urban	-1.6		-0.1		-1.6		-0.1	
Quintile5-urban	-1.7		-0.3		-1.7		-0.2	
Quintile1-rural	0.3		0.0		0.4		0.1	
Quintile2-rural	0.3		0.1		0.4		0.2	
Quintile3-rural	1.2		0.2		1.3		0.3	
Quintile4-rural	1.8		0.3		1.9		0.4	
Quintile5-rural	1.2		0.2		1.3		0.3	
Non-poor	0.3		0.1		0.4		0.2	
Poor	-0.1		0.0		0.0		0.0	
Urban non-poor	-1.5		-0.2		-1.4		-0.1	
Urban poor	-2.2		-0.5		-2.0		-0.4	
Rural non-poor	1.2		0.2		1.3		0.3	
Rural poor	0.3		0.1		0.4		0.1	
Vientiane, urban	-1.8	1.3	-0.4	0.0	-1.8	1.3	-0.4	0.0
Vientiane, rural	5.4	-1.8	0.7	0.0	5.0	-1.8	1.0	0.0
North, urban	-0.4	0.4	0.1	0.1	0.1	0.0	0.2	0.1
North, rural	0.6	0.5	0.1	0.0	0.9	0.3	0.2	-0.2
Central, urban	-1.8	0.5	-0.2	0.0	-1.8	0.5	-0.1	0.0
Central, rural	1.1	0.6	0.2	-0.1	1.0	0.6	0.3	-0.1
South, urban	-2.5	0.3	-0.4	0.1	-2.4	0.3	-0.3	0.1
South, rural	0.3	0.6	0.1	0.0	0.5	0.5	0.2	0.0

Note: WF: Percent change in household welfare (-B), Pov: Percentage point change in the poverty headcoutn ratio

Table 3.8: Fractions of Net Sellers and Net buyers

	CPI=PPI				PPI≠CPI			
Rice	Glutinous		Ordinary		Glutinous		Ordinary	
	NS	NB	NS	NB	NS	NB	NS	NB
All	0.23	0.23	0.05	0.12	0.23	0.23	0.05	0.12
Urban	0.14	0.48	0.03	0.29	0.14	0.48	0.03	0.29
Rural w/ road	0.27	0.14	0.05	0.06	0.27	0.14	0.05	0.06
Rural no road	0.29	0.09	0.08	0.02	0.29	0.09	0.08	0.02
Q1-urban	0.12	0.40	0.04	0.17	0.12	0.40	0.04	0.17
Q2-urban	0.21	0.38	0.04	0.22	0.21	0.38	0.04	0.22
Q3-urban	0.15	0.48	0.03	0.32	0.16	0.48	0.03	0.32
Q4-urban	0.14	0.50	0.03	0.30	0.14	0.50	0.03	0.30
Q5-urban	0.08	0.62	0.04	0.44	0.08	0.62	0.04	0.44
Q1-rural	0.17	0.10	0.04	0.04	0.17	0.10	0.04	0.04
Q2-rural	0.22	0.12	0.04	0.03	0.22	0.12	0.04	0.03
Q3-rural	0.28	0.13	0.05	0.04	0.28	0.13	0.05	0.04
Q4-rural	0.33	0.13	0.06	0.05	0.33	0.13	0.06	0.05
Q5-rural	0.35	0.18	0.07	0.09	0.35	0.18	0.07	0.09
Non-poor	0.26	0.26	0.05	0.14	0.26	0.26	0.05	0.14
Poor	0.17	0.16	0.04	0.06	0.17	0.16	0.04	0.06
Urban non-poor	0.15	0.49	0.04	0.31	0.15	0.49	0.04	0.31
Urban poor	0.10	0.42	0.02	0.17	0.10	0.42	0.02	0.17
Rural non-poor	0.31	0.14	0.06	0.06	0.31	0.14	0.06	0.06
Rural poor	0.18	0.10	0.04	0.03	0.18	0.10	0.04	0.03
Vientiane, urban	0.09	0.59	0.03	0.46	0.09	0.59	0.03	0.46
Vientiane, rural	0.47	0.22	0.11	0.16	0.47	0.22	0.11	0.16
North, urban	0.15	0.37	0.02	0.19	0.15	0.37	0.02	0.19
North, rural	0.21	0.12	0.06	0.05	0.21	0.12	0.06	0.05
Central, urban	0.15	0.43	0.03	0.24	0.15	0.43	0.03	0.24
Central, rural	0.28	0.11	0.05	0.04	0.28	0.11	0.05	0.04
South, urban	0.19	0.54	0.07	0.26	0.20	0.54	0.07	0.26
South, rural	0.30	0.16	0.04	0.05	0.30	0.16	0.04	0.05

Note: NS: Net sellers, NB: Net buyers.

Table 3.9: Impact of Rice Price Increases in 2008 in Laos with PPI=CPI

	Glutinous Rice			Ordinary Rice			Rice		
	WF	Ch. Pov.	Pov.	WF	Ch. Pov.	Pov.	WF	Ch. Pov	Pov
All	0.0	0.0	27.6	0.0	0.0	27.6	0.0	0.0	27.6
Urban	-0.5	0.2	17.6	-0.2	0.0	17.4	-0.6	0.3	17.7
Rural w/ road	0.2	0.0	30.0	0.0	0.0	29.9	0.2	0.0	29.9
Rural no road	0.2	-0.4	42.2	0.1	0.0	42.6	0.3	-0.4	42.2
Quintile1-urban	-0.5			-0.2			-0.7		
Quintile2-urban	-0.4			-0.1			-0.5		
Quintile3-urban	-0.5			-0.2			-0.7		
Quintile4-urban	-0.5			-0.1			-0.6		
Quintile5-urban	-0.5			-0.2			-0.7		
Quintile1-rural	0.0			0.0			0.1		
Quintile2-rural	0.1			0.0			0.1		
Quintile3-rural	0.3			0.1			0.3		
Quintile4-rural	0.4			0.0			0.4		
Quintile5-rural	0.2			0.0			0.3		
Non-poor	0.0			0.0			0.0		
Poor	-0.1			0.0			-0.1		
Urban non-poor	-0.4			-0.1			-0.6		
Urban poor	-0.7			-0.3			-1.0		
Rural non-poor	0.3			0.0			0.3		
Rural poor	0.1			0.0			0.1		
Vientiane, urban	-0.5	0.4	15.7	-0.3	0.0	15.3	-0.9	0.7	16.0
Vientiane, rural	1.0	-0.4	14.7	0.1	0.0	15.2	1.1	-0.4	14.7
North, urban	-0.1	0.3	14.9	0.1	0.1	14.7	0.0	0.4	15.0
North, rural	0.1	0.1	36.6	0.0	0.0	36.5	0.2	0.1	36.6
Central, urban	-0.5	0.4	22.6	-0.1	0.0	22.2	-0.7	0.4	22.6
Central, rural	0.2	-0.1	33.3	0.0	-0.1	33.4	0.3	-0.2	33.3
South, urban	-0.7	-0.6	10.7	-0.3	0.1	11.4	-1.0	-0.6	10.8
South, rural	0.1	-0.1	25.4	0.0	0.0	25.5	0.1	-0.1	25.4

Note: WF: The percent change of household welfare (-Bi), Ch. Pov.=Percentage point change of poverty rates, Pov. = new poverty rates.

Table 3.10: Impact of Rice Price Increases in 2008 in Laos with Estimated PPI (≠CPI)

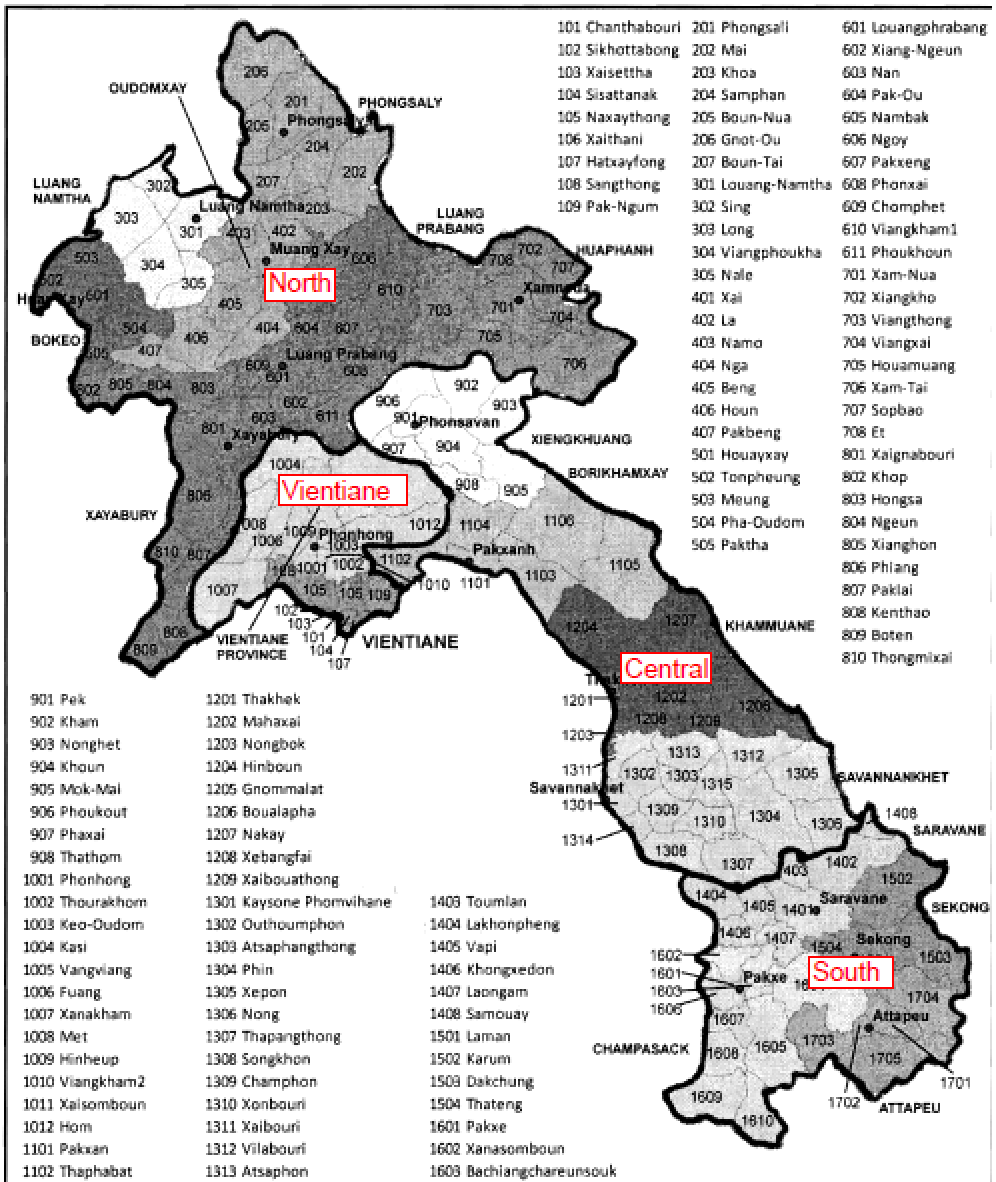
	Glutinous Rice			Ordinary Rice			Rice		
	WF	Ch. Pov.	Pov.	WF	Ch. Pov.	Pov.	WF	Ch. Pov	Pov
All	0.0	0.0	27.6	0.0	0.0	27.6	0.0	0.0	27.6
Urban	-0.5	0.2	17.6	-0.1	0.0	17.4	-0.6	0.3	17.7
Rural w/ road	0.2	0.0	29.9	0.0	0.0	29.9	0.3	-0.1	29.9
Rural no road	0.2	-0.4	42.2	0.2	0.0	42.6	0.4	-0.4	42.2
Quintile1-urban	-0.4			-0.1			-0.6		
Quintile2-urban	-0.4			-0.1			-0.4		
Quintile3-urban	-0.5			-0.1			-0.6		
Quintile4-urban	-0.5			-0.1			-0.6		
Quintile5-urban	-0.5			-0.1			-0.6		
Quintile1-rural	0.1			0.0			0.1		
Quintile2-rural	0.1			0.1			0.1		
Quintile3-rural	0.3			0.1			0.4		
Quintile4-rural	0.4			0.1			0.4		
Quintile5-rural	0.3			0.1			0.3		
Non-poor	0.1			0.0			0.1		
Poor	0.0			0.0			-0.1		
Urban non-poor	-0.4			-0.1			-0.5		
Urban poor	-0.6			-0.3			-0.9		
Rural non-poor	0.3			0.1			0.3		
Rural poor	0.1			0.0			0.1		
Vientiane, urban	-0.5	0.4	15.7	-0.3	0.0	15.3	-0.8	0.7	16.0
Vientiane, rural	1.0	-0.4	14.7	0.1	0.0	15.2	1.1	-0.4	14.7
North, urban	0.0	0.3	14.9	0.2	0.1	14.7	0.2	0.3	14.9
North, rural	0.2	0.0	36.5	0.1	0.0	36.5	0.2	0.0	36.5
Central, urban	-0.5	0.4	22.6	-0.1	0.0	22.2	-0.6	0.4	22.6
Central, rural	0.2	-0.1	33.3	0.0	-0.1	33.4	0.2	-0.2	33.3
South, urban	-0.7	-0.6	10.7	-0.2	0.1	11.4	-1.0	-0.6	10.8
South, rural	0.1	-0.1	25.4	0.0	0.0	25.5	0.2	-0.1	25.4

Note: WF: The percent change of household welfare (-Bi), Ch. Pov.=Percentage point change of poverty rates, Pov. = new poverty rates.

Figure 3.1: Map of Lao PDR

Source: World Bank website: http://go.worldbank.org/NV9XO4V230

Figure 3.2: Four Regions in Laos



Source: The borders of four regions are added by the author in the map which is taken from from Epprecht et al. (2008).

Figure 3.3: Evolution of International and Domestic Ordinary (Non-glutinous) Rice in Laos, January 2006 to March 2009 (January 2006=100)

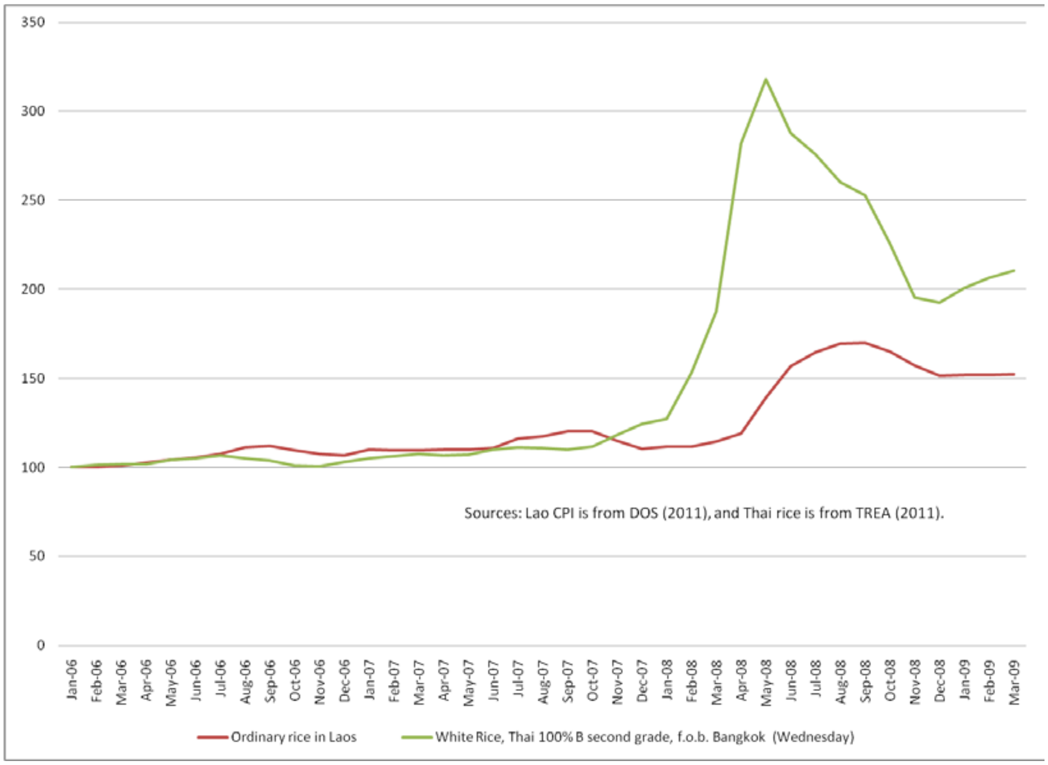
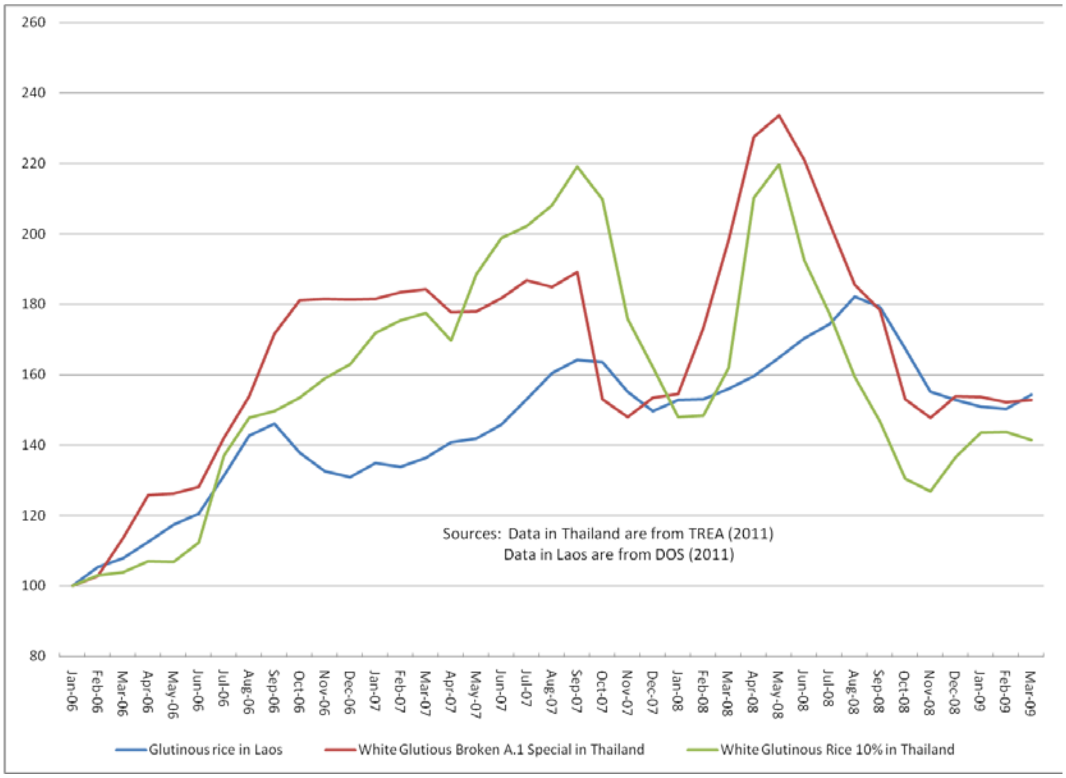


Figure 3.4: Evolution of International (Thai Export Price) and Domestic Glutinous Rice in Laos, January 2006 to March 2009 (January 2006=100)



4. References

Ai, C. and Norton, E. C. (2003). “Interaction terms in logit and probit models.” *Economics Letters*, 80(1):123–129.

Amemiya, T. (1981). “Qualitative response models: A survey.” *Journal of Economic Literature,* 19(4):1483–1536.

Angelucci, M. and Giorgi, G. D. (2009). “Indirect Effects of an Aid Program: How do Cash Transfers Affect Ineligibles’ Consumption?” *American Economic Review*, 99(1):486–508.

Angelucci, M., Giorgi, G. D., Rangel, M. A., and Rasul, I. (2009). “Family Networks and School Enrolment: Evidence from a Randomized Social Experiment.” *Journal of Public Economics*, 94(3-4): 197-221.

Asian Development Bank. (2008). *Food Prices and Inflation in Developing Asia: Is Poverty Reduction Coming to an End?*. Manila: Asian Development Bank.

Badri, N. G., and Walmsley, T. L., eds. (2008). *Global Trade, Assistance, and Production: The GTAP 7 data base*, Center for Global Trade Analysis, Purdue University.

Bardhan, P., and Udry, C. (1999). *Development Microeconomics*. Oxford and New York: Oxford University Press.

Behrman, J. R., Pollak, R. A., and Taubman, P. (1982). “Parental Preferences and Provision for Progeny.” *Journal of Political Economy, 90*(1), 52-73.

Bobonis, G. J. and Finan, F. (2009). “Neighborhood Peer Effects in Secondary School Enrollment Decisions.” *Review of Economics and Statistics*, 91(4):695–716.

Bourguignon, F., Bussolo, M., and Pereira da Silva,Luiz A., eds. (2008). *The Impact of Macroeconomic Policies on Poverty and Income Distribution: Macro-Micro Evaluation Techniques and Tools*. New York: Palgrave Macmillan.

Caldes, N. and Maluccio, J. A. (2005). “The Cost of Conditional Cash Transfers.” *Journal of International Development*, 17(2):151–168.

Cameron, A. C. and Trivedi, P. K. (2005). *Microeconometrics: Methods and Applications*. Cambridge University Press, Cambridge and New York.

Chen, S., and Ravallion, M. (2004). “Welfare Impacts of China's Accession to the World Trade Organization.” *The World Bank Economic Review*, *18*(1), 29-57.

Childs, N., and Burdett, A. (2000). The U.S. Rice Export Market. No. RCS-2000). Washington, DC, USA: Economic Research Service, USDA. Retrieved from http://www.ers.usda.gov/briefing/rice/specialarticle/usricemarket.pdf

Dammert, A. C. (2009). “Heterogeneous Impacts of Conditional Cash Transfers: Evidence from Nicaragua.” *Economic Development and Cultural Change*, 58(1):53–83.

Damon, A. and Glewwe, P. (2009). “Three Proposals to Improve Education in the LAC Region: Estimates of the Costs and Benefits of Each Strategy.” in *Latin American Development Priorities: Costs and Benefits,* Lomborg, B. eds., Cambridge University Press, New York.

Das, J., Do, Q.-T., and Ozler, B. (2005). “Reassessing Conditional Cash Transfer Programs.” *World Bank Research Observer*, 20(1):57–80.

de Janvry, A., and Sadoulet, E. (2010). “The Global Food Crisis and Guatemala: What Crisis and for Whom?” *World Development*, *38*(9), 1328-1339.

de la Brière, B., & Rawlings, L. (2006). Examining Conditional Cash Transfer Programs: A Role for Increased Social Inclusion? SP Discussion paper No. 0603. Washington, D.C.: World Bank.

Deaton, A. (1989). “Rice Prices and Income Distribution in Thailand: A Non-Parametric Analysis.” *Economic Journal, 99*(395), 1-37.

Dercon, S., and Shapiro, J. S. (2007). “Moving On, Staying Behind, Getting Lost: Lessons on Poverty Mobility from Longitudinal Data.” in D. Narayan, and P. Petesch eds, *Moving Out of Poverty. Volume 1. Cross-Disciplinary Perspectives on Mobility*, Washington, D.C.: World Bank; Houndmills, U.K. and New York: Palgrave Macmillan, 77-126.

Dessus, S., Herrera, S., and De Hoyos, R. (2008). “The Impact of Food Inflation on Urban Poverty and its Monetary Cost: Some Back-of-the-Envelope Calculations.” *Agricultural Economics, 39*, 417-429.

Duflo, E., Glennerster, R., and Kremer, M. (2008). “Chapter 61 Using Randomization in Development Economics Research: A Toolkit,” in *Handbook of Development Economics*, Elsevier , Volume 4, 3895–3962.

Engvall , A., Fenton, N., Lindelow, M., & Souksavath, P. (2009). *Poverty in Lao PDR 1992/3-2007/8.* Vientiane

Epprecht, M., Minot, N., Dewina, R., Messerli, P., & Heinimann, A. (2008). *The Geography of Poverty and Inequality in the Lao PDR.* Berne and Washington DC: Swiss National Centre of Competence in Research (NCCR) North-South, Geographica Bernensia, and International Food Policy Research Institute (IFPRI).

FAO. (2010). “FAO statistical databases.” http://faostat.fao.org/

Ferreira, F. H. G., Filmer, D., & Schady, N. (2009). “Own and sibling effects of conditional cash transfer programs : theory and evidence from Cambodia.” Policy Research Working Paper Series 5001, The World Bank.

Fiszbein, A. and Schady, N. (2009). *Conditional Cash Transfers: Reducing Present and Future Poverty.* The World Bank, Washington, D.C.

Friedman, J., and Levinsohn, J. (2002). “The Distributional Impacts of Indonesia's Financial Crisis on Household Welfare: A “Rapid Response” Methodology.” *The World Bank Economic Review, 16*(3), 397-423.

IFPRI (2005). *Nicaragua: Red de Proteccion Social (RPS) Evaluation Dataset, 2000-2002*. International Food Policy Research Institute, Washington, D.C.

Ivanic, M., and Martin, W. (2008a). “Implications of Higher Global Food Prices for Poverty in Low-Income Countries.” *Agricultural Economics*, *39*, 405-416.

Ivanic, M., & Martin, W. (2008b). “Implications of Higher Global Food Prices for Poverty in Low-Income Countries.” Policy Research Working Paper, WPS4594. The World Bank.

Khandker, S., and Haughton, J. (2009). *Handbook on poverty and inequality*. Washington, DC, USA: The World Bank.

Khandker, S. R., Pitt, M. M., and Fuwa, N. (2003). “Subsidy to Promote Girls’ Secondary Education: the Female Stipend Program in Bangladesh.” , MPRA Paper, University Library of Munich, Germany, http://econpapers.repec.org/RePEc:pra:mprapa:23688.

Kremer, M., Miguel, E., and Thornton, R. (2009). “Incentives to Learn.” *Review of Economics and Statistics*, 91(3):437–456.

Lalive, R., and Cattaneo, M. A. (2009). “Social Interactions and Schooling Decisions.” *Review of Economics and Statistics*, *91*(3), 457-477.

Maluccio, J. A. (2005). “Coping with the Coffee Crisis in Central America: The Role of the Nicaraguan Red de Proteccin Social.” FCND Discussion Paper, 188. International Food Policy Research Institute (IFPRI).

Maluccio, J. A. and Flores, R. (2005). Impact Evaluation of a Conditional Cash Transfer Program: The Nicaraguan Red de Proteccion Social. Research reports 141, International Food Policy Research Institute (IFPRI).

Mas-Colell, A., Whinston, M. D., and Green, J. R. (1995). *Microeconomic theory*. New York: Oxford University Press.

Minot, N., & Goletti, F. (2000). “Rice Market Liberalization and Poverty in Viet Nam.” Research reports 114, International Food Policy Research Institute (IFPRI).

Moore, C. (2009). “Nicaragua’s *Red de Proteccion Social*: An Exemplary but Short-Lived Conditional Cash Transfer Programme.” Country Study 17, International Policy Centre for Inclusive Growth.

Norton, E. C., Wang, H., and Ai, C. (2004). “Computing Interaction Effects and Standard Errors in Logit and Probit Models.” *The Stata Journal*, 4(2):154–167.

Pendergast, J. F., Gange, S. J., Newton, M. A., Lindstrom, M. J., Palta, M., and Fisher, M. R. (1996). “A Survey of Methods for Analyzing Clustered Binary Response Data.” *International Statistical Review / Revue Internationale de Statistique*, 64(1):89–118.

Piesse, J., and Thirtle, C. (2009). “Three Bubbles and a Panic: An Explanatory Review of Recent Food Commodity Price Events.” *Food Policy, 34*(2), 119-129.

Ponce, J., and Bedi, A. S. (2010). “The Impact of a Cash Transfer Program on Cognitive Achievement: The Bono De Desarrollo Humano of Ecuador.” *Economics of Education Review, 29*(1), 116-125.

Psacharopoulos, G. and Patrinos, H. A. (2004). “Returns to Investment in Education: A further update.” *Education Economics*, 12(2):111–134.

Ravallion, M. and Wodon, Q. (2000). “Does Child Labour Displace Schooling? Evidence on Behavioural Responses to an Enrollment Subsidy.” *Economic Journal*, 110(462):C158–75.

Singh, I., Squire, L., and Strauss, J. (1986). *Agricultural Household Models : Extensions,Aapplications, and Policy*. Baltimore: Johns Hopkins University Press.

Takamatsu, S. (2002). “Economic Aanalysis of Rice Market Integration in Laos.” Master's thesis, Kobe University, Japan. Retrieved from http://www.tc.umn.edu/~takam002/master_thesis_sum.pdf

Taylor, E. J., and Adelman, I. (2003). “Agricultural Household Models: Genesis, Evolution, and Extensions.” *Review of Economics of the Household, 1*(1-2), 33-58.

Timmer, C. P. (2010). “Reflections on Food Crises Past.” *Food Policy, 35*(1), 1-11.

Thai Rice Exporters Association (TREA). (2011). “Average FOB price: 2007-2008,” Retrieved 02/01, 2011, from http://www.thairiceexporters.or.th/default.htm

United Nations. (2011). “We can end poverty 2015 millennium development goals” Retrieved 05/03, 2011, from http://www.un.org/millenniumgoals/bkgd.shtml

Vu, L. H., & Glewwe, P. (2009). “Impact on the Food Crisis on Poverty in Cambodia.” Unpublished manuscript, University of Minnesota.

Vu, L. H., and Glewwe, P. (2011). “Impacts of Rising Food Prices on Poverty and Welfare in Vietnam.” *Journal of Agricultural and Resource Economics*, Forthcoming.

Wodon, Q., and Zaman, H. (2010). “Higher Food Prices in Sub-Saharan Africa: Poverty Impact and Policy Responses.” *World Bank Research Observer, 25*(1), 157-176.

Wooldridge, J. M. (2002). *Econometric Analysis of Cross Section and Panel Data: 1st Edition*. MIT Press, Cambridge and London.

Wooldridge, J. M. (2010). *Econometric Analysis of Cross Section and Panel Data: 2nd Edition*. MIT Press, Cambridge and London.

World Bank. (2006). "Lao PDR: Rural and Agriculture Sector Issues Paper." Working Paper, 37566. Washington, DC: World Bank.

World Bank. (2009). "Vulnerability and Safety Nets in Lao PDR: A Policy Note." Unpublished manuscript, The World Bank, Vientiane, Lao PDR.

World Bank. (2010). *World Development Indicators.* Washington, DC: World Bank.

World Bank. (2011). "Food Price Watch - AUGUST 2011." Washington, DC. Retrieved 05/03, 2011, http://go.worldbank.org/JA4CUPKLJ0

A.Appendix

A.1 Parameter Conditions (Using Cobb-Douglas Utility Function) for Each Case in Section 2.3.1

Next, consider parameter conditions for the allocation without the program. In I, it is assumed that $S_1^0 < \overline{S}$. Using (2.10.b),

$$S_1^0 = \frac{\beta_1}{(w_1 + b_1)}\{(w_1 + w_2)T + Y(z)\} < \overline{S} \tag{A.1}$$

In II, $S_1^0 \geq \overline{S}$ is assumed. Thus,

$$S_1^0 = \frac{\beta_1}{(w_1 + b_1)}\{(w_1 + w_2)T + Y(z)\} \geq \overline{S}, \tag{A.2}$$

Next, move to the parameter conditions for the allocation *with* the program: $S_1 \geq \overline{S}$ since the amount of cash transfers is assumed to be large enough to have $S_1 \geq \overline{S}$. This condition applies to all cases. Using (A.9.b),

$$\begin{aligned} & S_1^1 \geq \overline{S} \\ \Longrightarrow & \frac{\beta_1}{(w_1+b_1-t)}\{(w_1+w_2)T+Y(z)\} \geq \overline{S} \\ \Longrightarrow & S_1^0 \geq \frac{(w_1+b_1-t)\overline{S}}{w_1+b_1} \end{aligned} \tag{A.3}$$

In Cases 2 and 3, an optimal allocation should be determined when S_1^2 (or S_1^3) $\geq \overline{S}$. Using (2.14.b),

$$\begin{aligned} & S_1 \geq \overline{S} \\ \Longrightarrow & \frac{\beta_1}{(w_1+b_1)}\{(w_1+w_2)T+Y(z)+t\overline{S}\} \geq \overline{S} \\ \Longrightarrow & S_1^0 \geq \frac{(w_1+b_1-\beta_1 t)\overline{S}}{w_1+b_1} \end{aligned} \tag{A.4}$$

Since Case 1 is the last case, the condition of S_1^0 in this case is the complement of (A.4) given (A.3):

$$\frac{(w_1+b_1-t)\overline{S}}{w_1+b_1} \leq S_1^0 < \frac{(w_1+b_1-\beta_1 t)\overline{S}}{w_1+b_1} \tag{A.5}$$

In summary, Case 1 should meet (A.1), (A.3) and (A.5):

$$\frac{(w_1+b_1-t)\overline{S}}{w_1+b_1} \leq S_1^0 \leq \frac{(w_1+b_1-\beta_1 t)\overline{S}}{w_1+b_1}(<\overline{S}) \tag{A.6}$$

Case 2 should meet (A.1), (A.3) and (A.4):

$$(\overline{S}>)S_1^0 > \frac{(w_1+b_1-\beta_1 t)\overline{S}}{w_1+b_1} \tag{A.7}$$

Case 3 should meet (A.2), (A.3) and (A.4):

$$\begin{aligned} S_1^0 \geq \overline{S}, S_1^0 > \frac{(w_1 + b_1 - \beta_1 t)\overline{S}}{w_1 + b_1} \\ \Longrightarrow S_1^0 \geq \overline{S} \end{aligned} \tag{A.8}$$

A.2 The Mathematical Derivation of Excluded Case in Section 2.3.1

The case in which $S_1^1 < \overline{S}$ is excluded by assuming that the amount of cash transfers is large enough to have $S_1^1 \geq \overline{S}$. Mathematically, they are solved as:

$$C = C^0, H_1 = H_1^0, S_2 = S_2^0, H_2 = H_2^0 \tag{A.9a}$$

$$S^1 = \frac{\beta_1}{(w_1 + b_1 - t)}\{(w_1 + w_2)T + Y(z)\} > S_1^0 \tag{A.9b}$$

Compared to solutions (2.10), these solutions in Case 1 are the same except that the education for the target sibling (S_1^1) under the program is strictly larger than target siblings' education without the program (S_1^0). This phenomenon is due to the Cobb-Douglas utility function with which the cross-price elasticity of the demand functions are zero. In this case, the size of program effects is positively correlated with parental income since $S_1^1 - S_1^0 = \frac{\beta_1 t\{(w_1+w_2)T+Y(z)\}}{(w_1+b_1)(w_1+b_1-t)}$.[1] Intuitively, in this case, more affluent parents can spend more on the education of the target sibling when the opportunity costs for target sibling's education decline. By contrast, spillover effects do not exist since the income and substitution effects are canceled out due to the Cobb-Douglas utility function.

[1]The sign of $\frac{\beta_1 t\{Y(z)\}}{(w_1+b_1)(w_1+b_1-t)}$ is assumed to be positive in this case.