ESSAYS ON SCHOOLING AND ECONOMIC DEVELOPMENT:

A MICRO-ECONOMETRIC APPROACH FOR RURAL PAKISTAN AND EL SALVADOR

A DISSERTATION

SUBMITTED TO THE DEPARTMENT OF ECONOMICS

AND THE COMMITTEE ON GRADUATE STUDIES

OF STANFORD UNIVERSITY

IN PARTIAL FULFILLMENT OF THE REQUREMENTS

FOR THE DEGREE OF

DOCTOR OF PHILOSOPHY

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August 1999

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Abstract

Education is regarded as an important determinant of income in both developed and developing countries. A number of cross-country studies indicate that low overall levels of investment in human capital in the form of education have had serious adverse effects on the long-term economic growth of many developing countries. However, in these macroeconomic studies, the micro-level mechanisms of human capital investment are not explored adequately. In order to answer policy questions about the tools and timing of appropriate education policies, household and school-level responses toward various environmental changes need to be clarified. Yet, few studies have focused on the inter-linkage between various market imperfections in rural society and human capital investment demand in the context of developing countries. Moreover, information issues on the supply side of the education of rural societies, which may create adverse selection and moral hazard problems, are seldom investigated empirically. The lack of rigorous studies on these topics could perhaps be attributed to the limited availability of data sets with which to test relevant hypothesis.

This dissertation is composed of four essays on schooling and economic development, using household level data sets. Chapter 1 introduces the four essays and describes their background and contributions. Chapter 2 and Chapter 3 investigate the demand side of schooling investments with two panel data sets from Pakistan. These essays evaluate how credit and insurance market imperfections affect household schooling decisions quantitatively. Chapter 4 and Chapter 5 focus on the supply side of schooling by using child, household and school level data from El Salvador. These latter two essays statistically analyze the importance of an appropriate teacher incentive scheme and how an adequate school decentralization program can overcome information problems.

Chapter 2 investigates the role of permanent and transitory income shocks in school attendance using household panel data from Pakistan. The results of school entrant and dropout regressions indicate that the transitory income movements affect children's schooling behavior significantly, implying that credit and insurance market imperfections exist. In the presence of capital market incompleteness, transient poverty as well as chronic poverty may be an important obstacle to human capital investment. Our analysis also points out that Pakistani parents apparently favor sons in terms of education. Schooling response to a negative income shock is consistently larger for daughters than sons. Moreover, there may exist resource competition among siblings, and having out-of-school brothers and sisters increases the degree of education of a child. Human capital investment decision and intrahousehold schooling allocation seem to be

affected by a need for self-insurance devices. In terms of education policy, provisions of emergency coping aids and/or selective reduction of school fees for those poor households who face temporary difficulties may be more cost effective than programs aiming either at reducing poverty itself or at reducing school costs for the poor as a whole. Moreover, this chapter proposes a test framework which can distinguish the consumption model from the investment model of schooling. The empirical results indicate that the investment model has better performance than the consumption-labor supply model in explaining the actual observations.

Chapter 3 investigates the sequential educational investment process of Pakistani households by integrating observations from the field, economic theory, and econometric analysis. The field surveys were conducted twice in rural Pakistan, in order to collect retrospective data of 2365 children of 367 households. The most striking feature discovered in the field is the high educational retention rate, conditional on school entry. We also find that at the higher education levels the schooling progression rates become comparable between male and female students, implying the important dynamic aspects of the gender gap in education. These results imply that under binding borrowing constraints, parents pick the 'winners' for educational specialization and allocate more resources to them. Second, the supply side constraints of education in the village significantly constrain the education, especially for females. Although the demand for education cannot be controlled directly by the government, the supply side interventions through quantity and quality improvements of public schools may produce significant impacts on human capital accumulation process in rural Pakistan. Third, we found the significant educational effect of social status, which is traditionally related to the occupation. The fourth finding is that parental physical and human asset ownership systematically contributes to the schooling probability of children. Moreover, income shocks and parental health shocks both affect child school decisions. Also, there is evidence of the gender gap in the response toward the shocks, as suggested by the theoretical framework. Finally, we found gender specific birth order effects which take a different form at different levels of education.

Chapter 4, co-authored with Emmanuel Jimenez, measures the effects of decentralizing educational responsibility to communities and schools on student outcomes by using the example of El Salvador's Community-Managed Schools Program (or, EDUCO, from the Spanish acronym, Educacion con Participacion de la Comunidad). The EDUCO program was designed to expand rural education rapidly following a civil war. This chapter compares student achievement on standardized tests and school attendance of rural students in EDUCO schools versus those who are in traditional schools. It controls for student characteristics, school and classroom inputs, and endogeneity, using municipality-level EDUCO and traditional school densities as identifying

instrumental variables. It finds that the rapid expansion of rural schools through EDUCO (a) has positively affected student achievement in language skills through enhanced community involvement; and (b) has diminished student absences, which may have longer-term effects on achievement.

Based on a principal-agent model, Chapter 5 investigates the organizational structure that made the El Salvador's primary school decentralization program (EDUCO program) successful. First, we employ the "augmented" reduced form educational production function by incorporating parents and community involvement as a major organizational input. We observe consistently positive and statistically significant EDUCO participation effects on standardized test scores. We also estimated the teacher compensation functions, teacher effort functions, and input demand functions by utilizing the theoretical implications of a principal (parental association) - agent (teacher) framework. While the EDUCO school teachers receive a piece rate, depending on their performance, wage payment is relatively fixed in the traditional schools. Empirical results indicate that the slope of wage equation is positively affected by the degree of community participation. This finding can be interpreted as the optimal intensity of incentive. Hence, community participation through parental group's classroom visits seems to enhance the teacher effort level and thus increases students' academic performance indirectly. On the other hand, teacher's effort level in the traditional schools is consistently lower than that in the EDUCO schools, indicating a moral hazard problem. Moreover, parental associations can affect not only teacher effort and their performance by imposing an appropriate incentive scheme but also school-level inputs by decentralized school management. Our empirical results support the view that decentralization of education system should involve delegation of school administration and teacher management.

Acknowledgements

I am particularly indebted to my principal advisor, Professor Marcel Fafchamps, for his patience and encouragement. Before coming to the United States, I had vague notions of working on the non-linear dynamics to solve development issues. I found myself working on micro-development economics, combining field observations, a rigorous theoretical framework, and careful econometric analysis. My decision to follow this research style is, I believe, due to Marcel, who introduced me to front-line research on micro-development economics. I would like to thank Professor Takeshi Amemiya for his constant encouragement and warm support. Amemiya-sensei's incisive comments always kept me focused on the unresolved issue in my analysis. On various occasions, Professor Anjini Kochar gave me insightful critiques, which dramatically improved my papers. She also kindly encouraged me to work on issues of South Asian Economies by offering me several research assistantships, where I was exposed to her rigorous treatment of micro-development economics. From the beginning of my studies at Stanford, Professor Pan Yotopoulos has encouraged my work on development economics. I am indebted to him for instructing me in the policy-oriented development economics on numerous occasions. I am also grateful to Professor Anne Royalty for becoming a member of my oral examination committee.

My research cannot be completed without the help of researchers at various institutions outside the Stanford campus. First, I would like to thank Dr. Lawrence Haddad, the director of the Food, Consumption, and Nutrition Division of the International Food Policy Research Institute (IFPRI) for providing me with the Pakistan household panel data set. At IFPRI, I also benefited from guidance and discussions with Dr. Sumiter Broca and Dr. Agnes Quisumbing. Second, I would like to thank Dr. Sarfraz Khan Qureshi and Dr. Ghaffar Chaudhry, the director and the joint director, respectively, of the Pakistan Institute of Development Economics for supporting my field surveys in Pakistan. Also, I cordially thank the village enumerators of my project in Pakistan: for Punjab, Azkar Ahmed, Muhammad Azhar, Anis Hamudani, and Ali Muhammad; for NWFP, Aziz Ahmed, Abdul Azim, Asad Daud, and Lal Muhammad. Without their capable enumeration, my field research has never been accomplished. Thirdly, I would like to thank Dr. Emmanuel Jimenez, the research manager and Dr, Elizabeth King, senior economist, of Development Research Group of the World Bank for providing me with an opportunity to work as a consultant for the Bank. I also would like to thank Manny for his kind offer to collaborate a paper on El Salvador, which is included as chapter four of this dissertation.

I gratefully acknowledge the Foundation for Advanced Studies on International Development (FASID), the Matsushita International Foundation, and the World Bank for their financial support of my research.

Essays in this dissertation have been read and criticized by many people on numerous occasions. Particularly, I would like to thank Richard Adams, Harold Alderman, Bradford Barham, Amit Burki, Michael Carter, Victor Chernozhukov, Paul Glewwe, Nick Hope, Kazumasa Iwata, Haroona Jatoi, Hanan Jacoby, Yoshihiro Kaneko, Takashi Kurosaki, Lawrence Lau, Thomas MaCurdy, Andrew Mason, Sohail Malik, Ronald McKinnon, Jonathan Morduch, Martin Ravallion, James Roumasett, Keijiro Otsuka, Hideo Owan, Louis Rose, Assaf Razin, Scott Rozelle, Julie Schaffner, Gavin Wright, Futoshi Yamauchi, and Frederic Zimmerman for useful comments and discussions at the various stages of my project. I also benefited from discussions with seminar participants at Brandeis University, University of Hawai'i at Manoa, Stanford University, Tokyo Metropolitan University, University of Toronto, University of Wisconsin at Madison, Yokohama National University, the Asian Development Bank, the International Food Policy Research Institute, and the World Bank. I also would like to thank session participants at the Pakistan Society of Development Economists 13th Annual Meeting at Islamabad on December 1997, the Pacific Rim Allied Economic Organizations Conference (the Western Economic Association) at Bangkok on January 1998 and the Japanese Economic Association Annual Meeting on September 1998 for many constructive comments.

I would like to thank all my friends for the valuable advice, warm encouragement, and unlimited compassion they gave me during this journey. Although they are too many to be listed, I'd like to mention the names of the following friends at least: Robert Baulch, Mohammad Shame Emran, John Gibson, Rishi Goyal, Michiyo Hashimoto, Masako Ii, Kenji Ishizuka, Mandar Jayawant, Sung Jin Kang, Ethan Kaplan, Nhat Le, Jeong-Joon Lee, Myeongkyu Lee, Guo Li, Hongbin Li, Robert McMillan, Eleni Gabre-Madhin, Jim Minifie, Chiaki Moriguchi, Amir Najmi, Hiroyuki Nakata, Haruko Noguchi, Albert Park, Minggao Shen, Akihisa Shibata, Bobby Sinclair, Yasuyuki Todo, Nsikan Udoyen, Takashi Ui, Ayako Yasuda, and Peter Walkenhorst.

I deeply thank Maki Nagai who put up with being a Ph.D. student's fiancée for a long time. Finally, with the bottom of my heart, I would like to dedicate this dissertation to my parents, Tsutomu and Etsuko Sawada. Without their help, I would never been able to complete my dissertation. In spite of their suffering through two major historical incidents in Japan, they have always cared of others, including village dwellers in Pakistan. Which, I believe, cannot be over-respected.

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Chapter 1

Introduction

Recently, social sector reform has become the key focus in micro-level policy reforms in developing countries. Social services such as education and health are directly related to improvement of households' welfare. Therefore, economists and other social scientists, particularly at international institutions, have investigated the conditions that are necessary to improve the quality of social sector services in developing countries. Among various social sectors, education in particular has been regarded as an important sector. This is because education is thought to be the core determinant of income in both developed and developing countries. Moreover, education improves the quality of health and nutrition. Despite the importance of education in developing countries, there are numerous unexplored issues in economic aspects of education in developing countries. Such issues include the effects of market incompleteness and informational asymmetry on educational investment and school quality. The main obstacle to rigorous research in this area is the lack of an appropriate data set to identify key problems and to evaluate the effectiveness of actual policy interventions.

This dissertation, which is composed of four essays on schooling and economic development, is an attempt to investigate several unexplored issues in the literature by using three different micro-level data sets. The first two essays investigate the demand side of schooling investments with two household-level panel data sets from Pakistan. These essays evaluate how credit and insurance market imperfections affect households' schooling decisions quantitatively. The first essay investigates the role of permanent and transitory income shocks in school attendance using household panel data from Pakistan. The essay also addresses the issues of gender gap in education and intrahousehold schooling resource allocation in the presence of capital market incompleteness. The second essay investigates the sequential educational investment process of Pakistani households by integrating observations from the field, economic theory, and econometric analysis. The latter two essays focus on the supply side of schooling by using child, household and school level data from rural El Salvador. These two essays statistically analyze the importance of an appropriate teacher incentive scheme and how an adequate school decentralization program and community participation can overcome information problems.

1.1 Importance of Demand for Education: the Case of Pakistan[1]

A number of cross-country studies indicate that overall low levels of investment in human capital had negative effects on the long-term economic growth of many developing countries [Barro and Sala-I-Martin (1995)]. Figure 1.1 portrays the relationship across 108 countries in 1985 between per capita real GDP and the percentage of primary school attained in the total population. For example, in Figure 1.1, Pakistan is well below the cross-country regression line. This implies that, controlling for differences in the per capita income level, the Pakistani human capital investments have been relatively low. The problem of a high dropout rate in schooling seems to be serious in Pakistan as well. Figure 1.2 represents the cross-country relationship between income level and the dropout rate. Although we can see that there is a cross-country negative relationship between these two variables, Pakistan is well above the fitted line, indicating that from an international perspective, Pakistan has had a relatively high dropout rate. Moreover, the investments have been biased towards males relative to females. Figure 1.3 depicts the relationship between the per capita real GDP and a gender gap measure. Pakistan is well above the cross-country regression line. This observation indicates that Pakistani parents favor sons in terms of education.

What are the implications of these observations for the economic development of Pakistan? The results of recent cross-country growth regressions show that once the starting level of real per capita GDP is held constant, the school-attainment variables are significantly related to the growth rate of real per capita GDP [Barro and Sala-i-Martin (1995)]. Therefore, the low levels of investment in human capital, particularly the low level of women's education, may seriously affect economic growth of Pakistan. In fact, Birdsall, Ross and Sabot's (1993) regression results indicate substantial forgone income gains for Pakistan due to low investments in schooling over the last three decades. Their simulations revealed that Pakistan would have increased the current per capita income by 25% if it had had Indonesia's 1960 primary school enrollment rates, and by 16% if as many girls as boys had attended primary school in 1960.

Despite the extensive cross-country analysis of human capital investments, the micro-level mechanisms of human capital investments are not necessarily clear. In these macroeconomic studies, the micro-level mechanisms of human capital investment are not explored adequately. In order to answer policy questions about the tools and timing of appropriate education policies, the micro-level household response toward various environmental changes needs to be clarified. Risk, uncertainty, and constraints on access to credit all potentially

[1] The Figures shown in this subsection are extracted from Sawada (1997).

influence the investment, production, and consumption decisions of poor farmers in the developing countries.

The recent development literature emphasizes the importance of informal insurance devices to complement the lack of formal market mechanisms in LDCs. For example, a number of microeconomic studies have emerged which address the role of formal and informal risk mitigating or coping mechanisms of LDC farm households on their welfare and poverty [Alderman and Paxson (1992); Besley (1995); Deaton (1990, 1991, 1997); Fafchamps (1992); Morduch (1994, 1995); Paxson (1992, 1993); Townsend (1994, 1995); Udry (1994)]. In many cases, farmers are confronted by the ex post shock. Crops and livestock may be destroyed by natural hazards such as hurricanes, floods, fire, and serious drought. Accidents, sickness, or sudden death can disable the farmer or her family. Yet, maintaining consumption stability is critical for their life. Farmers thus have evolved several ways to cope with these ex post risks of disasters. Such risk-coping devices include selling some of their assets such as livestock [Rosenzweig and Wolpin (1993); Fafchamps, Czukas and Udry (1997)], using family savings [Paxson (1992); Alderman (1996)] and stored grain [Park (1996), Townsend (1995)], participating in the labor market or seasonally migrating to places where there are jobs [Kochar (1995; 1999a); Walker and Ryan (1990)], receiving remittances from family members who are off the farm [Rosenzweig and Stark (1989); Lucas and Stark (1985); Rosenzweig (1988)], and informal arrangements of mutual insurance such as state-contingent loans, transfers and gifts among relatives, friends and neighbors [Caldwell, Reddy, and Caldwell (1986); Cox and Jimenez (1992); Coate and Ravallion (1993); Fafchamps (1992); Lund and Fafchamps (1997); Platteau and Abraham (1987); Ravallion and Deardren (1988); Rosenzweig (1988); Townsend (1995); Udry (1994)]. The emerging consensus of the empirical literature is that insurance and credit markets are not efficient in the sense of the Pareto optimality, especially for the poorest households. However, if we take into account of various informal insurance devices which complement the lack of formal schemes, the degree of financial market imperfection is much smaller than many researchers had expected. Moreover, better-off households with land ownership seem to face almost perfect financial markets [Morduch (1995; p.103)].

Yet, the lack of formal insurance and credit mechanisms force LDC households to employ the informal insurance schemes as listed above. In particular, the market forces usually fail to provide both formal credit and insurance to investments in human capital. Hence, it is natural to regard the human capital investments in rural Pakistan as intertemporal optimizing decisions made by the farm households under conditions of credit and insurance market incompleteness. Since the poor households, especially the landless farmers, frequently cannot borrow against their future

income, they are likely to have high marginal utility of current consumption. Therefore, the opportunity cost of child education is quite high, and thus transitory shocks to parental income may lead to a decline in school attendance. This is the hypothesis of child labor as informal income insurance proposed by Jacoby and Skoufias (1997). Their empirical results indicate that, in southern Indian villages, seasonal fluctuations in school attendance are a form of informal self-insurance for households vulnerable to risk. Transient poverty as well as chronic poverty may be an important obstacle to human capital investment. Yet, no studies except Jacoby (1994) and Jacoby and Skoufias (1997) have focused on the inter-linkage between various market imperfections in rural society and human capital investment demand in the context of developing countries. Moreover, no study has explored how socio-cultural issues such as particular gender preference interact with a household's motive to preserve informal insurance devices against variability in realized income. Possibly the lack of studies on these topics can be attributed to the limited availability of data to test relevant hypotheses. With two unique micro data sets from rural Pakistan, Chapters 2 and 3 of this dissertation empirically analyze issues of market imperfection and related issues in the context of demand for education.

1.2 Importance of Supply for Education: the Case of El Salvador

In addition to household demand considerations, both the availability of local schooling and the quality of the existing schools should affect education patterns significantly. These supply side constraints on education include the lack of access to schools inside the village, high transportation costs of schooling due to the inconvenient school location, the lack of teachers and school facilities, and inefficient class schedule. Because the government cannot directly control demand, supply side interventions by the government through quantity and quality improvements of schools will have significant impacts on the human capital accumulation process. This issue is important especially in El Salvador, since public schools could not be extended in the 1980s during the country's civil war, and its educational supply system is currently being overhauled. In recent years, progress has been made in the educational sector. Yet, the internal inefficiencies of schools, inadequate school infrastructure, and poor managerial and administrative skills of teachers still persist.

There are two primary ways of intervening in a rural education so that the government can increase overall school attendance. First, the government can increase the number of primary schools of a given quality. Indeed, improvements of access to schooling by increasing the supply of schools have been the dominant agenda in LDCs since the 1960's [Lockeed et al. (1991)].

Despite the general effort to increase the quantity of schools, remote and inappropriate school locations and resultant high schooling costs seem to be still serious in many rural areas of developing countries.

Second and more importantly, the quality of existing schools should be improved, since quality improvements of available schools are a necessary condition for improving rural education. There are several different forms of enhancing the quality of the educational supply: expansion and renovation of the existing schools to improve school infrastructure and capacity, teacher recruitment and dismissal to enhance teachers' quality, multiple shifts to increase enrollment and reduce unit costs, multi-grade classes to improve access in rural communities, biennial intakes of students, single-sex schools, and informal and/or adult schooling. Particularly, teacher quality improvements seem to be an important necessary condition, which involve issues of human resource management. For example, many researchers and practitioners listed the teacher's absenteeism as one of the major problems of low teaching quality. If teachers are absent, substitute teachers are not usually available and classes are cancelled in rural developing countries. Although teacher absence can be attributed to legitimate reasons, such as sickness, it is more often due to simple dereliction of duty. Teacher absenteeism is especially prevalent in rural areas of LDCs. It is obvious that students cannot learn from a teacher who is not present, and absenteeism among teachers encourages similar behavior among students (Lockheed et al. 1991, p. 101).

This phenomenon implies the existence of a teachers' incentive problem. Information problems, which may create adverse selection and moral hazard problems, must be a focal point of supply-side reforms in education of rural societies. Recent development policy studies tell that community participation and cooperation become the key to overcome weak formal institutions such as the lack of an enforcement mechanism for formal contracts and various information problems [World Bank (1998); Stiglitz (1999)]. For example, appropriate teacher incentive schemes and monitoring devices provided by community groups could prevent the student absences due to teacher absences. We would expect that, in a decentralized school, there are efficiency gains from community-based involvement since community-level management enables the school to overcome the adverse selection and moral hazard problems by considering community specific conditions and by closely monitoring teacher and administrator performance. Therefore, decentralization of an education system should involve delegation of school administration and teacher management. Formation of formal and/or informal community associations should be a part of education reforms in developing countries.[2]

[2] Moreover, in order to maintain quality of schooling and teaching, the government and its district

Despite the compelling reasoning, there is relatively little empirical evidence in developing countries to document the merits of school-based management. Two exceptions are James, King and Suryadi (1996) for Indonesia and Jimenez and Paqueo (1996) for the Philippines. The main reason of the lack in empirical studies is that these administrative arrangements have only recently begun to be implemented. Hence, the lack of studies on these topics can be attributed to the limited availability of data to test relevant hypotheses.

In order to examine the advantage of decentralized schools quantitatively, we employ the newly available data set on the El Salvador's Community-Managed Schools Program (or, EDUCO, from the Spanish acronym, Educacion con Participacion de la Comunidad). The EDUCO program is a celebrated example of community managed schools and was designed to expand rural education rapidly following a civil war. The third and fourth essays of this dissertation utilize the unique data set which was collected by the Ministry of Education of El Salvador with the assistance of the World Bank and USAID in October 1996. The survey was composed of five questionnaires: student, parents, school director, teacher, and parental association questionnaires. This unique data enable us to conduct an appropriate evaluation of an education decentralization program. The third essay compares student achievement on standardized tests and school attendance of rural students in EDUCO schools with those who are in traditional-type centralized schools. To this end, we estimate a reduced form education production function. On the other hand, the fourth essay estimates structural equations which enhance school productivity of EDUCO schools. Particularly, the estimation of a teacher wage compensation scheme becomes the key to discuss incentive problems.

1.3 Contribution of the Dissertation

By using three unique micro data sets, this dissertation empirically investigates demand and supply of education under market imperfections. This dissertation is an attempt to analyze unexplored issues in the literature by addressing the importance of credit and insurance availability on households' schooling decisions and appropriate teacher incentive schemes to improve the supply side quality of education.

Chapter 2 utilizes the standard intertemporal model of human capital investment suggested by Jacoby and Skoufias (1997) and the standard panel data set of Pakistani households collected by International Food Policy Research Institute (IFPRI). However, our investment

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educational offices should continue regular monitoring of teaching performance and curriculum. At the same time, a better teacher training curriculum should be developed.

model can be distinguished from the schooling consumption model and we can derive testable restriction to compare these two competing models. Therefore this chapter will examine the validity of the Jacoby and Skoufias (1997) type investment model of education. Moreover, this chapter extends the model to include gender and intrahousehold aspects so that we can explicitly discuss how these household preference or socio-economic issues interact with a household's motive to maintain self-insurance devices against variability in realized income. As is pointed out by many researchers and policy makers, these social aspects cannot be neglected in South Asia [Thomas and Strauss (1996)]. With respect to the empirical methodology, the Jacoby and Skoufiaus (1997) study investigates the effects of income shocks on seasonality and variability of schooling time. Hence, grade and diploma effects are not addressed. On the other hand, Chapter 2 analyses the school entry and exit decisions separately. In fact, as will be discussed in Chapter 3, a close inspection of schooling patterns of the Pakistani households indicates the importance of school entry and exit decisions, rather than the variability of school time. This observation validates our approach.

Chapter 3 also employs the investment model of education. Yet, the most important contribution of Chapter 3 is in the collection and the analysis of the unique data set from rural Pakistan on the whole retrospective history of child education and household background. We should note that human capital outcome, represented by years of completed schooling, is a stock rather than a flow variable. In this case, current outcomes depend not only on past inputs but also on current inputs. Therefore, general reduced form solutions will include the entire history of exogenous variables [Strauss and Thomas (1995; pp.1974-75)]. Yet, introducing dynamics by having the intertemporal linkage of school investments complicates estimation procedure. Moreover, we rarely obtain long-term historical data on individual and household characteristics. Because computation is difficult and desirable data is typically unavailable, this dynamic aspect is ignored in most of the reduced form literature. In order to examine explicitly the dynamic and sequential aspects of schooling decisions, Chapter 3 utilizes the unique data set on retrospective histories of child education, which has been collected exclusively for this analysis during the author's two field surveys in Pakistani villages. Hence, the data collection itself can be a crucial contribution to the literature. In addition to this data contribution, Chapter 3 analyses the sequential nature of school entry and exit decisions. This unique data set enables us to estimate the full sequential schooling decision model. The results of educational stage specific schooling behaviors provide new and important insights of demand for education. For example, the educational stage specific differences in gender and intrahousehold inequality are formally examined. Such an analysis cannot be found in the literature, particularly for Pakistan, due to the

lack of data sets. Hence, Chapter 3, together with Chapter 2, makes an important contribution to the understanding of a household's intertemporal risk-coping strategies and resulting dynamic educational decisions in developing countries.

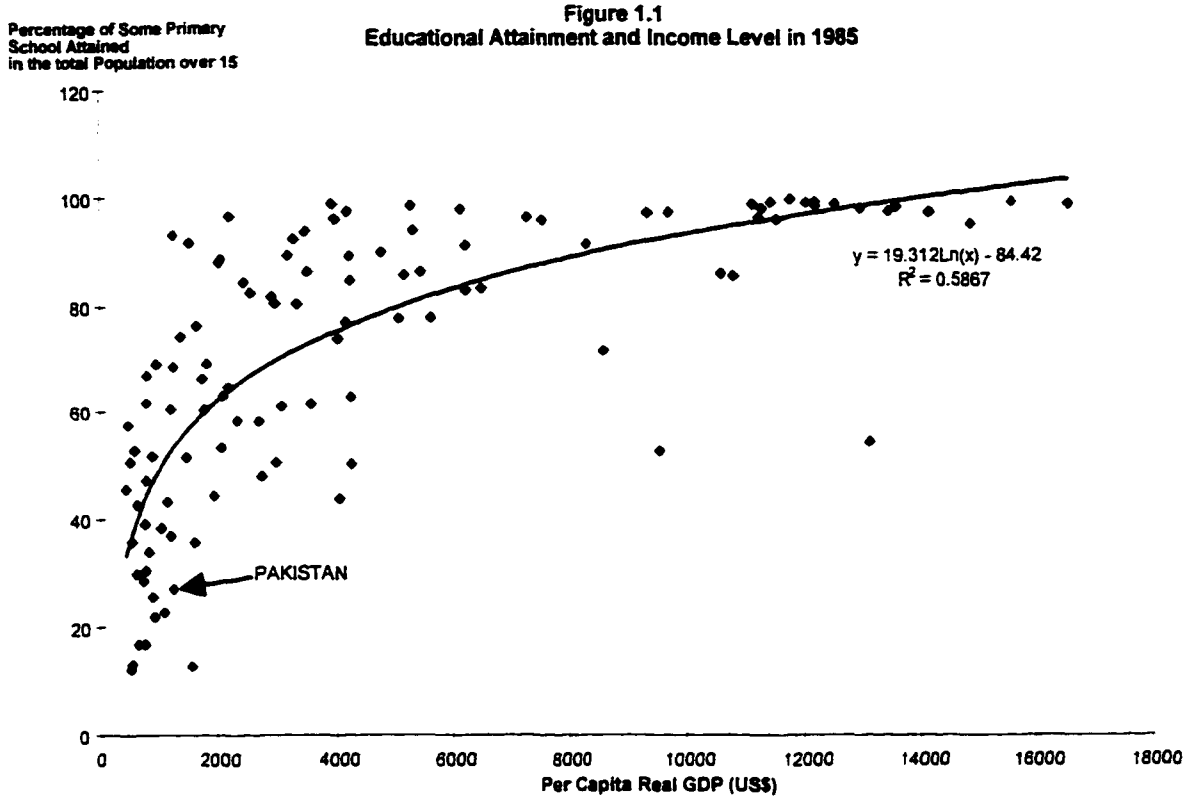
Chapter 4 and 5 provide new insights in the literature on private versus public supply of education, as well as of other social sector services such as health and nutrition in developing countries. An analysis of community management of primary schools provides an important contribution to education policy, especially in developing countries, since both recent studies and policy dialogues emphasize the importance of decentralization of education and efficiency gains from community-based involvement. In fact, many developing countries have been making efforts to delegate school management responsibility to schools or community groups, away from a centralized educational system. The rationale behind this decentralization policy is that community-level management enables school to consider community specific conditions and thus decreases the gap between teachers' right action and their incentives by providing a close monitoring device. Therefore, the presumption among policy makers and government officials is that decentralization of education will enhance quality and efficiency of schools.

However, there is only a little empirical evidence in developing countries to document this presumption. The main reason of the lack of empirical demonstration is that these administrative arrangements have only recently begun to be implemented. So the accumulation, investigation and dissemination of rigorously gathered evidence on the impact of school-community level management of educational establishments can be a contribution to the literature and policy. In this sense, the formal econometric analyses in Chapter 4 and 5 provide new insights in the literature, especially because much research on educational decentralization is largely less rigorous case studies.

Using the unique data set of El Salvador's EDUCO program, a celebrated example of decentralization of education, Chapter 4 asks whether the EDUCO program is associated with higher test scores and attendance rates, after controlling for the endogenous nature of school choice. El Salvador's Ministry of Education collects the data set with the assistance of the World Bank for the purpose of the program evaluation. The empirical analysis of this unique data set, i.e., an integrated household, child, school and teacher level data set, itself will be a contribution of Chapter 4. Although Chapter 4 applied a standard econometric model of endogenous program effects [Greene (1997; p.981-982)], this chapter has contributions to the literature not only in its unique data and empirical results, but also in its policy implications. Especially, the results of Chapter 4 suggests that by making parents responsible for schools, there will be better educational outcomes for students, supporting the advantage of community-managed schools.

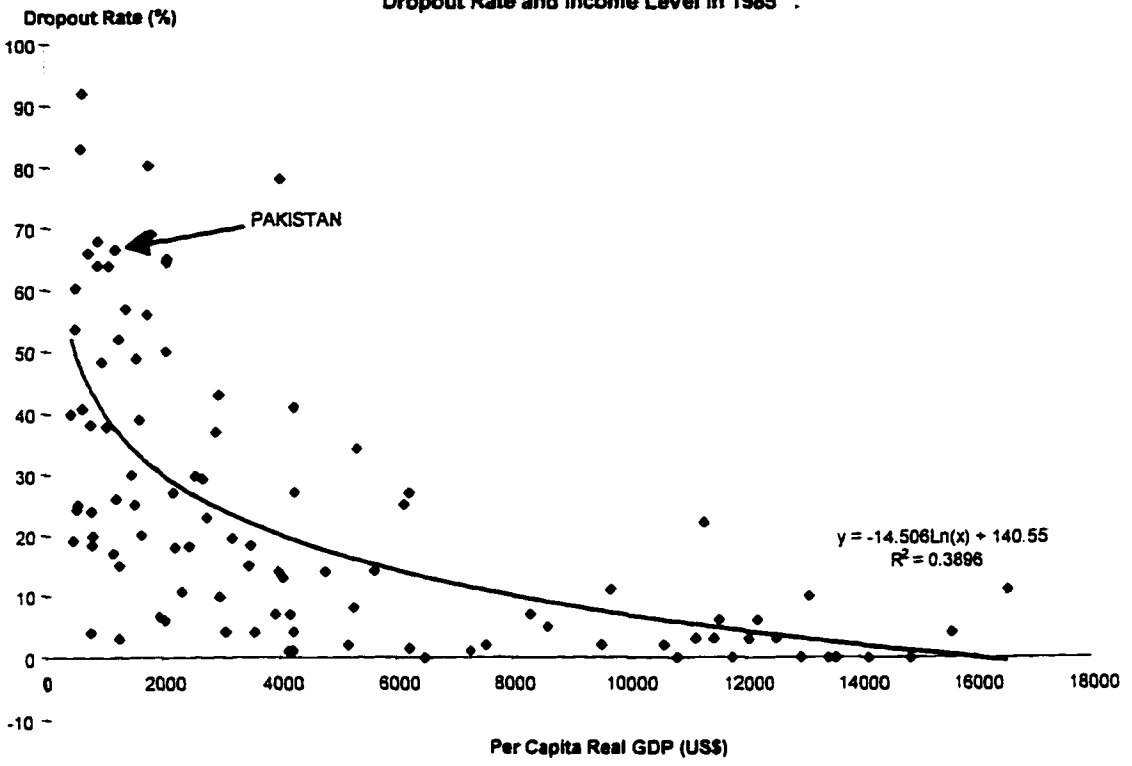
In Chapter 5, by utilizing a principal (parental association) - agent (teacher) framework, we estimated the wage compensation scheme, observed effort function, and school input demand function. The first contribution of Chapter 5 is our development of a formal theoretical framework of decentralization of education program in the context of a developing country, which is largely missing in the literature. Moreover, we constructed an estimable structural framework of the positive community participation effects. The most important contribution of this chapter is applications of the agency framework to social sector management issues, together with empirical estimations of theoretical implications. With respect to the estimation methodology, the valuable contributions of the chapter are threefold. First, in order to select the observed measure of an agent's effort level, the empirical framework employed the econometric approach of the selection of regressor, combined with descriptive statistics and qualitative information of the parental association questionnaire. Second, this chapter empirically investigates the consistency between the observed contracts, i.e., slope of wage compensation scheme, and the theoretical prediction of the model, i.e., the optimal intensity of incentive. As Prendergast (1999) clearly stated, empirical investigations of the consistency between contracts and the agency theory are still the active research area in the literature. Our unique data set allows us to empirically examine this theoretical consistency. Third, the empirical model of Chapter 5 has a methodological innovation in the selection of instrumental variables for the community participation variable, which is endogenously determined. Based on the theoretical condition of the monitoring intensity principle, we select the amount of monetary transfer from the government to the community associations as an identifying instrumental variable. However, the exogeneity assumption of the geographical allocation of government transfers may be restrictive, since the government transfers might be a function of a community's characteristics. Hence, the empirical model also includes another identifying instrumental variable, "net community participation measure," which is regarded as satisfying the requirements of an appropriate instrumental variable.

Figure 1.1
Educational Attainment and Income Level in 1985



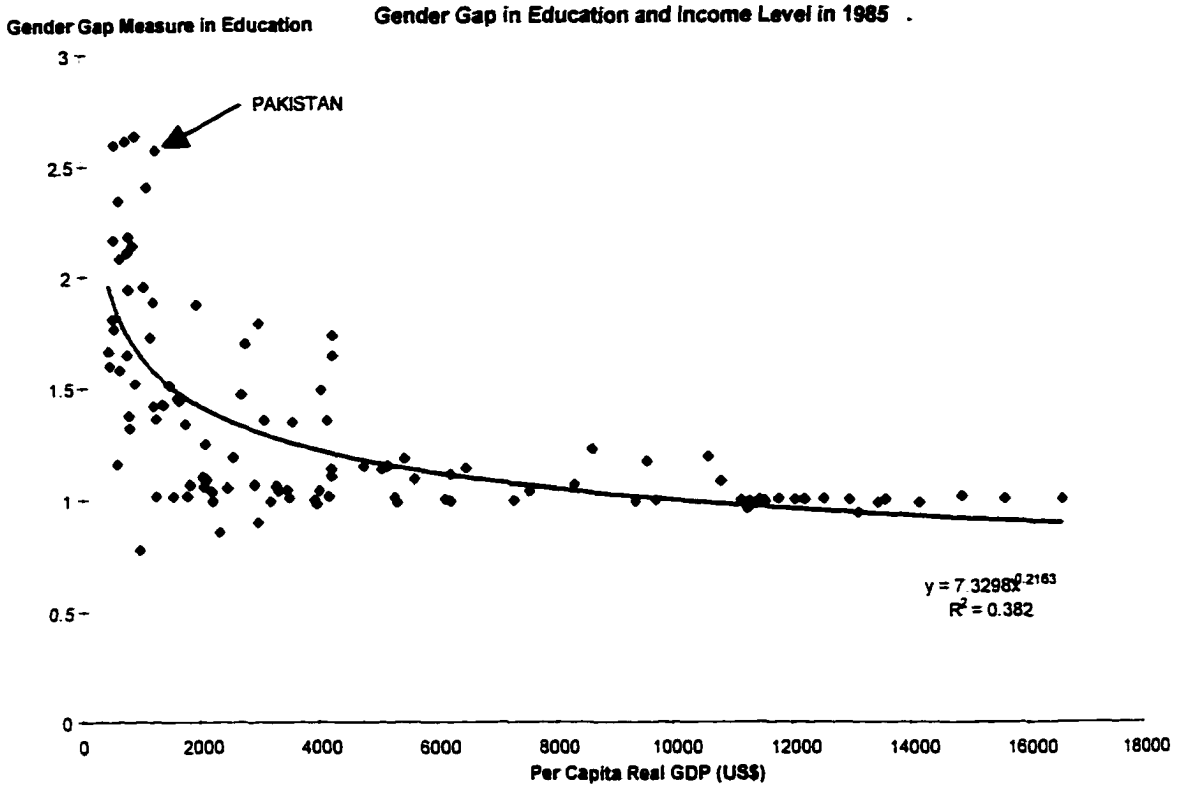
(Data Source) Barro, R. J. and J. W. Lee (1996), 'International Measures of Schooling Years and Schooling Quality,' AEA Papers and Proceedings 86, 218-223; Summers, R. and A. Heston (1991), 'The PENN World Table (Mark 5): An Expanded Set of International Comparisons, 1950 - 1988,' Quarterly Journal of Economics 106, 327-368.

Figure 1.2
Dropout Rate and Income Level in 1985



(Data Source) See Figure 1.1.

Figure 1.3
Gender Gap in Education and Income Level in 1985 .



(Note) The educational gender gap measure = [% of men who experienced schooling]/[% of women who experienced schooling]
(Data Source) See Figure 1.1.

Chapter 2

Income Risks, Gender, and Human Capital Investment in Rural Pakistan

2.1 Introduction

Education is regarded as an important determinant of income in both developed and developing countries. Recent macroeconomic studies have identified human capital accumulation as a primary source of long run economic growth [Barro and Lee (1994); Barro and Sala-i-Martin (1995); Lucas (1988); Romer (1986, 1990)]. A number of cross-country studies, however, suggest that Pakistani aggregate human capital investments measured in terms of schooling outcomes, are low relative to other countries of similar per capita income levels [Behrman and Schneider (1993); Birdsall, Ross and Sabot (1993); Summers (1992); Sawada (1997)]. These international comparisons indicate that low overall levels of investment in human capital had serious adverse effects on the long-term economic growth of Pakistan. Behrman and Schneider (1993) concluded that Pakistani investments have been skewed towards higher rather than basic education and towards males relative to females. Birdsall, Ross and Sabot (1993)'s regression results imply substantial forgone income gains for Pakistan due to low investments in schooling over the last three decades. For instance, their simulations reveal that Pakistan would have increased current per capita income by 25% if Pakistan had had Indonesia's 1960 primary school enrollment rates and by 16% if Pakistan had sent as many girls as boys to primary school in 1960.

In the above macroeconomic studies, by definition, the micro-level mechanisms of human capital investment are not explored adequately. In order to answer policy questions about the tools and timing of appropriate education policies, household response toward various environmental changes needs to be clarified. From an educational policy perspective, therefore, we need to investigate micro-level behavior of households' human capital investment. In this regard, it is now well known that the availability of formal and/or informal risk coping mechanisms is essential to welfare and poverty reduction of farm households in developing countries.[1] In terms of schooling behavior of households in poor rural areas of Pakistan, the

[1] Recently, a number of microeconomic studies have emerged which address the role of formal and informal risk mitigating or coping mechanisms of LDC farm households on their welfare and poverty [Alderman and Paxson (1992); Besley (1995); Deaton (1990, 1991, 1997); Fafchamps (1992); Morduch (1994, 1995);

available microeconomic empirical evidence indicate that the returns to education are quite high, especially so in the non-farm activities [Fafchamps and Quisumbing (1998)]. Also, the productivity of education is likely to be significant in farming, especially when new technologies are being adopted [Yotopoulos (1967); Jamison and Lau (1980)].[2] The poor's capacity and incentives to invest in schooling are thus key factors in long-term development. Particularly, the role of stochastic nature of poverty is thought to be important, since the lack of insurance can increase the incidence of poverty significantly even if a household is not in poverty in terms of its average income [Morduch (1994)]. For policy design, it is extremely important to distinguish the transitory poor from the chronically poor. Transient poverty is experienced for only a short period, while chronic poverty is experienced for a long period. When transient poverty is dominant, the appropriate policy response should be to promote policies such as micro-credit program, provision of crop insurance, employment guarantee schemes and price stabilization policies. These policies are supposed to help income and consumption smoothing of the poor households who are in trouble temporarily. On the other hand, the reduction of chronic poverty requires costly continuous interventions to increase the productivity of the poor in long run. According to World Bank (1990), nearly 90 percent of households in the six South Indian villages surveyed by the International Crop Research Institute for the Semi-Arid Tropics (ICRISAT) were under transitory poverty, while only 10 percent of households were chronically poor. This indicates the seriousness of transient poverty. Most poverty is thought to be temporary, with households moving in and out of poverty over time. Although the traditional theory of demand for education posits that a household with high income is expected to undertake educational investments, the household, in reality, might shy away from it if schooling is considered to be a high-risk investment. Moreover, under credit constraints, potential effects of transient and chronic poverty on farm household production and consumption decisions may not be symmetric.

Paxson (1992, 1993); Townsend (1994, 1995); Udry (1994)]. In many cases, farmers are confronted by the ex-post shock. Crops and livestock may be destroyed by natural hazards such as hurricanes, floods, fire, and serious drought. Accidents, sickness, or sudden death can disable the farmer or her family. Farmers have evolved several ways to deal with these ex post risks of disasters, e.g., selling some of their assets such as livestock [Rosenzweig and Wolpin (1993); Fafchamps, Czukas and Udry (1997)], using family savings [Paxson (1992); Alderman (1996)], participating in the labor market or seasonally migrating to places where there are jobs [Kochar (1995; 1999a); Walker and Ryan (1990)], receiving remittances from family members who are off the farm [Rosenzweig and Stark (1989); Lucas and Stark (1985); Rosenzweig (1988)], informal arrangements of mutual insurance such as state-contingent transfers and gifts among relatives, friends and neighbors [Cox and Jimenez (1992); Coate and Ravallion (1993); Fafchamps (1992); Lund and Fafchamps (1997); Ravallion and Deardren (1988); Rosenzweig (1988); Townsend (1995); Udry(1994)].

[2] Yotopoulos (1967) conducted the first study which used a production function for agricultural output as basic tool for analyzing the impact of education on productivity.

This chapter investigates the role income shocks play in school attendance in the developing country context. We analyze explicitly the separate effects of chronic and transient poverty on the human capital investment decision of the poor LDC farmers. Since poor households, especially landless farm households, frequently cannot borrow against future income, they are likely to have relatively high marginal utility of current consumption. Moreover, market forces usually fail to provide both credit and insurance to investment in human capital [Schultz (1961); Becker (1993)]. Therefore, the opportunity cost of and current utility loss from investment in child education are quite high. Under this circumstance, the poor farmers will choose optimally not to educate their children despite high rates of return on education. Human capital investments also involve sunk costs and irreversibility. Credit constraints can limit access to indivisible and irreversible but profitable investment opportunities [Fafchamps and Pender (1997)].[3] When crop income falls short of expectations, farm income can be preserved through various risk-coping strategies. The risk coping strategies can be defined as a set of household strategies that minimize consumption fluctuation, given exogenous fluctuations in income. Poor households who face ex-post risk, therefore, will have considerable motivation for adopting risk coping devices. Interestingly, studies on ICRISAT villages found that labor market participation acts as an informal but strong insurance device against crop income fluctuations [Walker and Ryan (1990, pp. 87-88); Kochar (1995; 1999a)]. Under these circumstances, there will be a motivation for obtaining informal income insurance by letting children work when realized uncertainty is unfavorable to parental income. If households cannot borrow ex-post, transitory shocks on parental income may lead to withdrawals of children from school. Child income may be an important device for risk coping because of their on-farm wage-earnings and their domestic job opportunities. This is the hypothesis of child labor as income insurance proposed by Jacoby and Skoufias (1997). Jacoby and Skoufias (1997)'s econometric results indicate that, in southern Indian villages, seasonal fluctuations in school attendance are a form of self-insurance. Few studies, however, have focused on the inter-linkage between capital market imperfections and human capital investments in the context of developing countries. Possibly the lack of studies on this topic can be attributed to the limited availability of longitudinal data to test intertemporal optimal conditions and other relevant hypotheses.

[3] Particularly, the transitory poverty due to a lack of insurance devices for poor LDC farmers who face unstable income streams creates another reason for under-investment in education; in the presence of large fluctuations income, a household will have a precautionary saving motive acting as if under a self-inflicted borrowing constraint [Carroll (1992); Deaton (1992)]. Moreover, risk averse households are unable to insure themselves against income shocks and tend to shy away from risky activities [Sandomo (1971)].

The second half of this chapter presents an empirical framework to test the sensitivity of schooling to the changes in permanent and transitory components of household income, using panel data from rural Pakistan. The theoretical framework of this chapter is the standard investment model of education developed by Jacoby and Skoufias (1997), together with a standard household panel data set. With respect to the empirical framework, seasonality of education is the key focus of the Jacoby and Skoufias (1997) paper. Hence grade or diploma effects are not addressed. Yet, the descriptive statistics in Chapter 3 indicate the importance of school entry and exit decisions, rather than the variability of schooling which is analyzed by Jacoby and Skoufious (1997), at different educational stages. These two chapters also imply the importance of socio-cultural factors and supply-side constraints in determining level of child education.

Moreover, unlike the Jacoby and Skoufias (1997) paper, we investigate gender and intrahousehold aspects of human capital investments explicitly, which are considered as important issues for the welfare of poor households in South Asia. In Pakistan, parents underinvest in female education. The reasons for the low school attainments of girls in Pakistan include (i) the low demand for daughter's education due to household's poor economic background, and (ii) shortage of teachers, especially female teachers for girls. The opportunity costs of female education might be quite high especially since daughters can accomplish various household tasks such as child-care, sibling raising, housekeeping, meal preparations, and on-farm work. Moreover, investment in the education of daughters may not yield much economic returns for parents since a daughter will move to the other family after marriage, and part of the returns from daughter's education will "leak" to the other family. Given this "leakage effect" of education, there will be less economic incentives for human capital investment in girls.[4] Social and cultural issues might be important, too. One factor that seems to have a strong negative impact on the female schooling in Pakistan is the practice of purdah, the seclusion of women. Since education for daughters often involves the risk that daughters will break purdah, parents will choose not to educate them rationally. Moreover, female work participation generally carries a low value in Pakistan. The expected wage rate for female students after graduation is systematically lower than that for male students. In fact, it is found that female education does not affect the productivity and labor allocation in any systematic fashion, consistent with the marginal role women play in market oriented activities in Pakistan [Fafchamps and Quisumbing

[4] See Greenhalgh (1985) and Parish and Willis (1993) for case studies in East Asia

(1998)]. The benefit of education is limited to the males only and thus female education seems to be an unprofitable investment in rural Pakistan.

Moreover, issues of educational resource allocation within the household should be considered explicitly. Given the amount of household resources available at a time, having an additional child will decrease household resource availability per child. Hence, there may exist educational resource competition among siblings when the household is under credit constraints [Strauss and Thomas (1995)]. Whether the elder or younger siblings obtain more schooling depends on the life cycle pattern of the household income. However, having out-of-school brothers and sisters increases the degree of education of a child, since sibling income potentially extends the household's overall resource availability. On the other hand, if credit is perfectly available for a household so as to fully smooth consumption intertemporally, resource competition among siblings does not affect child schooling pattern. With perfect access to the credit market, a household decides the optimal years of schooling so that marginal productivity of schooling is equalized to the exogenously available interest rate. A difference in credit availability, therefore, gives completely different implications of intrahousehold allocation of educational resources.

Chapter 2 is organized as follows: In Section 2.2, the above informal discussions are formalized in an intertemporal model of households' consumption and schooling decisions. The model distinguishes the effect of transient poverty from that of chronic poverty by decomposing income into permanent and transitory components. Section 2.3 presents an empirical model to analyze the theoretical implications. We estimate the conditional probabilities of schooling decisions by the logit model with household fixed effects. In Section 2.4, the Pakistani household panel data set collected by the International Food Policy Research Institute (IFPRI) is briefly described. This section then presents and discusses the estimation results. The final section concludes the findings and policy implications of our analysis.

2.2 Optimal Schooling Decision and its Gender Difference in a Simple Dynamic Model

As mentioned above, the delay in schooling and/or withdrawal of children from school can be a device for coping with risk under credit. This will be especially true for poor households, which face risk of catastrophe. Child labor can be an insurance device for parental income, when crop income falls short of expectations. To see this structure formally, we will construct a dynamic household model which is based on Levhari and Weiss (1974) and Jacoby

and Skoufias (1997)'s seminal works on human capital investment under uncertainty. In order to investigate intrahousehold allocation of educational resources, we extend the Jacoby and Skoufias (1997) model to a generalized form with multiple children.[5]

Suppose that a household with I children persists T periods. Consumption and schooling decision are assumed to be made by parents so as to maximize the household's aggregated expected utility, which is represented by a time-separable utility function of consumption allocation over T periods:

$$(1) \qquad \underset{\{C_t, S_{it}\}}{Max}\ E_t\left[\sum_{k=0}^{T-t}\beta^k U(C_{t+k}) + \beta^{T+1} W(H_{T+1}, A_{T+1})\right],$$

where $U(\bullet)$ is a well-behaved utility function with $U' > 0$ and $U'' < 0$, and β represents subjective discount factor of the household.[6] A concave function $W(\bullet)$ denotes the value of the financial bequest and the salvage value of the final stock of child's human capital. This household's consumable resources in each period are composed of exogenously given assets A_t, parental income Y_{Pt}, and child's income $Y_{Cit}(1 - S_{it})$, where $0 < S < 1$ represents the time allocation to schooling.[7] Our model takes parental income as an exogenous stationary stochastic process in order to focus on the risk-coping behaviors. Under these settings, the law of motion equation for the intertemporal budget constraint of this household becomes:

$$(2) \qquad A_{t+1} = \left[A_t + Y_{Pt} + \sum_{i=1}^{I} Y_{Cit}(1 - S_{it}) - C_t\right](1 + r_t),$$

where r denotes a non-stochastic interest rate on savings.[8]

---

[5] The basic model is based on the assumption that the household acts as a single decision-maker. Yet, as we will see shortly, this so-called unitary model can address wide variety of the issues of intrahousehold resource distribution [Alderman and Gertler (1997); Haddad, et. al. (1997)].

[6] We do not explicitly incorporate labor supply decision in the model mainly because of model tractability. We should note, however, that, a recent study finds that a trade-off between hours of work and study exists in the context of developing countries, indicating a trade-off between child labor and human capital [Akabayashi and Psacharopoulos (1998)]. Our model framework is consistent with this observation.

[7] Note that the total time endowment of children is normalized to one.

[8] For tractability, we assume that human capital does not change child wage rate immediately and the final stock of human capital is reflected in the household utility.

2.2.1 The Model Time Line

Let Y^P and Y^T represent permanent and transitory incomes, respectively. Then the *risk management* behavior can be defined as a response toward a change in the permanent income Y^P, since effectiveness of risk management strategy will affect children's opportunity cost of schooling in long-run. *Risk coping* strategies can be regarded as a short run response toward a transitory change in income Y^T.

In the period t, this household makes a decision on the period-t consumption and schooling after transitory and permanent income are realized. In other words, an information set at the beginning of the period t, I_t, which the household uses for the decision making, includes permanent income and the period-t transitory income. Formally, we have: $Y_{Pt} = Y_P^P + Y_{Pt}^T$, $E\left(Y_{Pt}^T | I_t\right) = Y_{Pt}^T$. This equation represents that, when parents make a decision about consumption allocation and schooling investment, their period-t cropping income has already been realized so that they have complete knowledge of their transitory and permanent incomes within the period.[9] We also assume that parents know the immediate income from child's labor market participation or on-farm work, i.e., $E\left(Y_{Cit} | I_t\right) = Y_{Cit}$. On the other hand, when this household makes a decision on the period t consumption and schooling, transitory income at the period $t+1$ has not been resolved yet and thus is assumed to be stochastic. Formally, this is represented by $Y_{Pt+1} = Y_P^P + Y_{Pt+1}^T$, $E\left(Y_{Pt+1} | I_t\right) = Y_P^P$, $E\left(Y_{Pt+1}^T | I_t\right) = 0$. The child's human capital production function is assumed to be a concave function of years of schooling, child specific factors CH, school accessibility and quality q, and an additive stochastic element e which incorporates possibilities such as risk of job-mismatching after schooling. Then, the household's human capital accumulation equation can be represented by the following equation:

$$H_{t+1} = H_t + \sum_{t=1}^{t} f(S_{it}, CH, FEM, q) + e_{it}, \tag{3}$$

[9] In other words, risk management strategies are assumed to be pre-determined and their outcomes are given, so that we can focus on risk-coping issues, although our framework allows us to identify these two income components separately.

where the concavity of human capital production function implies that $f_S > 0$ and $f_{SS} < 0$. The variable *FEM* is the gender specific indicator variable such that *FEM*=1 if the child is female and *FEM* = 0 if the child is male. We assume that e is independently distributed across individuals with $E(e_t | I_t) = 0$ and independent of other stochastic elements. The hypothesis of gender gap in wage level or return to education can be represented by the relationships that $f(S, CH, 0, q) > f(S, CH, 1, q)$ and $f_S(S, CH, 0, q) > f_S(S, CH, 1, q)$.

2.2.2 Possibilities of Credit Constraints

The households in developing countries, especially poor landless farm households, frequently cannot borrow against future income, i.e., they are likely to be credit-constrained. The credit constraints on households result from credit market imperfections, which may include financial repression such as interest rate restrictions imposed by government or from asymmetric information between lenders and borrowers [e.g., McKinnon (1973); Stiglitz and Weiss (1981); Carter (1988)]. To take into account of the potentially binding credit-constraint, the household is assumed to solve for optimal consumption and schooling under the following additional inequality:

$$A_t + Y_P^P + Y_{Pt}^T + \sum_{i=1}^{I} (1 - S_{it}) Y_{Cit} + B \geq C_t \tag{4}$$

where B represents a maximum amount of credit available to a household. When $B = 0$, the household is said to be completely credit-constrained. If B is sufficiently large and thus the credit-constraint equation (4) is never binding, the optimal solution of schooling becomes the one under perfect credit availability.

The household's problem can be described as follows:[10]

$$\underset{\{C_t, S_{it}\}}{Max}\ E_t\left[\sum_{k=0}^{T-t} \beta^k U(C_{t+k}) + \beta^{T+1} W(H_{T+1}, A_{T+1})\right]$$

$$s.t. \qquad A_{t+1} = \left[A_t + Y_P^P + Y_{Pt}^T + \sum_{i=1}^{I} Y_{Cit}(1 - S_{it}) - C_t\right](1 + r_t)$$

[10] Note that we assume an internal solution for the optimal schooling decision.

$$
\begin{aligned}
& H_{t+1} = H_t + \sum_{i=1}^{I} f(S_{it}, CH, FEM, q) + e_{it}, \\
& A_t + Y_P^P + Y_{Pt}^T + \sum_{i=1}^{I} (1 - S_{it}) Y_{Cit} + B \geq C_t \\
& B \geq 0,\ A_0 \text{ and } H_0 \text{ given},\ A_T \geq 0
\end{aligned}
\tag{1'}
$$

This stochastic programming model has two state variables, i.e., physical assets A and human capital H. When income is stochastic, analytical solutions to this problem, even without human capital, cannot be derived in general [Zeldes (1989)]. However, we can derive a set of first-order conditions that is necessary for an optimum solution. A dynamic programming approach reduces this multi-period problem to a sequence of simpler two-period decision problems. As a first step, we introduce a value function $V(A,H)$, which is defined as:

$V_t(A_t, H_t) \equiv \underset{\{C_t, S_{it}\}}{Max} \left\{ E_t \sum_{k=0}^{T-t} \beta^k U(C_{t+k}) + \beta^{T+1} W(H_{T+1}, A_{T+1}) \middle| \text{ s.t. constraints of (1')} \right\}$. This value function at time t is the present discounted value of expected utility evaluated along the optimal program. This is a function of assets and human capital at the beginning of period t.[11] The value function satisfies the following recursive equation, the Bellman equation:

$$
V_t(A_t, H_t) = \underset{\{C_t, S_{it}\}}{Max} [U(C_t) + \beta E_t V_{t+1}(A_{t+1}, H_{t+1})], \tag{5}
$$

subject to the constraints of (1'). Let λ represent the Lagrange multiplier associated with credit constraint equation. This variable λ indicates the increase in expected lifetime utility that would result if the current constraint were relaxed by one unit. If the household is constrained from borrowing more, not from saving more, λ enters with a positive sign.

The first order conditions associated with C, S, H, and A for this dynamic programming problem are represented as follows:

$$
U'(C_t) = \frac{\partial V_t}{\partial A_t} \tag{6}
$$

$$
\beta E_t \left[\frac{\partial V_{t+1}}{\partial H_{t+1}} \frac{\partial f}{\partial S_{it}} \right] = \beta E_t \left[\frac{\partial V_{t+1}}{\partial A_{t+1}} Y_{Cit} (1 + r_t) \right] + \lambda_t Y_{Cit} \tag{7}
$$

[11] This value also depends on the conditional joint distribution of future income, interest rate and the length

(8) $$\frac{\partial V_t}{\partial H_t} = \beta E_t\left[\frac{\partial V_{t+1}}{\partial H_{t+1}}\right]$$

(9) $$\frac{\partial V_t}{\partial A_t} = \beta E_t\left[\frac{\partial V_{t+1}}{\partial A_{t+1}}(1+r_t)\right] + \lambda_t$$

2.2.3 The Case of Perfect Credit Availability (λ=0)

When a household can borrow and save money freely at an exogenously given interest rate, the credit constraint is not binding, and thus the Lagrange multiplier associated with the credit constraint is zero, i.e., λ=0. In this case, combining (6) and (9), we get:

(10) $$U'(C_t) = \beta E_t\left[U'(C_{t+1})(1+r_t)\right].$$

Equation (10) is the usual intertemporal marginal utility equalization condition that gives an Euler equation for the optimal consumption path. From equation (7) and (8), combined with (9), we get:

(11) $$\left[\frac{\partial f / \partial S_{it+1}}{\partial f / \partial S_{it}}\right]\left[\frac{Y_{Cit}}{Y_{Cit+1}}\right] = \frac{1}{(1+r_t)}, \forall\, i.$$

This equation corresponds to the equation (4) of Jacoby and Skoufias (1997) under complete financial markets. The left-hand side of equation (11) is marginal rate of transformation and the right-hand side represents exogenously given interest rate. Equation (11) indicates that a household with perfect access to credit will determine the evolution of optimal schooling so as to equalize the net marginal productivity of schooling and the non-stochastic market interest rate. The optimal schooling decision rule at t can be represented as a reduced form equation of (11):

(11') $$S_{it}^{*} = S^{NC}(CH, FEM, q, r_t, g_{it}; I_t^{NC}),$$

where g_{it} represents the child's wage growth rate, i.e., $g_{it} \equiv (Y_{Cit-1}/Y_{Cit}) - 1$, and I_t^{NC} represents the

---

of this generation.

information set at t. This is a nonlinear difference equation for the optimal schooling decision. This equation (11') indicates that if credit constraint is not binding, parental income or schooling decisions of other children does not affect the schooling decision of a child. In other words, two separabilities, one for consumption and schooling decision and the other for intrahousehold schooling allocation, hold in this model. The optimal level of schooling is a function of child specific variables, gender specific elements, and school availability and quality.

2.2.4 Case of Binding Credit Constraint ($\lambda>0$)

When the credit constraint is binding and thus $\lambda > 0$, we have the following modified Euler equation from the two equations (6) and (9):

$$U'(C_t) - \beta E_t\{U'(C_{t+1})(1+r_t)\} = \lambda_t > 0. \tag{12}$$

This indicates that under a binding credit constraint, the household cannot achieve the smooth consumption profile available with credit markets [Figure 2.1]. The marginal utility differential, λ, represents the welfare cost of the credit market imperfections. Instead, the household effectively faces an endogenous shadow interest rate. To see this, substituting equations (6) and (8) into (7) gives

$$\left[\frac{\partial f / \partial S_{it+1}}{\partial f / \partial S_{it}}\right]\left[\frac{Y_{Cit}}{Y_{Cit+1}}\right] = E_t\left[\frac{\beta U'(C_{t+1})}{U'(C_t)}\right], \forall i. \tag{13}$$

This corresponds to the equation (4) of Jacoby and Skoufias (1997) for the intertemporally autarkic households. By inspecting equation (13), it becomes obvious that under credit market imperfections, the separability between consumption and schooling investment decisions breaks down. Moreover, the separability among different children's schooling decisions does not hold. Equation (13) for I children in a household and equation (4) satisfied as equality together constitute a complicated system of non-linear simultaneous equations. Under this non-separability, the reduced form schooling decision can be represented by the following nonlinear difference equation.

$$(13') \qquad S_{it}^{*} = S^{C}\left(Y_{P}^{P}, Y_{Pt}^{T} + \sum_{j \neq i} Y_{Cjt}(1 - S_{jt}^{*}), CH, FEM, q, r_t, B, g_{it}; I_t^{C} \right),$$

where I_t^{C} represents a vector of other variables which are known at time t. In equation (13'), parental income, Y^{P} and Y^{T}, and other children's schooling decisions, S_{jt}^{*}, $\forall j \neq i$, become relevant to the child i's schooling. Gender specific elements affect the optimal schooling decision as well, as in the case of complete credit market model. The sign of derivative of equation (13') and their implications are summarized as the following two propositions.

Proposition 1 (*Permanent versus transitory income effects*): Under binding credit constraint, the realized transitory income in the period t has a positive impact on the optimal level of schooling at t. On the other hand, the effect of permanent income on the optimal schooling is ambiguous. The effect of an increase in transitory income is always greater than the effect by an increase in permanent income.

Proof: By differentiating equation (13), we have

$$(14) \quad \frac{dS_{it}^{*}}{dY_{Pt}^{T}} = \left[\frac{f_{Sit+1} f_{SitSit}}{f_{Sit}^{2}} \frac{Y_{Cit}}{Y_{Cit+1}} + E_t\left(\frac{\beta U'(C_{t+1})}{U'(C_t)^{2}} \right) U''(C_t) Y_{Cit} \right]^{-1} \bullet E_t\left(\frac{\beta U'(C_{t+1})}{U'(C_t)^{2}} \right) U''(C_t) > 0,$$

$$(14') \quad \frac{dS_{it}^{*}}{dY_{P}^{P}} = \left[\frac{f_{Sit+1} f_{SitSit}}{f_{Sit}^{2}} \frac{Y_{Cit}}{Y_{Cit+1}} + E_t\left(\frac{\beta U'(C_{t+1})}{U'(C_t)^{2}} \right) U''(C_t) Y_{Cit} \right]^{-1} \bullet \left[E_t\left(\frac{\beta U'(C_{t+1})}{U'(C_t)^{2}} \right) U''(C_t) - E_t\left(\frac{\beta U''(C_{t+1})}{U'(C_t)} \right) \right] \begin{matrix} > \\ < \end{matrix} 0$$

It is easily verified that $\frac{dS_{it}^{*}}{dY_{Pt}^{T}} > \frac{dS_{it}^{*}}{dY_{P}^{P}}$. Q.E.D.

This proposition indicates that for credit-constrained households, the effect of transitory shortfalls of income on human capital investment decisions is at least as large as that of a decline in permanent income of the same magnitude. In other words, schooling behavior is expected to be more sensitive to transitory poverty than chronic poverty.

Jacoby and Skoufias (1997) emphasized the distinction between anticipated and unanticipated components of transitory income. The anticipated component is the projection of the current change in income net of an aggregate component on information available to the household in the previous period. On the other hand, the unanticipated component is predicted from information unknown to the household in the previous period. However, in case of binding

credit constraints, it does not matter much whether a shock was anticipated or not. If the household cannot borrow and has insufficient resources to cover consumption needs, it will use any means to meet these needs, whether or not the income shortfall was anticipated or not. What changes is how the household behaves in the previous period. If a shock is fully anticipated, then the household should save more in the preceding period to buffer it. It may also decide whether it is not worth trying to send kids to school. But these effects happen in the preceding period; the effects on the current period conditional on having sent kids to school and having accumulated a given level of assets are the same whether a shock is anticipated or not.[12]

Proposition 2 (*Resource competition effect*): Under binding credit constraint, additional education of a sibling has a negative impact on the optimal education level of a child. This resource competition effect is stronger when a sibling at school has a higher (potential) wage rate than other children within the household do.

Proof:

$$\frac{dS_{it}^{*}}{dS_{jt}^{*}} = -\left[\frac{f_{Sit+1}f_{SitSit}}{f_{Sit}^{2}}\frac{Y_{Cit}}{Y_{Cit+1}} + E_t\left(\frac{\beta U'(C_{t+1})}{U'(C_t)^{2}}\right)U''(C_t)Y_{Cit}\right]^{-1} \bullet E_t\left(\frac{\beta U'(C_{t+1})}{U'(C_t)^{2}}\right)U''(C_t)Y_{Cjt} < 0.$$

It is easily verified that $\frac{dS_{it}^{*}}{dS_{jt}^{*}} < \frac{dS_{it}^{*}}{dS_{kt}^{*}} < 0$, $i \neq j$, $i \neq k$, if $Y_{Cjt} > Y_{Ckt}$. Q.E.D..

This indicates that, under binding credit constraint, parents must select how to ration available resources between their children. When a child's opportunity cost of schooling is large, then he/she will be compensated by the other child's low level of schooling and/or (shadow) wage income. In a typical rural Pakistan setting, men have higher wage rate and return to education. Then, sons can gain from having sisters instead of brothers since they will be provided with more years of schooling. Similarly, daughters can gain from having sisters instead of brothers [Garg and Morduch (1998)].

[12] Moreover, Jacoby and Skoufious (1997) used the interactions between farm characteristics and rainfall to identify the idiosyncratic, unanticipated income change. Unfortunately, the IFPRI data does not contain village-specific rainfall data which is indispensable for identifying the idiosyncratic, unanticipated income change. Hence, Chapter 2 used the transitory component which potentially contains both unanticipated and anticipated changes. Some improvements were made in Chapter 3.

2.3 The Econometric Framework: Estimation of Conditional Probability

The existence of credit market imperfections and the issues of intrahousehold resource allocation can be investigated by testing whether coefficients of permanent and transitory incomes, (Y_P^P, Y_{Pt}^T), and siblings' income, $\sum_{j \neq i} Y_{Cjt}(1 - S_{jt}^*)$, are zero or not [see equations (11') and (14')]. Hence, we are particularly interested in testing restrictions imposed on these coefficients in the following econometric model. Another aim of our empirical analysis is to test whether there is a distinct gender gap in education by inspecting the direction of coefficients on female dummy variables.[13] Moreover, the potential resource competition effects among siblings can be investigated by incorporating sibling composition variables.

2.3.1 Estimation of Conditional Probability Functions

Consider the four levels of education in Pakistan: none, primary, middle, secondary, and post-secondary [Table 2.1]. Educational outcomes are assumed to result from sequential decisions. The first decision is whether to enter into a primary school. For those who enter into a primary school, the second decision is whether to finish a primary school or dropout before graduation. Then, for those who graduate a primary school, the third decision is whether to enter into a middle school or quit schooling. The fourth decision is whether to finish or dropout before graduation. For those who graduate middle school, the fifth decision is whether to enter into a secondary school. The sixth decision is whether to leave education before grade 10 or to graduate a secondary school. The final decision is whether to continue beyond a secondary school, i.e., to enroll in college, technical or teacher training school. This sequential decision making process is analogous to a two-state Markov model with exogenous variables, although certain transitions are ruled out by nature of schooling process, e.g., a child cannot graduate from a primary school if he/she does not have entry in the first place.

As will be described below, our panel data do not record the detailed history of schooling decisions of all children. This makes the estimation of the full sequential decision model impossible. All we know is that the schooling decision over the three years survey period.[14] Our approach here is to construct a simple model of binary dependent variables of regenerative

[13] This indicates that we will investigate the relationship, $S_t^*(\bullet, FEM=1) < S_t^*(\bullet, FEM=0)$.

[14] The author collected household-level retrospective data on education through re-surveys of IFPRI panel households in rural Pakistan for chapter 3. By gathering the entire schooling history of all children, the full

sequential decision making, controlling for differences in decision making of different decision stages by adding variables such as child age and time dummies. We estimate probability equations for dropouts from school separately from entrants to school, i.e., probabilities, conditional on the schooling decision of the last period. Conceptually, sampled children can be classified into one of the following categories: (i) no schooling, (ii) entrant, (iii) continuing schooling and (iv) dropout [Table 2.2]. These are mutually exclusive and exhaustive categories. The first and second cases are used for entrants models, which are conditional on the sample of children without previous schooling, i.e., conditional on $S^*_{t-1} \leq 0$. In the third and forth cases, we construct a binary dropouts qualitative model, which is conditional on the sample of children with some schooling, i.e., $S^*_{t-1} > 0$. The child's schooling behavior at time t - 1 is determined before entrance/dropout decision at time t. In this setting, we can estimate the entrant model and the dropout model separately as conditional probability models [Table 2.2]. Since, our data set does not allow us to know the entire history of past schooling behavior of children, this is the best we can do. Lack of time series observations thus places constraints on the regressions we are able to run. Given the data constraints, we believe that the regressions we have chosen are the most insightful and consistent with the theoretical framework.

As described above, consider the two decisions, i.e., school entrance and exit. Educational outcomes are assumed to result from these sequential decisions. The first decision is whether to enter education. For those who attend a school, the second decision is whether to continue schooling or exit education. We, therefore, can define two binary dependent variables as follows [Table 2.2]:

ENT_{it} = 1 if child i enter school at t
= 0 if child i does not enter school at t,

DRP_{it} = 1 if child i finish education at t
= 0 if child i continue schooling at t.

Since equation (13') is a non-linear equation in general, the problem of econometric model specification is made manageable at the cost of some generality [Amemiya (1981, p.1486)]. Following the convention in the empirical literature, we utilize a linear specification of the augment of the cumulative distribution function. Then the conditional probabilities can be

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sequential schooling decision model can be estimated econometrically.

written as [Amemiya (1981; 1985); Maddala (1983)]:

$$\Pr(ENT_{it}=0)=\Pr(S^*_{it}\le 0 \mid S^*_{it-1}\le 0, X_{it})=1-F(\alpha_h+X_{it}\pi),$$
$$\Pr(ENT_{it}=1)=\Pr(S^*_{it}>0 \mid S^*_{it-1}\le 0, X_{it})=F(\alpha_h+X_{it}\pi),$$

$$\Pr(DRP_{it}=0)=\Pr(S^*_{it}>0 \mid S^*_{it-1}>0)=F(\alpha_h+X_{it}\beta),$$
$$\Pr(DRP_{it}=1)=\Pr(S^*_{it}\le 0 \mid S^*_{it-1}>0)=1-F(\alpha_h+X_{it}\beta),$$

where X indicates a vector of explanatory variables and α_h represents household specific fixed effects. Note that i and h represent child and household subscripts, respectively. Recall that the optimal schooling decision rule under imperfect credit is given by equation (13'). A household's location is one of the most important determinants of child wage availability, school accessibility and school quality such as the number of schools and the number of teachers. Hence, the child wage growth rate, g, and school availability, q, are assumed to be captured by child specific characteristics, CH, household specific characteristic, α_h, and labor market conditions which are affected by the economy's aggregate performance. We assume that time specific dummy variables, t_t, capture the effects of aggregate shocks and the possible cohort effects. The child specific characteristics, CH, include information about the child's relation to the household head, and the age of child. A vector of sibling composition variables, SIB substitutes the siblings' income $\sum_{j\neq i} Y_{cjt}(1-S^*_{jt})$, which represents the resource competition effect. Moreover, we assume that household fixed effects also capture the upper-limit of credit, B, and the interest rate household face, r. Finally, we can define the matrix X as $X\equiv[Y^p, Y^f, CH, SIB, FEM, t]$.[15]

Coefficients of these models can be estimated separately. $\Pr(ENT=1)$ represents a probability of entrance to primary school given the child did not have schooling last year. The parameters π can be estimated from the subsample with $S^*_{it-1}\le 0$ by dividing it into two groups: not enter primary school, enter primary school. Similarly, $\Pr(DRP=1)$, a probability of dropout given the child entered school can be estimated from the subsample with $S^*_{it-1}>0$. This model is easily estimated provided that we make the probability of choice at each stage independent of the choice at the previous stage.[16]

[15] Parental income is a function of assets as in the standard life cycle-permanent income framework of consumption, so that the value of family asset is omitted from the estimation.

[16] This model is valid only if the random factors influencing responses at various stages are independent.

2.3.2 The First Step

We estimate the model by a two step procedure. In the first stage, we decompose income into permanent and transitory components. Then, we run the above mentioned binary variable regressions using the consistent estimates of permanent and transitory incomes in the right hand side. Conceptually, a household's income at time t can be decomposed into permanent income and transitory income as follows: $Y_t \equiv Y_t^P + Y_t^T$, where $E(Y^T) = 0$. We employ Paxson (1992), Alderman and Garcia (1993), Alderman (1996) and Fafchamps, Czukas, and Udry (1997)'s regression approach to estimate permanent and transitory income. Formally, this approach utilizes separate panel estimation results for each district:

$$Y_{ht} = \beta_h + X_{ht}^P \beta_1 + X_{ht}^T \beta_2 + \beta_t + u_{ht},$$

where h represents household and district identifications, respectively. The first term, i.e., household fixed effects β_h, and the second term, $X^P{}_{ht}\beta_1$, in the right hand side denote permanent components of income with X^P being matrix of physical and human asset variables. The vector β_1, therefore, represents a vector of returns from these assets. Similarly, transitory variables matrix is denoted by X^T and $X^T{}_{ht}\beta_2$ represents transitory income. The time specific fixed effects, β_t, are treated as another component of the transitory income, since these capture effects of aggregate shocks.

This model is estimated by household fixed effects panel regression separately for each district. The fitted value of the first two terms in the right hand side together, i.e., the fitted value of $\beta_h + X^P{}_{ht}\beta_1$, is considered as the permanent component of the income. The prediction of the fourth and fifth terms, i.e., the fitted value of $X^T{}_{ht}\beta_2 + \beta_t$, is treated as the transitory component. The residual is thought to be the sum of permanent income, transitory income and measurement error.

2.3.3 The Second Step 1: A Framework for Entrants Conditional on $S^*_{t-1} \leq 0$

We estimate the above mentioned binary dependent variable models using the estimated permanent and transitory incomes in the right hand side. For the sample that is composed of (i) no schooling and (ii) school entrants, we can define a binary variable, *ENT*. For children before

schooling, $ENT = 0$ and for those children who enter school, $ENT = 1$ at the entrance year [Table 2.2]. The probabilities that $ENT = 0$ and $ENT = 1$, conditional on $S^*_{t-1} \leq 0$, become:

$$\Pr(ENT_{it} = 0) = \Pr(S^*_{it} \leq 0 \mid S^*_{it-1} \leq 0, X_{it}) = 1 - F(\alpha_h + X_{it}\pi),$$
$$\Pr(ENT_{it} = 1) = \Pr(S^*_{it} > 0 \mid S^*_{it-1} \leq 0, X_{it}) = F(\alpha_h + X_{it}\pi),$$

respectively, where X is a matrix defined as $X \equiv [Y^P, Y^T, CH, SIB, FEM, t]$ and α_h represents household fixed effects. We estimate this qualitative response model with household fixed effects. This approach might be better since we can capture possible household specific unobserved characteristics which may reflect each household's credit availability, child value, distance to schools and so on. Although it is difficult to justify the choice of one distribution or another on theoretical grounds [Amemiya (1981)], it has been found that the probit model does not lend itself at all to the treatment of fixed effects since there is no feasible way to remove heterogeneity with large numbers of cross-sectional units [Greene(1993)]. Estimation of the probit model with fixed effects is intractable. Let us realign the data so that the data of child i at time t can be represented by the τth data of household h. Then, the likelihood function for this model with household fixed effects can be represented by $L = \prod_h \prod_\tau \left\{ F(\alpha_h + X_{h\tau}\pi)^{1-ENT_{h\tau}} \left[1 - F(\alpha_h + X_{h\tau}\pi)\right]^{ENT_{h\tau}} \right\}$. However, it has been shown that the maximum likelihood estimators for α_h and π are inconsistent if there are only a small number of observations per household [Chamberlain (1980) and Hsiao (1986), pp.159-161].

Chamberlain (1980) developed an alternative approach using a conditional likelihood function. Chamberlain (1980) showed that the conditional likelihood approach could be applied directly to the fixed effect logit probability model. Hence, we implement estimation of the model assuming $F(\bullet)$ is logistically distributed, i.e., $F_{h\tau} = 1/[1 + \exp\{-(\alpha_h + X_{h\tau}\pi)\}]$. To see this approach, define $ENT_h = (ent_{h1}, ent_{h2}, \cdots, ent_{hT})$ be the observations for the hth household as a whole. Then the total number of observed "ones" for the dependent variable in the hth household becomes $\sum_{\tau=1}^{T} ent_{h\tau}$ and thus the probability of the outcome ENT_h conditional on this number can be represented as:

$$prob\left(ENT_h \middle| \sum_{\tau=1}^{T} ent_{h\tau} \right) = \frac{\exp\left(\sum_{\tau=1}^{T} ent_{h\tau} X_{h\tau}\pi \right)}{\sum_{d_h \in B_h} \exp\left(\sum_{\tau=1}^{T} d_{h\tau} X_{h\tau}\pi \right)},$$

where $B_h = \left\{ (d_{h1}, \cdots, d_{hT}) \middle| \, d_{h\tau} = 0 \text{ or } 1 \text{ and } \sum_{\tau=1}^{T} d_{h\tau} = \sum_{\tau=1}^{T} ent_{h\tau} \right\}$. Using the above conditional density, the conditional log-likelihood function is defined as

$$l = \sum_{h=1}^{N} \left[\sum_{\tau=1}^{T_h} ent_{h\tau} X_{h\tau}\pi - \log \sum_{d_h \in B_h} \exp\left(\sum_{\tau=1}^{T_h} d_{h\tau} X_{h\tau}\pi \right) \right],$$

where N denotes the number of households in the sample. Note that the conditional maximum likelihood does not depend on the household specific parameter and thus the estimator of π can be easily obtained by maximizing this function. Chamberlain (1980) showed that this conditional likelihood function gives consistent estimates for coefficients π and their variances under mild regularity conditions.

2.3.4 The Second Step 2: A Framework for Dropouts Conditional on $S^*_{t-1} > 0$

The case of school dropouts can also be formulated in a framework similar to the one used for entrants. In this regression, we divided the sample into (iii) continuing and (iv) dropout students and estimate the probability of $S^*_t > 0$ or $S^*_t \leq 0$, conditional on schooling at t-1, i.e., $S^*_{t-1} > 0$. Suppose that X is a list of variables as before. Then, the conditional probabilities become:

$$\Pr(DRP_{it} = 0) = \Pr(S^*_{it} > 0 \mid S^*_{it-1} > 0) = F(\alpha_h + X_{it}\beta)$$
$$\Pr(DRP_{it} = 1) = \Pr(S^*_{it} \leq 0 \mid S^*_{it-1} > 0) = 1 - F(\alpha_h + X_{it}\beta),$$

where X is defined as $X \equiv [Y^P, Y^T, CH, SIB, FEM, t]$ and α_h is household fixed effects. We will estimate this model by maximizing the conditional likelihood function with the assumption of logistic distribution, that is, $F_{h\tau} = 1/[1 + \exp\{-(\alpha_h + X_{h\tau}\beta)\}]$, as before.

2.4 The Data Source and Empirical Results

We employ the rural Pakistan panel data collected through the IFPRI (International Food Policy Research Institute) Pakistan Food Security Management Project. The data set contains rich information about various aspects of the economic environment as well as decisions of poor farmers in the area. For example, this data set covers various topics such as income, expenditures, food consumption, nutrition and health status, education, employment, landowning, and rural credit [Alderman and Garcia (1993); Adams and He (1995)]. Moreover, because of its panel nature, we can trace various intertemporal behaviors of households.

The IFPRI panel data set was collected by 14 rounds of survey (round 1 to 14) over six years from 1986 (*kharif*; monsoon wheat season) to 1991 (*Rabi*; winter season). The base year (year zero) is July-September 1986; the first year is from September/November 1986 to July/August 1987; year two is from December 1987/February 1988 to July/October 1988; the third year is from December 1988/February 1989 to July/September 1990; the fourth year is June-July 1990; the fifth year is September-October 1991.[17] Around one thousand households were included in the initial survey. Based on the Pasha and Hasan (1982)'s development ranking of Pakistani districts, the IFPRI household surveys were conducted in the three less developed districts; Attock district of Punjab province, Badin district of Sind province, and North-West Frontier Province (Dir) [Alderman (1996)]. A relatively well-developed and irrigated district, Faisalabad in Punjab province, was also included in the survey for comparison purposes (Figure 2.3). The surveyed villages and households were selected initially from a stratified random sample. Two markets (*mandis*) were randomly chosen in each district and for each *mandi*; villages were divided into three different categories: those within five kilometers of the *mandi*; those within five to ten kilometers; and those within ten to twenty kilometers. The final survey villages were selected randomly from these categories. Households were then chosen randomly from a complete list of families in each village, although minor variations in the process reflect special conditions in each area [Alderman and Garcia (1993)].[18]

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[17] The survey month differs slightly across districts.

[18] Based on this IFPRI Pakistan panel data set, several studies have been implemented in the various subjects of poverty and food security and their consequences for nutrition and health [Alderman and Garcia (1993)], saving and consumption smoothing behavior against income shocks [Alderman (1996)], calorie-income relationship [Behrman, Foster, and Rosenzweig (1997)], determinants of the large educational gender gap [Alderman, Behrman, Ross and Sabot (1996a)], wage differentials and level of education [Alderman, Behrman, Ross and Sabot (1996b)], income distribution [Adams and He (1995)], human capital investment [Alderman and Gertler (1997); Fafchamps and Quisumbing (1998)], and the intrahousehold allocation of medical expenditures [Kochar (1999b)]. Alderman (1996) found that although households use

2.4.1 Variables

For income regressions, we utilize the five-year panel data of 764 households from 1986/87 until 1990/91. Aggregate household income variable is computed by summing six sources of income; crop profits, livestock income, rent, agricultural wages, nonfarm income, and transfers [Alderman and Garcia (1993)]. As dependent variables for permanent income, X^P include the value of total livestock, irrigated land holdings, rainfed land holdings, the number of male and female members aged sixteen or older, between the ages of six and sixteen, and number of children who are younger than six. Household fixed effects are also considered as a part of permanent income. Transitory income variables X^T include the number of adults older than sixteen who died during the period, number of dead animals, and district-level deviation of annual rainfall from 20 years average. The time specific fixed effects are also treated as transitory income components. Table 2.3 provides the summary statistics of these variables for each district.

For the logit estimations, we used the first four years out of six years of data due to the unavailability of schooling data in the later years. From the original IFPRI data files, we constructed a binary variable of school attendance, *YSTIME*, which takes one and zero for those who do and do not attend school, respectively. This variable is constructed by combining the data of the non-farm activity files (round 4 to 14) and that of the schooling questionnaire in the household information file (round 1, 8, 9, 10, 11, and 12). In Pakistan, a primary school year starts in May/July and ends in April, so we use the data of the round 1 (July-September 1986) for the base year, round 6 (June-August 1987) for the first year, round 9 (July-October 1988) for the second year, and round 12 (July-September 1989) for the third year. Taking the first difference of this variable *YSTIME*, the binary variable of school entrants, *ENT*, can be created for years one, two and three. Similarly, the binary variable of schooling continuation or dropout, *DRP*, is constructed from *YSTIME*.[19]

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a variety of instruments for saving to buffer consumption, they face difficulty of smoothing consumption under repeated income shocks. Further, non-farm income from unskilled labor, self-employment, and government employment are the important income sources in the regions [Adams and He (1995)]. Hence, the data set will be very useful in looking at the importance of child labor market participation in these regions.

[19] To check the potential sample bias of the IFPRI survey, we compared the school attendance rates calculated from these files with attendance rates from the Pakistan Integrated Household Survey (PIHS) that covers wider households. The age profiles of the school attendance rate from these data sets seem to be consistent each other.

Rural Pakistani households in the data set typically employ a joint family system where families of brothers live together and share household resources. In fact, household unit is defined as all offspring of a household head except married daughters who live separately. We therefore define sibling broadly as the all offspring of a household head such as children and grandchildren of the household head. We then need to select siblings variables, *SIB*, so as to capture the intrahousehold educational resource allocation effect, $\sum_{j \neq i} Y_{Cjt}(1 - S^{*}_{jt})$. Since our data set does not provide child wage rate, we assume that *SIB* is composed of number of elder brothers and sisters at school and out of school, number of younger brothers and sisters at school and out of school.

The effects of gender specific variable, *FEM*, are captured simply by a female dummy variable and gender interaction terms. Although the household specific effects are incorporated in the logit model to control for household and village level difference in school and labor market accessibility, credit availability, and other household level unobserved characteristics, this fixed effect is not explicitly estimated in our conditional logit model. The summary statistics of variables used in the conditional logit estimations are described in Table 2.4.

2.4.2 Income Regressions

Table 2.5 reports the estimated coefficients of the income regression equation for each district. The estimation procedure for the fixed effect panel model is employed for each district's income and assets data. In the first stage, coefficients of most of variables are consistent with theoretical prediction. The coefficients of physical asset variables are almost all positive with high degrees of statistical significance, indicating that holding physical assets gives positive returns. Similar implications can be derived for human asset variables. Positive and significant coefficients on elder male member variables indicate that return from male human assets are highly positive in these villages. For transitory shock variables, it is notable that deviation of annual rainfall from long-term average has a negative and statistically significant impact on household income. This indicates that these households in Pakistani villages have limited income insurance devices and thus are vulnerable to exogenous weather shocks.[20]

[20] However, we should note that several of the coefficients for the income regressions have unexpected signs, although these coefficients are not statistically significant. The most striking result is a large positive and significant coefficient on number of adult member dying during a year in Badin. This might capture

2.4.3 The Entrant Model

For entrant and dropout models, we employ three year panel data for children of ages between three and twenty three years old for entrants and between five and nineteen for dropouts, together with household background data. Basic estimation results of the conditional logit regressions are reported in Table 2.6.

The results from entrant regressions for children of age 3 - 23 (reported in Table 2.6) can be summarized as follows. First, coefficients of transitory income are consistently positive for entrant results, implying that positive shock to transitory income enhance probability of entrance to school. The joint Wald tests of the null hypothesis of no permanent and transitory income effects are rejected statistically in both specifications. The symmetric effects between permanent and transitory incomes are rejected and thus the results support the theoretical prediction of asymmetric effects of permanent and transitory incomes on schooling behaviors. Schooling behaviors in rural Pakistan, therefore, seem to be more sensitive to transitory poverty than chronic poverty. Recall that the optimal choice of amount of schooling under perfect credit availability was shown to be independent of parental income variables as in equation (11'), our empirical results therefore may indicate imperfect credit availability for human capital investment in these Pakistani villages, as in equation (13'). Directions of the estimated coefficients are consistent with the theoretical predictions presented in Proposition 1.

Second, this credit constraint effect is more significant for female children since the coefficient of female interaction terms are all statistically significant. These estimation results indicate that sensitivity or elasticity of schooling with respect to income shocks is large for females. Facing negative income shocks, female child shadow wage might be used as income insurance device more intensively than male child income. This is a new finding in the literature with respect to educational investments. A possible theoretical interpretation is that marginal schooling curve is flatter for females than for males. In this case, a negative income shock affects female education more than male education (Figure 2.2). Using the IFPRI Pakistan panel data set, Alderman and Gertler (1997) found that income elasticities of demand for medical expenditure is uniformly larger for females than for males, whose finding is consistent with ours.

Moreover, all of the gender dummy coefficients, *FEM*, are negative and significant for entrant regressions in Table 2.6 and 2.7, indicating that daughters have consistently lower probability of entrance of school than that of sons. This implies that a daughter has a higher

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effects other than negative income shocks. Overall coefficients, however, are statistically significant.

possibility of no-education than a son does. Pakistani parents apparently favor sons in terms of education.

The results also throw light on other aspects of intrahousehold resource allocation. First, coefficients for variables of number of siblings out of schools are all positive and statistically significant. These results indicate that existence of siblings out of school seems to enhance a child's school entry probability and thus sibling resource competition effects might exist. Second, statistically significant and positive coefficients on son/daughter and grandchild dummy variables imply that there is household head's apparent favor toward their own offspring.

2.4.4 The Dropout Model

The dropout regression results for children of age 5-23 are reported in the last two columns Table 2.6. The preliminary findings of these results are similar to the results of entrant models. First, coefficients of transitory income is consistently negative, which implies that higher transitory income reduce the probability of dropping out from school. As is in the case of entrant regressions, the negative directions of the estimated coefficients for dropout probabilities are consistent with theoretical predictions of Proposition 1. Moreover, these estimated coefficients support the theoretical prediction of asymmetric effects of permanent and transitory incomes on schooling behavior. Again, these results imply that the households in rural Pakistan might face binding credit constraints [equations (11') and (13')]. Schooling behavior in rural Pakistan, hence, seems to be more sensitive to transitory poverty than to chronic poverty.

Second, all of the female dummy coefficients, *FEM*, are positive and significant for dropout models, indicating that girls have higher probabilities of dropping out of school than boys do (Table 2.6 and 2.7). Moreover, transitory income coefficients are consistently positive and significant for female dummy interaction terms, implying that the transitory income elasticity of school dropout probability is higher for females than that for males (Table 2.7). Again, this finding implies a difference in the curvature of marginal schooling (Figure 2.2). These results regarding gender gap show that, after having entered a school, a daughter obtains systematically less education than a son, and that, facing negative income shocks, female children will be withdrawn from schools first. These households might use daughters' labor as income insurance device more intensively than sons' labor.

Third, for specification II, coefficients on number of elder brothers at school are positive and statistically significant while those on number of elder brothers out of school are negative and

significant. These results indicate that having elder brothers at school increases dropout probability, although existence of out-of-school elder brothers seems to decrease a child's school dropout probability. This demonstrates the importance of resource competition among siblings. Additional income to the household from elder sons might extend the total household resources and thus support the education of younger children. Together with the results of female specific effects, this indicates that the younger brother has a lower probability of dropping out from school.

2.4.5 Sibling Variables and Endogeneity Issues

In order to capture the intrahousehold educational resource allocation effect, $\sum_{j \neq i} Y_{Cjt}(1 - S^*_{jt})$, we employed the number of siblings at school and out of school as siblings variables in the estimations reported in Tables 2.6 and 2.7. To investigate the robustness of the results, we employ an alternative set of *SIB* variables (Table 2.8). The first set of variables includes a new variable such as

$$\frac{\textit{Number of elder brothers at school} - \textit{Number of elder brothers out of school}}{\textit{Total number of elder brothers} + 1}.$$

where one is added to the denominator in order to avoid division by zero.[21] As shown in the specification III column of Table 2.8, we include similar variables for elder sisters, younger brothers, and younger sisters. Empirical results seem to be remarkable. We observe that these coefficients are all negative and statistically significant for the entrant model. The results indicate that a higher proportion of brothers and sisters at school decreases school entrance probability, implying the existence of resource competition effects among siblings. The results of dropout model also indicate that coefficients for the sibling variables are positive and significant especially for elder and younger brothers (the specification III in Table 2.8). A higher proportion of schooling siblings increases dropout probability.

If, however, there is a common household shock to all children's schooling decisions, the sibling variables in Table 2.6, 2.7, and 2.8 generate an endogeneity problem. The simultaneity of educational decisions may result in biased estimated of coefficients. To eliminate the endogeneity bias, we utilize the second alternative set of sibling variables, which is composed of

the data of total number of elder brothers and that of sisters. Given the past household's birth decision, the number of elder siblings can be regarded as exogenous variables. The estimation results are represented in the specification IV columns of Table 2.8. The coefficient of number of elder sisters in the entrant model is the only coefficient that is statistically significant. This positive coefficient indicates that having many elder sisters increase school entry probability, which is similar to the findings of Parish and Willis (1993). Additional elder sisters are associated with more education for both men and women. This might be because elder sisters reduce the resource constraint on the family, either by providing domestic labor or by marrying early. The results of the specification IV in Table 2.8 imply that resource constraints are binding and elder daughters bear a good part of that burden [Strauss and Thomas (1995, p.1990)].

2.4.6 Permanent versus Transitory Income

Empirical results of the above regressions suggest that the role of permanent income play in school attendance is not statistically significant. While this finding is consistent with the theoretical implication, a possible alternative explanation for this result is derived from the use of household fixed effects. Permanent income is obtained by regressing income on a household fixed effect plus human and physical asset variables such as age composition of household members, land and livestock. Since these asset variables may not vary much over time, the large portion of permanent income might be captured by the household fixed effect. When we regress schooling variable on permanent income including household fixed effects, we might obtain high multicollinearity between the permanent income variable and the household fixed effects. Although estimated coefficients of transitory income remain valid, the double use of fixed effects may make estimation of permanent income coefficients difficult because of the lack of variation in explanatory factors in permanent income. In other words, household fixed effects, which result in insignificant permanent income coefficients, might capture most of the permanent income effects in entrant and dropout regressions. In order to examine this conjecture, entrant and dropout models of schooling are estimated by incorporating village fixed effect, instead of household fixed effect. The estimation results are represented in Table 2.9. With the village fixed effects, the coefficients of permanent income become statistically significant in most specifications. The results indicate that our conjecture about multicollinearity might be true. Higher permanent income increases school entrance probability and decrease school dropout

[21] Note that, without adding one, the numerator becomes zero if total number of elder brothers is zero.

probability. The magnitude of permanent income effects, however, is always smaller than that of transitory income effects, as our theoretical framework suggests.[22]

2.4.7 Splitting Sample to Investigate Effects of Credit Constraint

A widely accepted view of credit constraints on households is that the credit constraints originate in credit market imperfections due to asymmetric information between lenders and borrowers. The moneylender cannot tell exactly which household is 'better' borrower beforehand without additional information and the adverse selection problem is inherent to credit transactions. Hence, LDC farmers without land ownership are likely to be rationed out from the credit market, since they lack in collateral to borrow money [Carter (1988)]. It is thus natural to regard that the landless poor are likely to be credit constrained while the rich face relatively better credit availability.

To take into account this difference in credit availability, we will split our sample into two groups: the rich and the poor. Two different criteria are employed to divide our sample, i.e., income level and total irrigated land ownership. First, we split the sample by five-year average income level (Table 2.10). The 50% income percentile is used as the threshold points for the rich and the poor. Table 2.11 reports the estimation results with interaction term for the poor households. Second, the sample is divided into two groups by irrigated land ownership. The poor are defined as those who do not have irrigated land (Table 2.12). The rich are with some ownership of irrigated land. Again, interaction terms for the poor are included in the estimation model.

From these estimation results, several aspects should be noted. First, for entrant models, transitory income affects the poor significantly while the effect on the rich is not necessarily statistically significant, as in Table 2.11 and 2.12. For dropout models, there is no statistical significant difference between the transitory income effects for the rich and the poor. This might reflect the fact that the poor are likely to be more credit constrained than the rich and thus the poor is in need for self-insurance devices at the school entry decision. However, after this entry decision, transitory income effects might not be systematically different among households with various different income levels. On the other hand, gender aspects may be a factor determining differences in school dropout decision (Table 2.7 and 2.8). Second, permanent income might

[22] We also estimated the gender specific village fixed effects model (Table 2.13). However, the qualitative result is not different from the model with village fixed effects (Table 2.9). Even after controlling for the gender gap in school supply side within a village, we observe the gap in household investment strategies.

affect the entrance and dropout decision of the poor, especially of the landless households. Households with some land ownership may increase educational investments if they face a negative permanent income shock; landless farmers will decrease these investments (Table 2.12). The results may reflect the complementality between the land ownership and the demand for on-farm labors. Alternatively, the results might imply differences in farmers' attitude toward risks. Third, female dummy coefficients, *FEM*, are negative and significant for the entrant regressions and positive and significant for the dropout regressions. The results indicate that girls have lower probability of school entry and higher probability of dropping out of school than boys do. Therefore, Pakistani parents, both poor and rich, apparently favor sons in terms of education.

2.5 Conclusions

This chapter investigates the sensitivity of schooling to changes in permanent and transitory income using panel data from rural Pakistan. The logit model with fixed effects is employed to estimate regenerative sequential schooling decision process, i.e., models for entrants to and dropouts from school. The results of entrants models demonstrate that positive shocks to transitory income enhance probabilities of entrance to school. Similarly, results from dropout regressions indicate that higher transitory income will decrease probability of dropout from school significantly. Village fixed effects estimation results show that permanent income also affects schooling pattern, although the magnitude of permanent income effects are always smaller than that of transitory income effects. These results imply that, for the poor households in these rural Pakistani villages, transient poverty is a serious obstacle to human capital investments. Human capital investments in rural Pakistan may be discouraged by poverty combined with incompletely insured income volatility. Moreover, results using divided sample indicate that the poor are likely to be more credit constrained than the rich are. Once a child entered school, however, credit constraint effect might not be systematically different between the rich and the poor. These results imply that the poor households' human capital investments at the school entry level are impeded by the transient poverty. On the other hand, the rich households invest in human capital since they do not need to use child labor income to compensate the parental income shortfalls.

We should note that effects of permanent and transitory incomes are not symmetric. These findings are consistent with our theoretical framework summarized in proposition 1. Facing a bad realization of parental income in the current period and a decline in Y^T, a credit-

constrained household will have relatively high marginal utility in the current period, given the past consumption and schooling decision. Hence, the household will be motivated to switch resources from the future periods to the current period by decreasing current education. Therefore, the current period child income will be used as a risk-coping device to smooth consumption. The effects of permanent income change, however, will be lower than the effects of transitory income since there are two opposing effects of permanent income increase. Lower permanent income decreases consumable resources in the current period thus hampers human capital investment. At the same time, lower permanent income has an income effect which decreases the relative importance of current child income and thus increases the incentive of the family to invest in human capital. Hence, for credit-constrained households, transitory shortfalls of income will affect human capital investment decisions more seriously than a decline in permanent income of the same magnitude. Schooling behavior is more sensitive to transitory poverty than chronic poverty. Our estimation results from households in these Pakistani villages are consistent with this theoretical prediction.

Other findings are summarized as follows. First, daughters consistently and significantly have a lower probability of entrance to and higher probability of dropping out of school. Moreover, after having entered a school, a daughter obtains systematically less education than a son does. Facing negative income shocks, female children at school might be used as income insurance device more intensively than male children at school are. The high opportunity costs of female education, the "leakage effect" of daughter's education after marriage, and the limited wage earning opportunities due to socio-economic reasons lead to less investment in female education. The empirical results in this chapter suggest that rural households are more likely to shy away from investing in daughter's education when they face temporary negative income shocks. Uninsured poor households might even employ peculiar strategies to buffer consumption against income shocks, sacrificing in turn the education of their daughters.

Second, we found that number of brothers and sisters at school decreases the entrance and increases the dropout probabilities. Moreover, having out of school siblings improves school attendance of children. These results imply that credit constraint is binding for households and thus resource competition effects among siblings exist. Given the limited availability of total household resources, having an additional child will decrease resource availability per child. Issues of educational resource allocation within the household, therefore, might have important welfare consequences of children. On the other hand, if credit is perfectly available to the household, a household decides the optimal years of schooling so that marginal productivity of

schooling is equalized to the exogenously available interest rate. With perfect access to the credit market, resource competition among siblings will not affect children's schooling pattern. Accessibility and availability of credit market transactions, therefore, seem to be a critical determinant of intrahousehold allocation pattern of educational resources.

2.5.1 An Alternative Explanation?

The theoretical framework used to interpret the empirical results is based on the Jacoby and Skoufias (1997)'s investment model of demand for education. However, there are alternative ways to explain the empirical findings. First, we can employ a household model which includes children's educations as consumption goods. Under market imperfection, this model can explain that transitory income becomes sensitive towards transitory income movements. Second, if the labor market is imperfect and thus the separability between labor supply and consumption decisions breaks down, parental income will affects child educational investments through changing shadow return rate of education. Based on MaCurdy (1981; 1983) and Kochar (1999c), the model in Appendix 2.1 integrates these two alternative aspects of education. The school demand function framework is derived under the assumption of child education as consumption goods and endogenous labor supply.

When the credit market is perfect, the two separabilities, one for consumption and schooling decision and the other for intrahousehold schooling allocation, hold in this model, as is the case in the investment model. On the other hand, when the credit constraint is binding, both permanent and transitory components of income affect schooling demand. However, while the investment model tells us the asymmetric effects, permanent income and transitory income effects should be symmetric in this consumption model. Therefore, we can test whether actual data prefers the consumption model or the investment model by testing the symmetric restriction of income coefficients. If coefficients of permanent and transitory income are symmetric, then the result is consistent with the consumption model. On the other hand, if coefficients are asymmetric, we may conclude that the investment model is supported.[23]

The empirical results indicate the existence of credit constraints, since the coefficients of parental income variables are statistically significant. Moreover, the coefficients of permanent and transitory incomes are asymmetric. Hence, the empirical results indicate that the investment

[23] However, we should note these are two extreme models of schooling. In order to derive tractable analytical solutions, we cannot avoid imposing assumptions, which might not be empirically supported.

model has better performance than the consumption-labor supply model in explaining the actual observations.[24]

2.5.2 Policy Implications

There are important policy implications of the findings reported in this chapter. The first best policy is to target market failures in the very market in which they occur. To enhance human capital investments in rural Pakistan, a policy should ideally focus on the first best solution to encourage or supplement the development of credit and insurance markets. In terms of actual policy perspective, however, poverty reduction programs to provide poor parents with emergency coping aids may be more cost effective in keeping poor children in school than programs aiming either at reducing poverty itself or at reducing school costs for the poor as a whole.

Such a contingent subsidy or a "compensating the victims" approach, however, may involve information problems in its implementation. Parents, for example, have an incentive to report only their difficulty in order to obtain benefits. Moreover, after getting subsidy, they might invest in other opportunities than education of children. Avoidance of perverse incentives arising from adverse selection and moral hazard problems, therefore, becomes a key issue [Lipton and Ravallion (1995)]. Selective school subsidy programs should accompany an appropriate design of the implementation scheme to ease the information issues. Although these issues are beyond the scope of this chapter, community involvement or management of such a program might be preferred because of the use of peer-monitoring device to relieve the information problems (Chapter 5). The concept of contingent rent, that is the private agents can acquire the rent only if they take certain actions exploiting their own private information, might also be useful for the policy consideration [Hellman, Murdock and Stiglitz (1997)]. A school food program is an example of contingent rent since parents can acquire rent only if they sent children to schools. The project of distribution of edible oil among students, which is implemented in NWFP, will also be highly a good policy in terms of creating contingent rent.[25] Also, a selective school

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[24] The null hypothesis of asymmetric effects of permanent and transitory income is H_0: $\pi^P = \pi^T$, where π^P and π^T are coefficients on permanent and transitory incomes, respectively, in the entrant or dropout models. The alternative hypothesis is represented by H_A: $\pi^P \neq \pi^T$. This test investigates the relative importance of the investment model and consumption model. The Wald statistics for the empirical model in Table 2.6 columns are 8.81, 5.79, 3.68, and 2.99. These results all reject the symmetry hypothesis. The computed Wald test statistics for Table 2.9 columns are 1.81, 2.18, 4.18, 6.20, 6.75, and 7.44. Hence, the symmetry hypothesis is rejected in all specifications except the first two specifications for the entrant model.

[25] The World Food Program is implementing a project to reduce school dropout of girls in the districts of Kohistan, Tank, Dir and Battagram in NWFP through incentive in the form of edible oil.

scholarship program for children from households with emergency needs is a candidate of contingent rent policy. It might be more cost effective to reduce school fees selectively for those parents who face temporary difficulties.

The policies mentioned above should be combined with programs of improving female education, since, according to our observations, a combination of female education programs and policies which alleviate transitory poverty will be an effective approach to enhance human capital investments in Pakistan. Moreover, the benefits of women's education are now recognized widely by researchers and policy makers. Educated women have smaller number of children, lower infant mortality rates, and the children who survive are healthier and better educated [King and Hill (1993)]. An appropriate policy scheme to improve female education, therefore, is likely to promote economic development as a whole in rural Pakistan.

Appendix 2.1: Consumption and Labor Market Model of Demand for Education

This appendix presents an alternative framework to derive the optimal schooling decision function under assumptions of child education as consumption goods and endogenous labor supply. Then restrictions on income coefficients, which distinguish the Jacoby and Skoufious (1997) type investment model from the consumption model, are derived. In order to address the consumption aspects of education and labor market supply decision issues, we can utilize the framework of MaCurdy (1981; 1983) and Kochar (1999c).[26]

Assuming that there is a consumption value of child education, a household's problem can be written as

$$\underset{\{C_t, S_{it}\}}{Max}\ E_t\left[\sum_{k=0}^{T-t}\beta^k\{U(C_{t+k})+\sum_{i=1}^{I}\theta_i v(S_{it+k})\}+\beta^{T+1}W(A_{T+1})\right]$$

$$s.t. \quad A_{t+1}=\left[A_t+Y_P^P+Y_{Pt}^T+\sum_{i=1}^{I}Y_{Cit}(1-S_{it})-C_t\right](1+r_t)$$

$$Y_P^P+Y_{Pt}^T+\sum_{i=1}^{I}(1-S_{it})Y_{Cit}\geq C_t$$

$$A_t \text{ given}, A_T \geq 0.$$

The function $v(\bullet)$ is assumed to be concave. Note that the parameter θ_i is a welfare weight imposed on the household utility from the child i's schooling.

Case 1: Non-binding credit constraint

When a household can borrow and save freely at an exogenously given interest rate, the credit constraint is not binding. Then from the first-order conditions, we have the Euler equation for the optimal consumption:

$$U'(C_t)=\beta E_t[U'(C_{t+1})(1+r_t)]. \tag{A1}$$

With respect to the optimal level of schooling, we have schooling function:[27]

$$E_t\left[\frac{\partial v/\partial S_{it+1}}{\partial v/\partial S_{it}}\right]\left[\frac{Y_{Cit}}{Y_{Cit+1}}\right]=\frac{1}{\beta(1+r_t)},\ \forall\ i. \tag{A2}$$

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[26] The first order conditions from the intertemporal optimization problem imply that households adjust their consumption and labor supplies so that the discounted marginal expected value of wealth is the same in every period [Heckman (1976)]. This generates price of utility constant, or Frisch demand functions, which are a function of current prices and the expected value of discounted marginal utility of wealth or its inverse, the price of utility [Browning, Deaton and Irish (1985)]. Given panel data, it is possible to estimate the Frish demand functions by differencing out the unobserved price of utility [MaCurdy (1981)]. Very few studies, such as Blau (1985a) and Skoufias (1993a), have used the Frisch framework in the context of developing countries. The Frisch demand approach allows one to measure responses along the anticipated time trajectories of prices, but fails to allow measurement of the effects of shocks, which operate through the marginal utility of wealth. In addition, the approach breaks down in a number of instances that are likely to exist in many developing countries such as the presence of credit constraints, imperfect information, and uncertainty.

[27] Also, note that this condition potentially derives the optimal level of labor supply, 1-*S*.

As in equation (11), the left-hand side is marginal rate of transformation and the right-hand side represents a product of an exogenously given interest rate and a discount factor. The optimal schooling decision rule at t can be represented as a reduced form equation of (11):

$$(A2') \qquad S_{it}^{*} = S_{v}^{NC}(\beta, r_t, g_{it}; I_t^{NC}),$$

where g_{it} represents the child's wage growth rate, i.e., $g_{it} \equiv (Y_{Cit-1}/Y_{Cit}) - 1$, and I_t^{NC} represents the information set at t. This equation (A2') indicates that if credit constraint is not binding, parental income or schooling decisions of other children does not affect the schooling decision of a child. As in equation (11), the two separabilities, one for consumption and schooling decision and the other for intrahousehold schooling allocation, hold in this model. However, unlike equation (11), the optimal level of schooling is not a function of child specific variables, gender specific elements, and school availability and quality. This is the difference between the investment model and consumption model under perfect credit availability. However, we should note that if households' preference toward a child's education is a function of child specific characteristics, the optimal schooling decision can be a function of child specific variables and gender specific elements even under the consumption model, making the identification of the consumption model from the investment model difficult.

Case 2: Binding credit constraint

If credit constraint is binding, then the optimization problem can be reduced to period-by-period utility maximization:

$$\underset{\{C_t, S_{it}\}}{Max}\ U(C_t) + \sum_{i=1}^{I} \theta_i v(S_{it})$$

$$s.t. \qquad Y_P^P + Y_{Pt}^T + \sum_{i=1}^{I} Y_{Cit}(1 - S_{it}) = C_t .$$

Note that unlike the investment model, the credit constrained case can be expressed as a static optimization problem. This is simply because schooling gives consumption return instantaneously as a part of utility. There is no intertemporal dimension involved in schooling as consumption goods. From the first-order conditions, the Marshallian school demand function can be derived:

$$S_{it+k} = S_{it}^{C}(Y_t^{*}, Y_{C1t}, Y_{C2t}, \cdots, Y_{Clt}),$$

where $Y_t^{*} = Y_P^P + Y_{Pt}^T + \sum_{j=1}^{I} Y_{Cjt}$ is full income of this household. As in the case of the investment model, both permanent and transitory components of income affect schooling demand. However, permanent income and transitory income effects should be symmetric in this consumption model, while the investment model tells us the asymmetry effects of the two components of income.

Figure 2.1

Welfare Loss of Credit Market Imperfection

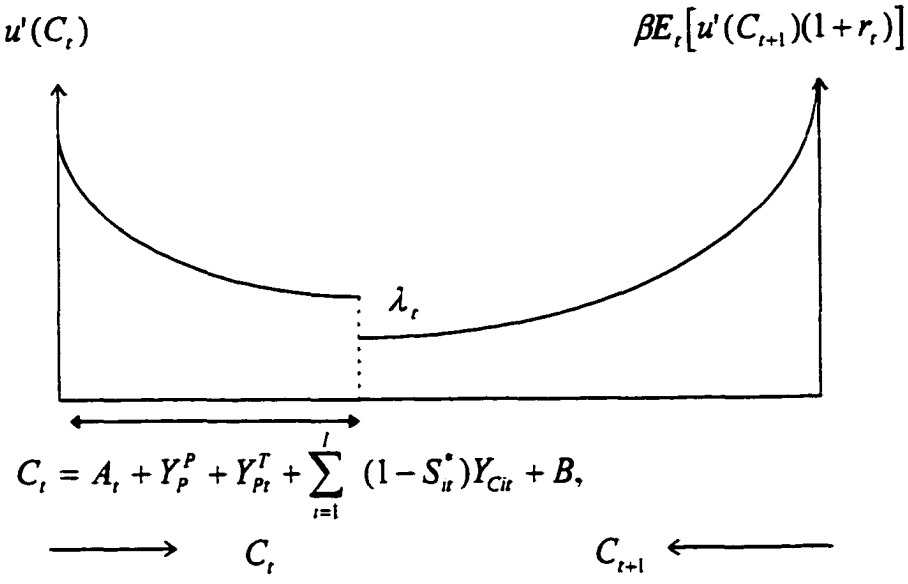


Figure 2.2
Determination of the Optimal Schooling

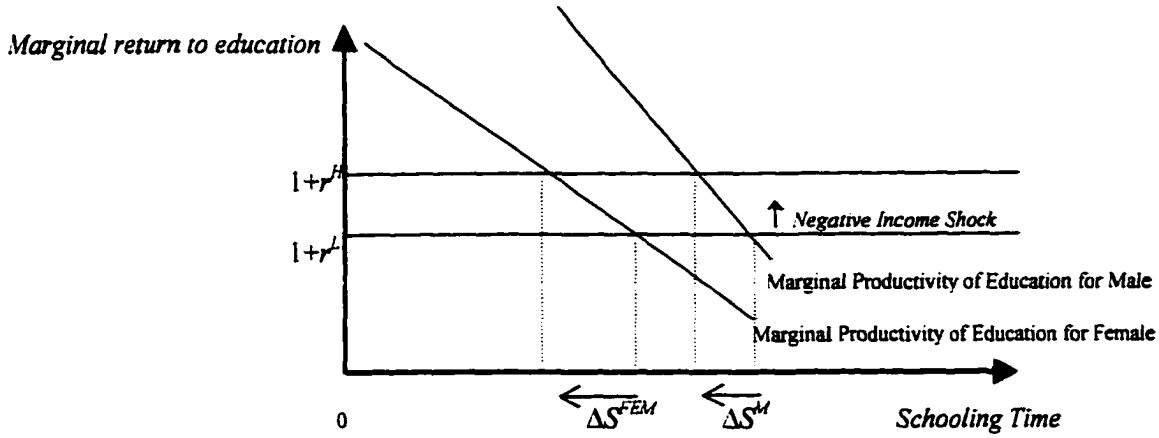
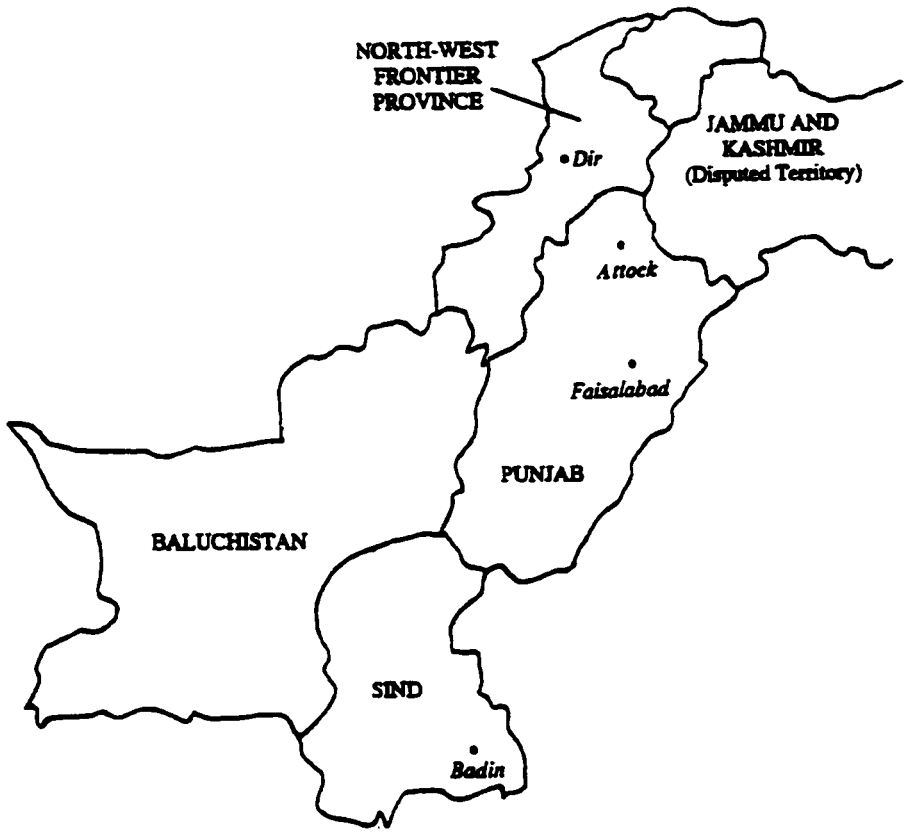


Figure 2.3
Map of Surveyed Regions



Source) Alderman and Garcia (1993)

Table 2.1
Education System in Pakistan

Grade	"Model" Age	Typical School Type	Other Type	Note
	3 - 5	Nursery or Kindergarten (Kachi)		
1 - 5	5 - 10	Primary School		
6 - 8	10 - 13	Middle School		
9 - 10	13 - 15	Secondary (high) School		Matriculate exam at the end
11 - 12	15 - 17	Intermediate College (F.A.)	Technical, Teacher etc.	Division wide board exam
13 - 14	17 - 18	Degree College (B.A.)		Division wide entrance exam
15 - 16	18 -	(M.A.)		
17 -		M.Phil		Equivalent to International Level M.A.

(Source) Ministry of Education and the Author's Interview

Table 2.2
Subsamples to Estimate the Sequential Schooling Decision Models

	Time	t-1	t
	Variable		
(i)	$ENT = 0$	No Schooling ($S^*_{t-1} \leq 0$)	No Schooling ($S^*_t \leq 0$)
(ii)	$ENT = 1$	No Schooling ($S^*_{t-1} \leq 0$)	Schooling ($S^*_t > 0$)
(iii)	$DRP = 0$	Schooling ($S^*_{t-1} > 0$)	Schooling ($S^*_t > 0$)
(iv)	$DRP = 1$	Schooling ($S^*_{t-1} > 0$)	No Schooling ($S^*_t \leq 0$)

Table 2.3
Summary Statistics of Variable Used for Income Regressions

Variable	District Code	Faisalabad Mean (Std. Dev)	Attock Mean (Std. Dev.)	Badin Mean (Std. Dev.)	Dir Mean (Std. Dev.)
Income					
Total annual household income (1,000 Rs)	income	44.87 (102.47)	23.52 (23.75)	32.99 (36.07)	45.12 (50.51)
Physical Assets					
Total value of livestock (1,000 Rs)	vlstock2	18.63 (16.64)	11.42 (12.02)	24.69 (22.73)	10.82 (9.15)
Total irrigated land (acres)	irrig	4.24 (7.92)	0.22 (0.74)	9.81 (18.07)	1.55 (5.92)
Total rainfed land (acres)	rainfed	0.02 (0.26)	9.70 (20.75)	0.02 (0.52)	3.05 (8.04)
Total land (acres)	land	4.34 (7.96)	13.87 (30.77)	13.00 (23.09)	6.08 (24.22)
Human Assets					
Number of male member above 16	n16m	2.82 (1.51)	2.56 (1.32)	2.60 (1.66)	3.19 (1.86)
Number of male member between 6 and 16	n616m	1.27 (1.25)	0.85 (0.92)	1.43 (1.30)	1.95 (1.52)
Number of female member above 16	n16f	2.62 (1.37)	2.47 (1.19)	2.45 (1.47)	3.01 (1.75)
Number of female member between 6 and 16	n616f	1.03 (1.17)	0.81 (0.98)	1.30 (1.27)	1.84 (1.56)
Number of children below 6	nchild	1.30 (1.45)	0.98 (1.07)	1.91 (1.66)	2.40 (1.86)
Transitory Shock Variables					
Number of died member (elder than 16)	die	0.03 (0.16)	0.02 (0.15)	0.02 (0.14)	0.02 (0.13)
Number of dead animals	dead	0.04 (0.38)	0.02 (0.16)	0.01 (0.13)	0.04 (0.34)
Deviation of annual rainfall from long term average (district level rainfall over 20 years)	raindev	31.28 (9.72)	-1.48 (8.81)	-10.33 (19.81)	-5.51 (5.79)
Year dummy for 86/87	yr1	0.19	0.20	0.20	0.20
Year dummy for 87/88	yr2	0.19	0.20	0.20	0.20
Year dummy for 88/89	yr3	0.19	0.20	0.20	0.20
Year dummy for 89/90	yr4	0.21	0.21	0.20	0.20
Year dummy for 91/92	(default)	0.21	0.20	0.19	0.20
Number of Observations		759	780	1168	951
Number of Households		159	162	239	205

Table 2.4
Summary Statistics for Data Used for Entrants and Dropouts Model

		Entrants		Dropouts	
	Variable	Mean	(Std. Dev.)	Mean	(Std. Dev.)
Dependent Variables					
=1 if enter school; =0 otherwise	ENT	0.11			
=1 if dropout of school; =0 otherwise	DRP			0.17	
Independent Variables					
Income Variables					
Total annual household income (1,000 Rs)	income	39.13	(43.76)	46.02	(58.80)
Permanent income (1,000 Rs)	per_inc	49.37	(55.89)	67.52	(62.43)
Transitory income (1,000 Rs)	tr_inc	-10.30	(23.32)	-21.03	(19.43)
Residual income (1,000 Rs)	res_inc	0.05	(33.64)	-0.47	(37.90)
Intrahousehold Variables					
Number of Siblings at School					
Number of elder brothers at school	mo_edu	0.50	(0.99)	0.84	(1.14)
Number of elder sisters at school	fo_edu	0.10	(0.43)	0.19	(0.52)
Number of younger brothers at school	my_edu	0.68	(1.10)	0.90	(1.13)
Number of younger sisters at school	fy_edu	0.20	(0.55)	0.36	(0.75)
Number of Siblings out of School					
Number of elder brothers out of school	mo_no	1.90	(1.74)	1.62	(1.58)
Number of older sisters out of school	fo_no	1.95	(1.81)	2.12	(1.69)
Number of younger brothers out of school	my_no	1.59	(1.53)	1.32	(1.30)
Number of younger sisters out of school	fy_no	1.97	(1.98)	1.85	(1.91)
Number of Siblings					
Number of elder brothers	ebrother	2.39	(2.13)	2.46	(1.99)
Number of elder sisters	esister	2.05	(1.92)	2.31	(1.78)
Number of younger brothers	ybrother	2.26	(1.98)	2.22	(1.80)
Number of younger sisters	ysister	2.17	(2.09)	2.21	(2.08)
Ratio of Siblings at and out of School					
(Elder brothers at school – elder brothers out of school) / (total number of elder brothers +1)	mo_f	-0.18	(0.28)	-0.11	(0.27)
(Younger brothers at school – younger brothers out of school) / (total number of younger brothers +1)	fo_f	-0.29	(0.24)	-0.31	(0.24)
(Elder sisters at school – elder sisters out of school) / (total number of elder sisters +1)	my_f	-0.11	(0.25)	-0.04	(0.25)
(Younger sisters at school – younger sisters out of school) / (total number of younger sisters +1)	fy_f	-0.25	(0.25)	-0.21	(0.28)
Gender Variable					
=1 if female; =0 otherwise	fem	0.59		0.21	
Relation-to-head of household					
=1 if son/daughter of the household head	sondau	0.68		0.76	
=1 if grandchild of the household head	grand	0.12		0.14	
=1 if sisnter / brother / nephew / niece / in-laws / other relative of the household head	(default)	0.20		0.10	

Table 2.4 (continued)
Summary Statistics for Data Used for Entrants and Dropouts Model

		Entrants		Dropouts	
	Variable	Mean	Std. Dev.	Mean	Std. Dev.
Age Dummy Variables					
age dummy (age of 3)	lage_3	0.04			
age dummy (age of 4)	lage_4	0.04			
age dummy (age of 5)	lage_5	0.04		0.01	
age dummy (age of 6)	lage_6	0.05		0.03	
age dummy (age of 7)	lage_7	0.07		0.08	
age dummy (age of 8)	lage_8	0.07		0.14	
age dummy (age of 9)	lage_9	0.05		0.11	
age dummy (age of 10)	lage_10	0.04		0.10	
age dummy (age of 11)	lage_11	0.04		0.09	
age dummy (age of 12)	lage_12	0.04		0.07	
age dummy (age of 13)	lage_13	0.03		0.07	
age dummy (age of 14)	lage_14	0.04		0.06	
age dummy (age of 15)	lage_15	0.04		0.05	
age dummy (age of 16)	lage_16	0.05		0.04	
age dummy (age of 17)	lage_17	0.05		0.03	
age dummy (age of 18)	lage_18	0.05		0.03	
age dummy (age of 19)	lage_19	0.05		0.03	
age dummy (age of 20)	lage_20	0.06		0.02	
age dummy (age of 21)	lage_21	0.06		0.01	
age dummy (age of 22)	lage_22	0.05		0.01	
age dummy (age of 23)	(default)	0.03		0.01	
Year Dummy Variables					
Year dummy (86/87)	(default)	0.15		0.20	
Year dummy (87/88)	lyear_2	0.45		0.39	
Year dummy (88/89)	lyear_3	0.40		0.41	
Number of observations for 86/87 (number of households)		767	(304)	423	(166)
Number of observations for 87/88 (number of households)		2218	(662)	866	(409)
Number of observations for 88/89 (number of households)		1974	(634)	910	(411)
Total Number of observations		4959		2199	

Table 2.5
Panel Fixed Effects Estimation of Income Equation
Dependent Variable: Total Annual Household Income
(in 1,000 Rupees)

	District	Faisalabad	Attock	Badin	Dir
Variable	Code	Coef. (t-stat)	Coef. (t-stat)	Coef. (t-stat)	Coef. (t-stat)
Physical Assets					
Total value of livestock (1,000 Rs)	vlstock2	1.33 (3.98)***	0.03 (0.27)	0.12 (2.42)**	0.23 (0.81)
Total irrigated land (acres)	irrig	9.20 (3.45)***	0.58 (0.31)	0.32 (1.81)*	1.91 (1.72)*
Total rainfed land (acres)	rainfed	13.01 (0.75)	-0.19 (0.80)	-0.16 (0.12)	1.49 (2.28)**
Human Assets					
Number of male member above 16	n16m	60.08 (6.59)***	5.48 (2.35)**	8.16 (4.25)***	-1.90 (0.41)
Number of male member between 6 and 16	n616m	66.05 (8.16)***	0.72 (0.37)	2.14 (1.41)	0.23 (0.08)
Number of female member above 16	n16f	-7.28 (0.95)	3.64 (1.65)*	-0.30 (0.16)	2.37 (0.79)
Number of female member between 6 and 16	n616f	-2.44 (0.35)	2.17 (1.00)	2.79 (1.99)**	0.53 (0.21)
Number of children below 6	nchild	1.92 (0.40)	0.08 (0.05)	0.35 (0.33)	4.01 (2.14)**
Transitory Shock Variables					
Number of died member (elder than 16)	die	-14.48 (0.59)	-4.62 (0.51)	18.89 (2.08)**	7.71 (0.43)
Number of dead animals	dead	-1.18 (0.15)	-1.84 (0.39)	-5.47 (1.04)	-1.46 (0.38)
Deviation of annual rainfall from long term average	raindev	-0.90 (2.14)**	-0.56 (3.36)***	-0.36 (2.37)**	1.91 (1.06)
Year dummy for 86/87	yr1	-4.64 (0.43)	-3.25 (1.42)	13.20 (2.06)**	-41.30 (1.56)
Year dummy for 87/88	yr2	-9.04 (0.94)	2.33 (0.62)	16.03 (3.41)***	-16.86 (2.05)**
Year dummy for 88/89	yr3	5.90 (0.71)	-7.92 (4.07)***	21.42 (3.30)***	-30.36 (2.02)**
Constant	_cons	-223.09 (4.24)***	0.47 (0.05)	-15.39 (1.76)*	51.36 (2.12)**
Number of Observations		759	780	1168	951
Number of Households		159	162	239	205
Overall R^2		0.186	0.076	0.418	0.119
F-statistics		10.49	7.51	8.32	3.06

Note: Estimation includes household fixed effects. Dummy variable for the fourth year is omitted since rain deviation variable is district specific. Note that the fifth year is the default.

* statistically significant at 10% level

** statistically significant at 5% level

*** statistically significant at 1% level

Table 2.6
Fixed Effects Logit Estimation of Entrants and Dropouts Model
Dependent Variable: ENT or DRP

	ENT	Coef. (z-stat.)	Coef. (z-stat.)	Coef. (z-stat.)	Coef. (z-stat.)
Independent variable		ENT	ENT	DRP	DRP
Specification		I	II	I	II
Income Variables					
Pemanent income (1,000 Rs)	per_inc	-0.008	-0.002	-0.005	-0.006
		(0.913)	(0.227)	(0.769)	(0.796)
Transitory Income (1,000 Rs)	tr_inc	0.102	0.087	-0.092	-0.083
		(2.802)***	(2.428)**	(2.050)**	(1.862)*
Residual Income (1,000 Rs)	res_inc	0.002	0.001	-0.002	-0.002
		(1.374)	(0.692)	(0.495)	(0.646)
Number of Siblings at School					
Number of elder brothers at school	mo_edu	0.229	-0.174	0.382	0.266
		(1.080)	(1.595)	(1.232)	(1.744)*
Number of elder sisters at school	fo_edu	0.300	0.262	-0.494	-0.325
		(1.488)	(1.762)*	(1.757)*	(1.394)
Number of younger brothers at school	my_edu	0.355		0.220	
		(1.713)*		(0.730)	
Number of younger sisters at school	fy_edu	-0.026		-0.166	
		(0.132)		(0.738)	
Number of Siblings out of School					
Number of elder brothers out of school	mo_no	0.468	-0.083	-0.731	-0.808
		(1.929)*	(0.667)	(2.068)**	(3.568)***
Number of older sisters out of school	fo_no	0.446	0.257	-0.068	0.130
		(2.463)**	(2.348)**	(0.308)	(0.794)
Number of younger brothers out of school	my_no	0.743		-0.175	
		(3.393)***		(0.595)	
Number of younger sisters out of school	fy_no	0.295		-0.264	
		(1.760)*		(1.331)	
Gender Variable					
=1 if female; =0 otherwise	fem	-1.751	-1.380	1.658	1.983
		(5.214)***	(8.016)***	(3.636)***	(7.829)***
Relation-to-head of household					
=1 if son/daughter of the household head	sondau	0.898	0.908	-0.094	-0.178
		(2.581)***	(2.641)***	(0.168)	-0.323
=1 if grandchild of the household head	grand	0.989	0.903	0.534	0.501
		(2.020)**	(1.867)*	(0.754)	0.704
Total number of observations		2675	2675	1270	1270

Note: Estimation includes household fixed effects, age dummy variables, year dummy variables. The conditional maximum likelihood method is employed. 370 household-year data (2284 observations) for entrant regressions and 283 household-year data (929 observations) for dropout regression are omitted due to all positive or negative outcomes.

* statistically significant at 10% level

** statistically significant at 5% level

*** statistically significant at 1% level

Table 2.7
Fixed Effects Logit Estimation of Entrants and Dropouts Models with Gender Interaction Terms
Dependent Variable: ENT or DRP

		Coef. (z-stat.)	Coef. (z-stat.)	Coef. (z-stat.)	Coef. (z-stat.)
Independent variable		ENT	ENT	DRP	DRP
Specification		I	II	I	II
Income Variables					
Pemanent income (1,000 Rs)	per_inc	-0.010	-0.004	-0.006	-0.006
		(1.056)	(0.398)	(0.744)	(0.796)
Interaction term with female dummy	IfXper_I	-0.001	0.000	0.001	0.002
		(0.400)	(0.259)	(0.227)	(0.309)
Transitory Income (1,000 Rs)	tr_inc	0.090	0.073	-0.069	-0.062
		(2.371)**	(2.009)**	(1.521)	(1.375)
Interaction term with female dummy	IfXtr__I	0.026	0.028	-0.031	-0.029
		(3.872)***	(4.097)***	(2.527)**	(2.374)**
Residual Income (1,000 Rs)	res_inc	0.003	0.001	0.000	0.000
		(1.385)	(0.767)	(0.049)	(0.030)
Interaction term with female dummy	IfXres_I	-0.001	-0.001	-0.004	-0.005
		(0.244)	(0.255)	(0.635)	(0.709)
Number of Siblings at School					
Number of elder brothers at school	mo_edu	0.257	-0.130	0.425	0.263
		(1.193)	(1.166)	(1.360)	(1.710)*
Number of elder sisters at school	fo_edu	0.341	0.310	-0.542	-0.341
		(1.674)*	(2.078)**	(1.917)**	(1.450)
Number of younger brothers at school	my_edu	0.335		0.273	
		(1.591)		(0.898)	
Number of younger sisters at school	fy_edu	-0.034		-0.217	
		(0.172)		(0.947)	
Number of Siblings out of School					
Number of elder brothers out of school	mo_no	0.499	-0.033	-0.620	-0.749
		(2.025)**	(0.262)	(1.737)*	(3.299)***
Number of older sisters out of school	fo_no	0.452	0.277	-0.080	0.141
		(2.460)**	(2.501)**	(0.365)	(0.851)
Number of younger brothers out of school	my_no	0.731		-0.144	
		(3.280)***		(0.482)	
Number of younger sisters out of school	fy_no	0.279		-0.295	
		(1.640)*		(1.463)	
Gender Variable					
=1 if female; =0 otherwise	Fem	-1.594	-1.229	0.947	1.362
		(4.479)***	(6.203)***	(1.701)*	(3.364)***
Relation-to-head of household					
=1 if son/daughter of the household head	Sondau	0.921	0.930	-0.167	-0.241
		(2.605)***	(2.655)***	(0.303)	(0.441)
=1 if grandchild of the household head	Grand	1.163	1.094	0.345	0.311
		(2.323)**	(2.207)**	(0.488)	(0.437)
Total number of observations		2675	2675	1270	1270

Note: Estimation includes household fixed effects, age dummy variables, year dummy variables. The conditional maximum likelihood method is employed. 370 household-year data (2284 observations) for entrant regressions and 283 household-year data (929 observations) for dropout regression are omitted due to all positive or negative outcomes.
* statistically significant at 10% level
** statistically significant at 5% level
*** statistically significant at 1% level

Table 2.8
Fixed Effects Logit Estimation of Entrants and Dropouts Model
Dependent Variable: ENT or DRP

		Coef. (z-stat.)	Coef. (z-stat.)	Coef. (z-stat.)	Coef. (z-stat.)
Independent variable	Code	ENT	ENT	DRP	DRP
Specification		III	IV	III	IV
Income Variables					
Pemanent income (1,000 Rs)	per_inc	-0.000	-0.003	-0.005	-0.006
		(0.030)	(0.354)	(0.704)	(0.809)
Interaction term with female dummy	IfXper_1	-0.001	-0.001	0.003	0.002
		(0.491)	(0.304)	(0.543)	(0.376)
Transitory Income (1,000 Rs)	tr_inc	0.121	0.072	-0.064	-0.058
		(3.217)***	(1.989)**	(1.428)	(1.282)
Interaction term with female dummy	IfXtr__1	0.025	0.027	-0.030	-0.032
		(3.664)***	(4.080)***	(2.438)**	(2.734)***
Residual Income (1,000 Rs)	res_inc	0.002	0.001	0.000	-0.001
		(1.245)	(0.750)	(0.069)	(0.125)
Interaction term with female dummy	IfXres_1	-0.002	-0.001	-0.004	-0.003
		(0.580)	(0.256)	(0.573)	(0.501)
Ratio of Siblings at and out of School					
(Elder brothers at school – elder brothers out of school) / (total number of elder brothers +1)	mo_f	-1.412		3.283	
		(3.162)***		(5.036)***	
(Younger brothers at school – younger brothers out of school) / (total number of younger brothers +1)	fo_f	-2.337		-0.373	
		(4.346)***		(0.527)	
(Elder sisters at school – elder sisters out of school) / (total number of elder sisters +1)	my_f	-2.486		1.287	
		(5.429)***		(2.189)**	
(Younger sisters at school – younger sisters out of school) / (total number of younger sisters +1)	fy_f	-1.818		0.919	
		(3.643)***		(1.777)**	
Number of Siblings					
Number of elder brothers	ebrother		-0.092		0.023
			(0.942)		(0.159)
Number of elder sisters	esister		0.276		0.023
			(2.807)***		(0.153)
Gender Variable					
=1 if female; =0 otherwise	fem	-1.288	-1.215	1.038	1.378
		(6.704)***	(6.171)***	(2.537)**	(3.466)***
Relation-to-head of household					
=1 if son/daughter of the household head	sondau	0.944	0.922	-0.128	-0.286
		(2.685)**	(2.637)***	(0.235)	(0.534)
=1 if grandchild of the household head	grand	1.303	1.087	0.602	0.299
		(2.612)**	(2.194)**	(0.849)	(0.426)
Total number of observations		2675	2675	1270	1270

Note: Estimation includes household fixed effects, age dummy variables, year dummy variables. The conditional maximum likelihood method is employed. 283 household-year data (929 observations) are omitted due to all positive or negative outcomes.
* statistically significant at 10% level; ** statistically significant at 5% level; *** statistically significant at 1% level

Table 2.9
Village Fixed Effects Logit Estimation of Entrants and Dropouts Model
Dependent Variable: ENT or DRP

		Coef. (z-stat.)	Coef. (z-stat.)	Coef. (z-stat.)	Coef. (z-stat.)	Coef. (z-stat.)	Coef. (z-stat.)
Independent variable		ENT	ENT	ENT	DRP	DRP	DRP
Specification		I	II	IV	I	II	IV
Income Variables							
Permanent income (1,000 Rs)	per_inc	0.002 (1.670)*	0.002 (1.609)	0.002 (1.738)*	-0.004 (1.668)*	-0.005 (2.106)*	-0.005 (2.406)**
Transitory Income (1,000 Rs)	tr_inc	0.031 (1.434)	0.033 (1.561)	0.042 (2.004)**	-0.100 (2.635)***	-0.100 (2.752)***	-0.103 (2.909)***
Residual Income (1,000 Rs)	res_inc	0.002 (1.516)	0.002 (1.548)	0.002 (1.512)	-0.002 (1.017)	-0.003 (1.057)	-0.002 (1.114)
Number of Siblings at School							
Number of elder brothers at school	mo_edu	-0.027 (0.435)	-0.022 (0.358)		-0.135 (1.516)	-0.128 (1.448)	
Number of elder sisters at school	fo_edu	0.441 (3.992)***	0.416 (3.806)***		-0.712 (3.618)***	-0.699 (3.542)***	
Number of younger brothers at school	my_edu	-0.020 (0.281)			-0.062 (0.696)		
Number of younger sisters at school	fy_edu	0.163 (1.664)*			-0.200 (1.831)*		
Number of Siblings out of School							
Number of elder brothers out of school	mo_no	-0.160 (3.357)***	-0.134 (3.735)***		-0.084 (1.196)	-0.078 (1.158)	
Number of older sisters out of school	fo_no	0.100 (2.312)**	0.090 (2.115)**		0.007 (0.112)	0.020 (0.317)	
Number of younger brothers out of school	my_no	-0.084 (1.614)			0.045 (0.632)		
Number of younger sisters out of school	fy_no	-0.034 (0.773)			-0.001 (0.013)		
Number of Siblings							
Number of elder brothers	ebrother			-0.127 (3.272)***			-0.077 (1.450)
Number of elder sisters	esister			0.130 (3.339)***			-0.040 (0.668)
Gender Variable							
=1 if female; =0 otherwise	fem	-1.175 (9.424)***	-1.169 (9.417)***	-1.129 (9.192)***	1.661 (8.952)***	1.613 (8.859)***	1.564 (8.674)***
Relation-to-head of household							
=1 if son/daughter of the household head	sondau	0.377 (1.880)*	0.350 (1.756)**	0.475 (2.408)**	0.068 (0.250)	0.073 (0.267)	0.046 (0.171)
=1 if grandchild of the household head	grand	0.831 (3.397)***	0.764 (3.165)***	0.731 (3.060)***	0.277 (0.803)	0.251 (0.743)	0.347 (1.038)
Total number of observations		2675	2675	2675	1270	1270	1270

Note: Estimation includes village fixed effects, age dummy variables, year dummy variables. The conditional maximum likelihood method is employed.

* statistically significant at 10% level

** statistically significant at 5% level

*** statistically significant at 1% level

Table 2.10
Distribution of Five-Year Household Average Income
(in 1,000 Rupees)

Percentailes	Median Income
1%	6.137
25%	16.997
50%	25.228
75%	41.417
99%	150.108

(Source) Author's calculation

Table 2.11
Fixed Effects Logit Estimation of Entrants and Dropouts Models
Pooled Sample with Interaction Terms by Income Distribution Dummy
Dependent Variable: ENT or DRP

Independent Variables	Code	ENT	Interaction Term for the poor	DRP	Interaction Term for the poor
Specification		I		I	
		Coef. (z-stat.)	Coef. (z-stat.)	Coef. (z-stat.)	Coef. (z-stat.)
Income Variables					
Pemanent income (1,000 Rs)	per_inc	-0.012 (1.126)	-0.009 (0.272)	-0.018 (2.021)**	0.071 (1.820)*
Transitory Income (1,000 Rs)	tr_inc	0.024 (0.529)	0.244 (2.853)***	-0.122 (2.250)**	-0.050 (0.386)
Residual Income (1,000 Rs)	res_inc	0.003 (1.541)	-0.045 (2.052)**	-0.002 (0.561)	0.024 (0.676)
Number of Siblings at School					
Number of elder brothers at school	mo_edu	0.133 (0.599)	-0.501 (0.857)	0.389 (1.112)	0.672 (0.730)
Number of elder sisters at school	fo_edu	0.514 (2.188)**	-2.007 (3.336)***	-0.571 (1.791)*	0.459 (0.477)
Number of younger brothers at school	my_edu	0.351 (1.633)	-0.804 (1.371)	0.194 (0.555)	0.904 (1.072)
Number of younger sisters at school	fy_edu	0.056 (0.244)	-1.038 (1.836)*	-0.149 (0.590)	0.421 (0.493)
Number of Siblings out of School					
Number of elder brothers out of school	mo_no	0.112 (0.467)	0.729 (1.238)	-0.679 (1.599)	0.526 (0.559)
Number of older sisters out of school	fo_no	0.467 (2.123)**	-0.656 (1.482)	-0.131 (0.492)	0.453 (0.637)
Number of younger brothers out of school	my_no	0.435 (1.887)*	0.651 (1.187)	-0.463 (1.291)	1.079 (1.387)
Number of younger sisters out of school	fy_no	0.332 (1.660)*	-0.698 (1.631)	-0.155 (0.668)	-0.065 (0.089)
Relation-to-head of household					
=1 if son/daughter of the household head	sondau	0.883 (2.204)**	0.126 (0.146)	-0.158 (0.279)	-28.950 (.000)
=1 if grandchild of the household head	grand	1.115 (1.981)*	-0.581 (0.447)	0.284 (0.391)	-60.423 (0.000)
Gender Variable					
=1 if female; =0 otherwise	fem	-1.457 (3.997)***	-1.090 (1.324)	1.729 (3.086)*	-0.436 (0.370)
Total number of observations			2675		1270

Note: Estimation includes household fixed effects, age dummy variables, year dummy variables. The conditional maximum likelihood method is employed.

* statistically significant at 10% level

** statistically significant at 5% level

*** statistically significant at 1% level

Table 2.12
Fixed Effects Logit Estimation of Entrants and Dropouts Models
Pooled Sample with Interaction Terms by Irrigated Land Ownership Dummy
Dependent Variable: ENT or DRP

			Interaction Term for landless		Interaction Term for landless
Independent Variables	Code	ENT		DRP	
Specification		I		I	
		Coef. (z-stat.)	Coef. (z-stat.)	Coef. (z-stat.)	Coef. (z-stat.)
Income Variables					
Pemanent income (1,000 Rs)	per_inc	-0.029 (2.753)***	0.032 (2.045)**	-0.012 (1.489)	0.007 (0.516)
Transitory Income (1,000 Rs)	tr_inc	0.068 (1.638)	0.085 (2.808)***	-0.138 (2.406)**	0.062 (1.074)
Residual Income (1,000 Rs)	res_inc	0.005 (2.549)**	-0.015 (2.094)**	-0.003 (0.588)	0.002 (0.221)
Number of Siblings at School					
Number of elder brothers at school	mo_edu	0.066 (0.287)	0.506 (2.126)**	0.531 (1.617)	0.070 (0.235)
Number of elder sisters at school	fo_edu	0.630 (2.656)***	-0.971 (2.438)**	-0.625 (1.739)*	0.421 (0.856)
Number of younger brothers at school	my_edu	0.273 (1.196)	0.377 (1.616)	0.449 (1.397)	-0.213 (0.786)
Number of younger sisters at school	fy_edu	0.190 (0.782)	-0.809 (2.429)**	-0.241 (0.908)	0.218 (0.713)
Number of Siblings out of School					
Number of elder brothers out of school	mo_no	0.446 (1.785)*	0.292 (1.281)	-0.722 (1.889)	0.194 (0.574)
Number of older sisters out of school	fo_no	0.820 (3.928)***	-0.887 (3.991)***	-0.006 (0.026)	-0.343 (1.336)
Number of younger brothers out of school	my_no	0.778 (3.342)***	0.295 (1.350)	0.232 (0.730)	-0.849 (2.843)*
Number of younger sisters out of school	fy_no	0.624 (3.094)***	-0.833 (3.261)***	-0.324 (1.451)	0.059 (0.232)
Relation-to-head of household					
=1 if son/daughter of the household head	sondau	0.751 (1.846)*	0.939 (1.103)	0.051 (0.063)	-0.031 (0.031)
=1 if grandchild of the household head	grand	0.971 (1.663)*	0.771 (0.716)	1.332 (1.357)	-1.804 (1.323)
Gender Variable					
=1 if female; =0 otherwise	fem	-1.302 (3.542)***	-1.643 (3.725)***	1.148 (2.197)**	1.432 (2.459)**
Total number of observations			2675		1270

Note: Estimation includes household fixed effects, age dummy variables, year dummy variables. The conditional maximum likelihood method is employed.

* statistically significant at 10% level

** statistically significant at 5% level

*** statistically significant at 1% level

Table 2.13
Village-Gender Fixed Effects Logit Estimation of Entrants and Dropouts Model
Dependent Variable: ENT or DRP

		Coef. (z-stat.)	Coef. (z-stat.)	Coef. (z-stat.)	Coef. (z-stat.)
Independent variable		ENT	ENT	DRP	DRP
Specification		III	IV	III	IV
Income Variables					
Pemanent income (1,000 Rs)	per_inc		0.002		-0.007
			(1.420)		(2.331)**
Interaction term with female dummy	IfXper_I		-0.001		0.003
			(0.424)		(0.785)
Transitory Income (1,000 Rs)	tr_inc		0.018		-0.088
			(0.615)		(1.936)*
Interaction term with female dummy	IfXtr__I		0.055		0.016
			(1.277)		(0.253)
Residual Income (1,000 Rs)	res_inc		0.002		-0.002
			(1.115)		(0.577)
Interaction term with female dummy	IfXres_I		-0.0001		0.001
			(0.039)		(0.186)
Number of Siblings					
Number of elder brothers	ebrother		-0.108		-0.081
			(2.663)***		(1.486)
Number of elder sisters	esister		0.130		-0.050
			(3.132)***		(0.806)
Relation-to-head of household					
=1 if son/daughter of the household head	sondau		0.471		0.093
			(2.322)**		(0.331)
=1 if grandchild of the household head	grand		0.701		0.278
			(2.821)***		(0.784)
Total number of observations			2662		1239

Note: Estimation includes village-gender fixed effects, age dummy variables, year dummy variables. The conditional maximum likelihood method is employed.

* statistically significant at 10% level

** statistically significant at 5% level

*** statistically significant at 1% level

Chapter 3

Sequential Schooling Decisions of Households: An Analysis of Field Survey Data from Rural Pakistan

3.1 Introduction

The recent revival of economic growth theory has renewed interest in the human capital investment-growth nexus in terms of macroeconomic perspectives [Barro and Sala-i-Martin (1995)]. International comparison studies indicate relatively low performance of human capital investments in Pakistan, in terms of overall level of school enrollment rate, high school dropouts, and distinct gender gap in education [Berhman and Schnieder (1993); Sawada (1997)]. These results imply a strong negative effect of low level of education on the long-term macroeconomic growth of Pakistan. The microeconomic behavior of the family, however, underlies such an observation of aggregate economic change. Parental decisions of child education depend on various factors involving the interplay of parental objectives and constraints faced by the family.

For the present study, field surveys were conducted in twenty-five poor Pakistani villages, formerly surveyed by the International Food Policy Research Institute (IFPRI), in order to investigate the key features of micro-level human capital accumulation process. The first question addressed in this Chapter is how the household demand for education is determined under various micro-level resource constraints of village economy. The most important determinant of educational investment may be household's socio-economic background and resource availability such as parental monetary and non-monetary wealth. Secondly, the chapter investigates the determinants of allocation decision of educational resources within a household by analyzing gender gap and birth-order effects on education. We utilize a standard investment model of demand for education as the benchmark. Essentially, risk, uncertainty, and constraints on insurance and credit influence households' investment and consumption decisions. It is, therefore, quite natural to formalize human capital accumulation in rural Pakistan as households' sequential schooling investment decisions under uncertainty and credit constraints, following suggestions by Jacoby and Skoufias (1997) and Sawada (1997). In sum, the first part of this chapter is devoted to apply a standard educational investment model in the context of Pakistan.

Then we evaluate the basic investment model with help from household information

gathered in the villages. In the empirical section of this chapter, the model is augmented so that we can examine quantitatively various aspects of schooling in rural Pakistan such as socio-cultural aspects, especially caste system and supply side conditions of education, which are not incorporated into the formal model. Through this process, we identify the obstacles that prevent household human capital investments. Although researchers have been studying issues of informal credit and insurance, household resource allocation, and long term education process separately in the context of developing countries, the lack of extensive panel data has prevented an integrated analysis within a consistent intertemporal framework. Information gathered by the author's field surveys would make it feasible to conduct an integrated study on schooling decisions of poor Pakistani households. This research will contribute to the literature since the only related attempt known to us so far is a paper by Jacoby and Skoufias (1997) and Sawada (1997). Through this research, it will be possible to identify a key microeconomic mechanism which can result in poor educational attainments and different schooling patterns between boys and girls. This chapter should be regarded as an effort to integrate measurement from the field, economic theory, and policy reform, as suggested by Townsend (1995).

The most important contribution of this chapter is the utilization of the unique data set on the whole retrospective history of child education and household background, which is carefully collected exclusively for this analysis through the author's field surveys. We should note that human capital outcome, represented by years of completed schooling, is stock rather than flow variable. In this case, current outcomes depend not only on past inputs but also on current inputs. Therefore, general reduced form solutions will include the entire history of exogenous influences [Strauss and Thomas (1995: pp.1974-75)]. Yet, it is rare that data sets have available such historical data on individual and household characteristics. Moreover, introducing dynamics by having the current period outcome depend on past outcomes complicates estimation procedure. Because data is typically unavailable, the dynamic aspects of education is ignored in most of the reduced form literature. In order to examine explicitly the dynamic, sequential aspects of schooling decisions, this chapter utilizes the unique data set on retrospective history of child education, which is collected exclusively for this analysis. Hence, the data collection itself can be a crucial contribution to the literature. In addition to this data contribution, this chapter analyses the sequential nature of school entry and exit decisions. This unique data set enables us to estimate the full sequential model. The results of educational stage specific schooling behaviors provide new and important insights on demand for education. For example, the educational stage specific gender differences in schooling are formally examined. Such an analysis cannot be

found in the literature, particularly for Pakistan, due to the lack of data sets. This chapter explains in detail a key sequential microeconomic structure of the school decision making process of Pakistani households. Hence, Chapter 3, together with Chapter 2, gives important new insights to the understanding the dynamics of household risk-coping strategies and resulting educational decisions in developing countries across time.

This chapter proceeds as follows. Section 3.2 describes the key features of human capital investments in rural Pakistan, which were identified from the field research. Based on the key observations from the field and a descriptive model framework Section 3.3 shows a standard theory of dynamic consumption and schooling investment decision. Section 3.4 then evaluates the basic investment model of Section 3.3 in a non-technical manner. It examines various aspects of schooling in rural Pakistan, which are not incorporated into the formal model, ranging from household background to socio-cultural aspects, with the help of preliminary assessments of the field observation. This section also illustrates the environment of a typical rural Pakistani village in order to extend the initial model framework. In Section 3.5, an econometric framework to estimate the discrete hazard rate of schooling is derived, based on the extended theory. This section then shows estimation results of the full sequential schooling decision model. The final section offers conclusions, policy implications, and suggestions for future research.

3.2 The Methodology and the Key Features Identified in the Field

3.2.1 The Filed Work Methodology

Our approach follows an iterative process of initial hypothesis-field survey-theory-empirical analysis, which is suggested by Townsend (1995). This chapter also combines the relative advantages of large-scale household survey with small scale, village-based studies. Instead of directly implementing econometric tests based on a theoretical framework with an existing well-defined data set, this chapter starts with key features of household behaviors discovered in the field. Modification of data collection was undertaken in the initial stage and the theory is augmented afterwards according to the field observations.

Field surveys were conducted twice in order to gather information exclusively for this chapter. First of all, the author organized two survey teams, one for Punjab and the other for the North-West Frontier Province (NWPF), which are composed of research assistants selected from researchers at Pakistan Institute of Development Economics and the former IFPRI survey

enumerators. This is because of difference in local language spoken in Pakistani villages; local language in Pujab province is *Punjabi* and people in NWFP speak *Pukhto*.[1]

The Punjab survey team carried out the first round survey in fourteen villages of Fisalabad and Attock Districts of Punjab province on February through April 1997 (Figure 3.1). The selection of our survey sites was predetermined, since basically we resurveyed the IFPRI panel households. Figures 3.2 and 3.3 represent the location of the first round survey villages in Fisalabad and Attock Districts, respectively. The Faisalabad district is a well-developed irrigated wheat and livestock production area. Production of cash corps such as sugarcane and vegetables is common as well. Although there is a fair amount of development of light industries between Faisalabad and Lahore such as textile and food industries, more than half of the average household income is from the agricultural sector [Table 3.1 and Alderman and Garcia (1993)]. On the other hand, earnings from non-farm activities are the major component of household income in Attock, which is the rainfed wheat production region near the industrial city of Taxila (Table 3.1).

The second round surveys were carried out in eleven villages of the Dir Districts of NWFP in December 1997 through January 1998. Dir is also a rainfed wheat production area with some cash crop production such as citrus, while there is only a limited set of opportunities of earning non-farm income within and around the district. However, out-migrations to the Persian Gulf countries are quite common in Dir. As a result, non-farm income and remittances account for more than sixty percent of average household income (Table 3.1).

The first stage of our project is composed of iterations of designing questionnaires and conducting pre-tests of questionnaires. We then conducted comprehensive household and village level surveys. Before conducting trips to each of these villages, the Punjab survey team implemented a set of pre-constructed questionnaires in several villages in the Attock district, which are not out survey sites. Through these pre-surveys, several questions were added to the original questionnaires. The original and additional questions were then modified, based on the perceived accuracy of responses, the amount of information obtained, and the effort and time needed to acquire it. As a result of this process, we ended up with having three different sets of the questionnaire for the retrospective surveys.

The first questionnaire is composed of questions regarding basic child information and retrospective schooling progress information. The main intent of this questionnaire is to

[1] Although the term *Pathan* is also widely used, the word *Pathan* does not exit among *Pukhto* speakers and *Pukhtuns*. Ahmed (1980, p.368) concluded that it is an Anglo-Indian corruption.

construct the whole history of schooling of all the children together with child characteristics. Specifically, the household heads were first asked to list the names and composition of his/her children. We tried to ask these questions in the presence of children, although it was not always possible, especially for daughters. Then enumerators proceeded to specific questions about children such as child age, sex, marital status, location of child residence, and amount of dowry payments. The second section asks detailed questions regarding long term child schooling progress, together with monetary and non-monetary cost variables of schooling. It is first determined whether a child has ever gone to school. Then we solicit them for information such as when in the calendar year a child enters, graduates, or has dropped out of a school. We also asked the household head's subjective assessment of academic performance of each child and reasons for the withdrawal of children from school when it's occured.

The second questionnaire is composed of questions concerning basic household background information. The main objective of this questionnaire is to measure household size, permanent components of household resource, and fluctuations in household assets and income over time. With respect to the permanent resource information, each household is asked for the level of parental education, and a retrospective history of household asset ownership such as land, tractors, and tubewell. For the transitory components of resources, households are asked to select the best and worst years since their marriage in terms of crop harvest, livestock incomes, and non-farm incomes. They are also asked about historical incidents of parental illness which potentially affects a child's education adversely. There is also a section which is composed of questions about large amount transfers from children, relatives, friends, and organizations. Households were supposed to respond if there was a transfer larger than 20,000 rupees.

The third village level questionnaire gathers village level retrospective information over the thirty years since 1970. This includes long term change of total acreage of land and number of households, mosques, shops, union council members, army soldiers, canal and revenue *Patwaris* (tax officers), active water users associations, rural health units, and medical shops within the village. Particularly, we collected information about the year when female or male primary school built in the village. These pieces of village-level information were gathered by interviewing with local government officials and/or educated village dwellers such as school teachers.

These questionnaires seemed to work well in the field. Farmers remember incidents related to child education and enjoyed talking about their children. Each household interview lasted approximately one and half to two hours per household, largely depending on the number

of children. We visited the villages without prior notification. The availability of respondents was uncertain in advance. Therefore, we may plausibly assume that our attrition of panel households is determined by a random process. Finally, in our field surveys, retrospective information about child schooling, parental education and health status, and household assets, was collected for 203 households in Punjab and 164 households in NWFP. Hence, 367 households were interviewed out of around 675 households in the original IFPRI surveys in Punjab and NWFP. Information on a total of 2365 children was collected. The combined data set gives a complete set of retrospective histories of child schooling, together with household and village level information, which make the estimation of a full sequential schooling decision model feasible. Moreover, the field survey data set is matched with the IFPRI household data files, which was collected through the IFPRI's Pakistan Food Security Management Project [Alderman and Garcia (1993)]. Since our purpose is an estimation of the full sequential schooling decision model, we utilize a part of the IFPRI data files that contains historical information about long-term retrospective information on household and village characteristics.

3.2.2 The Key Features Identified from the Field

The most striking feature discovered in the field is the high educational retention rate, conditional on school entry. According to our survey data, *after once entering the primary school*, the average years of schooling is 6.0 years for female and 8.8.years for male. On the other hand, overall sample average years of schooling for all female children are 1.6 years, where as they are 6.6 years for male children. These numbers indicate that after entering school, a child obtains fairly long education and, moreover, the gender difference in years of schooling becomes relatively small among those who are educated. This observation implies that there might be an increasing-returns-to-scale or an investment momentum existing in schooling.

Figure 3.5 indicates the distribution of total years of schooling. As we can see clearly, there are five spikes in this distribution. Note that the first spike at null schooling is very high, whereas the latter four spikes during years of schooling are quite low, implying the high schooling retention rate at the higher levels of education. First, about half of children have never been to school, indicating that historical average of primary school enrollment rate is about fifty percent in these villages. Second, the spikes at five years and eight years correspond to the children who left education after primary and middle school graduation, respectively. Third, the spike at ten years represents that some children left education after completing secondary school.

Finally, there is a spike at twelve years of schooling, which indicates the children who left education after completing intermediate college or technical school.

In order to quantify further the school progression rates at these different educational stages, we utilize the framework of estimating the hazard function. Using the education schedule of Pakistan represented in Table 3.2, years of education are discretized into pieces so that S_k takes on seven values, e.g., S_1 for primary school entry, S_2 for primary school exit, etc. (Table 3.4a).[2] Let n_k denote the number of individuals whose educational attainment is at least at the stage of S_{k-1}. We simply utilized data where S_k is not censored at the education level, k. The set of individuals whose school attainment is at least S_{k-1} is called the risk set at the stage of education, S_k, since the risk set is those individuals still at risk of leaving education at stage S_k. Thus n_k represents the size of the risk set at level S_k. Among n_k children, let h_k denote the number of children who have not completed education level k. Then, an empirical estimate of the hazard probability at education level k would be

$$h(S_k) = \frac{h_k}{n_k}.$$

The estimated hazard rate is summarized in Table 3.4a. As we can see, the hazard rate at the first entry, i.e., the probability of never entering school, is high both for boys (30%) and girls (67%). Yet, the female schooling hazard rate at this stage is more than twice as large as the male hazard rate. After entering primary school, however, hazard rates dramatically decline for all children: the hazard rates of primary school dropout are 15.5% and 25.9% for male and female students, respectively. These statistics indicate that once entering a school, the majority of children remain in school. Another interesting finding is that while the hazard rate is higher for girls than for boys at primary school entry and graduation and middle school entry, the hazard rates after middle school entry are consistently lower for females. This indicates that the gender gap in education eventually disappears at the higher stages of education.[3]

These basic statistics also suggest the substantial differences in the degree of educational

[2] We assume that for those who did not enter a primary school, the decision was made when the child was at the age of six, which is the median age of primary school entry (Table 3.3).

[3] We also estimated the Kaplan-Meier product limit estimator, although we do not present the results in this chapter. The Kaplan-Meier estimator of survival beyond stage k is the product of survival probabilities at k and the preceding periods. Graphing survival probability against sequence k produces a Kaplan-Meier survivor curve. Again, at the primary school entry level, school survival rate is much higher for males than for females. The slope of survival function, however, is flatter for females, indicating that gender gap in

gender gap among districts. According to Table 3.4b, in the Dir district of North West Frontier Province, the hazard rates are consistently higher for females at all stages of the schooling decision. The district differences seem to be largely due to socio-cultural factors. For example, the custom of seclusion of women, *purdah*, is strictly maintained in the Dir district. These regional divergences in gender gap in rural Pakistan raise an important policy issue. When the government allocates education expenditures, the disadvantaged groups such as girls and children in lagging regions should be targeted in order to assure more equitable gains from schooling [Alderman, Behrman, Khan, Ross, Sabot (1995)].

3.3 The Standard Theory of Educational Investments

A possible interpretation of the above findings is that parents might pick the 'winners' for educational specialization and allocate more resources to them. As an initial theoretical framework to account for this household behavior, we employ the two sets of optimal behavioral rules (Chapter 2). First, parents decide the intertemporal allocation of resources so as to maximize the expected total utility of the family. Second, parents also have to decide the allocation of educational resources among children according to the preference and the constraint of the household. However, these decisions may be made simultaneously, rather than sequentially.

3.3.1 Intertemporal Household Resource Allocation

According to the first optimality rule, a household's overall resource constraint and life-cycle consideration will determine the total amount of expenditure devoted to education. Credit and insurance availability will become especially important at this stage. If borrowing is allowed under an exogenously given interest rate, a household can maximize the total wealth simply by investing in the human capital of each child so that the marginal rate of return from education of each child is equal to the interest rate. If, however, credit availability is limited and thus household's consumption and investment decisions are not separable, the household resource availability such as parental income and assets affect the observed duration of child's schooling (Chapter 2). In fact, many estimates of schooling function using household data sets from developing countries report positive coefficients of current household income variables, which

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education becomes smaller at the higher levels of education.

imply the existence of credit market imperfections [Behrman and Knowles (1997); DeTray (1988); King and Lillard (1987); Deolalikar (1993); Chapter 2].[4]

3.3.2 Intrahousehold Resource Allocation

For the second optimality rule, parents redistribute the maximized wealth among family members according to their preference toward each child or returns to schooling. The non-proportionality of investments between children, especially between males and females and between older and younger siblings, is a serious issue in South Asia.[5] Hence, among the various issues of intrahousehold educational resource allocation, two aspects should be investigated formally in the settings of rural Pakistan: gender gap and birth order.

With respect to the first issue, in rural Pakistan, women are significantly less educated than men. There are several possible explanations for this distinct gender gap in education.[6] First, the expected *effective net* return to the a daughter's education seems to be consistently lower than that for a son's education. As discussed by Chaudhary and Chaudhary (1989), the high opportunity costs of daughters' education in rural Pakistan may lead to apparent intrahousehold discrimination against women in terms of education. For example, daughters can accomplish various kinds of household chores such as taking care of younger siblings and helping meal preparations. Second, due to the existence of *Jahez*, which is a dowry in Pakistan, a daughter's education necessitates an extra cost relative to a son's education, resulting in the gender gap [Das Gupta (1987) for Indian Punjab]. Parents may have an incentive to compensate future dowry expenses with a daughter's current labor contribution. Third, parents may perceive that returns to a daughter's education will pass to other families after marriage.[7] This is simply because Pakistan is a paternal society and thus daughters move to other families after marriage. Fourth, there is a custom of seclusion of women called *purdah* in Pakistan. Due to *purdah*, women's wage earning opportunities are quite limited, resulting in a clear gender gap in wage rate. Finally, the importance of sons as an old-age security and insurance device for parents

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[4] The typical dependent variable is current enrollment decisions or years of completed schooling

[5] In fact, the demographic evidence of "missing women" in South Asian countries and gender discrimination in South and East Asian countries has motivated the literature on intrahousehold resource allocation [Udry (1997)].

[6] We should note that gender difference in education creates long-lasting negative effects on economic development, since education of mother relates to fertility and population over time. Many empirical studies show a highly educated mother has lower infant mortality rate, fewer children, and more educated and healthier children [King and Hill (1993)].

[7] Parish and Willis (1993) also pointed out the importance of this effect.

might also enhance the subjective *net* return of a son's education and thereby generate gender gap in education. Thus parents might think that they can extract more resources from sons than from daughters by investing in a son's education. In sum, *effective net* return to a daughter's education seems to be consistently lower than to a son's education. As a result, parents might choose to optimize their aggregated returns and keep daughters uneducated.

The second important aspect of intrahousehold resource allocation is the birth order effect. If credit market is imperfect, a household's investable resources are quite limited. Hence, there should be resource rivalry among sisters and brothers (Chapter 2). There are two possible cases of evolution of sibling competition effects over time [Behrman and Taubman (1986)]. First, there may be negative birth-order effects. As more children are born, household resources constraint becomes severe and less resources becomes available per child. If this per child resource shrinkage effect is dominant, the later-born (higher-order) siblings will receive a worse education. On the other hand, elder siblings will be educated more than younger siblings. An increase in resource competition effects will lead to negative birth-order effects.

However, the resource competition effects might decline over time, since households can accumulate assets and thus increase income over time. Moreover, the elder children may enter the labor market, contributing to household resources. Resources from both parents and elder siblings then may be available for younger (higher-order) siblings, and therefore they could spend longer years at schools. This is the case of positive birth-order effects. Moreover, an economy of scale due to household-level public goods might exist, since siblings can share various educational inputs and materials. Positive knowledge spillover effects might be important as well. Younger children can learn easily from the experience of their elder siblings through home teaching. Hence, having elder siblings might promote an education of a younger child, rather than impede an education of that child, if the resource extension effects, scale economies, and spillover effects are larger than the competition effects.

In fact, existing empirical studies indicate mixed results of the above mentioned two hypotheses. Garg and Morduch (1998), for example, indicate that younger children tend to fare better than elder children in terms of health outcomes, using Ghanaian household data. These results suggest the positive birth-order effects. On the other hand, Birdsall (1991) find that being both first- and last-born in a family of three children with a non-working mother is associated with higher schooling. This finding implies that there is a combination of resource competition and resource extension/spillover effects among siblings. In reality, these two effects may be combined with each other in a complicated way. Moreover, there may exist combined effects of

gender gap and sibling competition. Parish and Willis (1993), for example, find that in Taiwan, an additional sibling is associated with less education among both sisters and brothers, implying the resource competition effect, whereas the late-born children tend to be better educated which indicates the resource extension effect. While older brothers reduce the educational attainment only of men, additional older sisters are associated with more education for both males and females. Their results indicate gender specific intrahousehold resource allocation effects. If there exists the sibling competition effect, parents should pick those who have a higher return to education for human capital investments. A corollary of this argument is that if there is a son, the son is educated and thus less resources will be allocated to other siblings. Using household survey data from Ghana, Garg and Morduch (1998) support this hypothesis empirically. They showed that in economies with pro-male bias, sibling rivalry could yield gains when there are relatively more sisters than brothers. Yet, there is no consensus in the literature about whether birth order effects really exist, and if they exist, whether they are positive, negative, or nonlinear in form [Parish and Willis (1993)].

3.3.3 The Formal Model of Sequential Schooling Decision

Having discussed the key observations in the field and the theoretical framework informally, the next step is to formulate a formal model of the household's optimal schooling behavior, integrating these key features. The model also incorporates uncertainty and credit constraints. The basic setup of our model is based on Levhari and Weiss (1974) and Jacoby and Skoufias (1997)'s seminal works on human capital investment under uncertainty. We extend the Jacoby and Skoufias (1997) model to a generalized form with multiple children. The basic setup of the model is the same as the model in Chapter 2.

Now let us specify the functional forms of utility and human capital production functions. For the utility function, we assume the constant absolute risk aversion (CARA) specification. For the human capital production function, we select the exponential function as well. These functions will be

(1) $$U(C_t) = \bar{\alpha} - \frac{1}{\alpha}\exp(-\alpha C_t),$$

(2) $$f(S_{it}, FEM_t, q_{it}) = \gamma_0 - \frac{q_{it}}{\gamma_1}\exp[-\gamma(FEM_t)S_{it}],$$

where it is easily verified that $f_S > 0$ and $f_{SS} < 0$. Note that α and $\gamma(FEM_i)$ represent the coefficient of absolute risk aversion and the return to education, respectively. The hypothesis of higher rate of return to son's education than daughter's education is represented by $\gamma(0) > \gamma(1)$. We also assume that parental income follows an *i.i.d.* normal stationary process. Let Y^P and Y^T represent permanent and transitory components, respectively, of parents' income, Y_{Pt}. Then, by definition, we have $Y_{Pt} = Y_t^P + Y_t^T$ with $E(Y_{Pt}|I_t) = Y_t^P$ and $E(Y_t^T|I_t) = 0$. Our further assumption is represented by $Y_{Pt} \sim N(Y_t^P, \sigma^2)$.

There are two different cases in this problem. First, when a household can borrow and save money freely at an exogenously given interest rate, the credit constraint is not binding. In this case, the household determines the evolution of optimal schooling so as to equalize the net marginal productivity of schooling and the non-stochastic market interest rate. The optimal schooling decision rule then becomes

$$S_{it}^* = \ln\frac{q_{it}}{q_{it-1}} - \frac{1}{\gamma(FEM_i)}\ln(1+r_t) + S_{it-1}^*, \ \forall\ i. \tag{3}$$

This is a linear difference equation for the optimal schooling decision. This equation (3) indicates that the optimal level of schooling is a function of school availability and quality, gender specific elements, and the market interest rate. If the credit constraint is not binding, parental income or schooling decisions of other children do not affect the schooling decision for a child.[8]

Alternatively, if the household is constrained from borrowing more, not from saving more, the household effectively faces an endogenous shadow interest rate, which is given by the marginal rate of substitution of consumption over time. Under credit market imperfections, the separability between consumption and schooling investment decisions breaks down. Moreover, the separability among different children's schooling decisions does not hold. Under this non-separability, the reduced form schooling decision can be represented by the following linear difference equation:

$$S_{it}^* = \pi_{1it-1} + \pi_{2i}(Y_{Pt} - Y_{Pt-1}) - \pi_{2i}\sum_{j\neq i} Y_{Cj}\Delta S_{jt}^* + S_{it-1}^* + \varepsilon_{it}, \ \forall\ i, \tag{4}$$

[8] In other words, two separabilities, one for consumption and schooling decision and the other for

where $\pi_{1it-1} \equiv -\frac{1}{\gamma(FEM_i)+\alpha Y_{Ci}}\left(-\ln\frac{q_{it}}{q_{it-1}}+\ln\beta+\frac{1}{2}\alpha^2\sigma^2\right)$ and

$\pi_{2i} \equiv \frac{\alpha}{\gamma(FEM_i)+\alpha Y_{Ci}} > 0$. Note that ε_{it} indicates a mean zero independent rational expectation error of parental income Y_{Pt}. In equation (4), the gender indicator variable, *FEM*, also affects the optimal schooling decision, as in the case of the complete credit market model. The first term on the right-hand side represents flow of educational service, household time preference, risk attitudes, and the degree of income instability, which is adjusted by gender variables. Parental income, Y_{Pt}, and other children's schooling decisions, S^*_{jt}, $\forall j \neq i$, also become relevant to the child i's optimal level of schooling. The second term represents the intertemporal household resource allocation effects. An increase in household income, which depends on various household variables, affects educational investments positively. The third term represents sibling schooling competition effects, including the birth order effects.[9] A larger number of siblings who are currently studying at school, given previous schooling decisions, will decrease child i's time allocation to schooling. Alternatively, wage earnings of elder siblings will enhance the optimal time allocation to schooling.

In equation (4), we can easily verify that

(5) $$\frac{\partial \pi_{1it-1}}{\partial Y_{Ci}} > 0 \text{ and } \frac{\partial \pi_{1it-1}}{\partial \gamma} > 0.$$

Suppose there is a systematic gender gap in wage and returns to education. These two results of comparative statics indicate that there is a systematic gender gap in the optimal time allocation to education, through wage gap and difference in returns to education. Moreover, by comparing equation (4) with equation (3), we can easily note that, under perfect credit availability, $\pi_{2i} = 0$. On the other hand, under the binding credit constraint, we have

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intrahousehold schooling allocation, hold in this model.

[9] According to equation (4), the optimization behavior of a household for the i-th child is conditional on that for all other children. The optimal choice of child i's schooling, S^*_i, depends on S^*_{-i}, the optimal schooling decision made for a child other than i. We therefore derived a Nash equilibrium of child educational decisions. Strategies that comprise a Nash equilibrium at each date are referred to as Markov perfect. The equilibrium represented by equation (4) can thus be interpreted as the Markov perfect equilibrium [Mashkin

(6) $$\frac{\partial \pi_{2i}}{\partial Y_{Ci}} < 0 \text{ and } \frac{\partial \pi_{2i}}{\partial \gamma} < 0.$$

These two signs represent that sensitivity of the optimal level of education to income change is larger for daughters than for sons. These results are basically the product of the flatter return schedule for female education. Facing an increase in household shadow interest rate due to a negative income shock, the optimal reduction of schooling should be larger for daughters than sons (Figure 3.6). The direction of these partial derivatives are supported empirically (Chapter 2). These theoretical predictions are also consistent with estimation results of Alderman and Gertler (1997) which showed that income elasticities of demand for human capital investments is uniformly larger for females than for males, using the IFPRI Pakistan panel data set.

Moreover, inequalities (6) indicate that resource competition effects impose more severe effects on daughter's education. Under the binding credit constraint, parents must select how to ration available resources between their children. When a child's opportunity cost of schooling is large, then he/she will be compensated by the other child's low level of schooling and/or (shadow) wage income. In a typical rural Pakistan setting, men have a higher wage rate and return to education. Then, sons might gain from having sisters instead of brothers since they will be provided with higher years of schooling. Similarly, daughters may gain from having sisters instead of brothers [Garg and Morduch (1998)].

3.4 Descriptive Assessments of the Theory[10]

Before getting into a formal econometric analysis, it will be useful to describe the author's personal assessments of the above initial theoretical considerations, utilizing household information gathered in the villages. This will be done in the spirit of Lanjouw and Stern (1991). Surveyed households are, typically, farmers with or without land. Father's and mother's levels of education are very low and their ownership of productive assets, such as land, machinery and livestock, is usually minimal. The limited resource availability of physical and human assets obviously seem to prevent landless households from investing in child education. Comparing the family of 70 year old Mir with the household of Bashir provides a good illustration. Both farmers live in a village in Attock province. These two household heads and their wives are totally

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and Tirole (1988), Pakes and McGuire (1991), and Besley and Case (1993; 1994)].

[10] In the purpose of anonymity, we utilized pseudo names of households.

illiterate without any experience of formal education. The main difference between these two families is in their land ownership: Mir is a landless farmer, while Bashir owns 6.1 acres of rainfed land which was inherited from his farther. In terms of the family size, landless Mir has four sons and three daughters currently, while Bashir has four daughters and a son. Among the seven children of Mir, only the second son, Talai, entered primary school. Talai, however, left education after graduating primary school, since parents needed him at home. This implies that due to a high opportunity cost of Talai's education, Mir let Talai withdraw from school after his completion of primary education. On the other hand, all five children of Bashir are educated: the first and the second daughters and a son have college level education, while the third daughter and the youngest daughter are still attending middle schools and primary school, respectively. The comparison of these two households illustrates that the lack of child education might be attributed to insufficient household resources, especially land in these examples.

Besides land ownership, comparisons between the former two households of these illiterate parents and the family of highly-educated Ayub in a village of North-West Frontier Province suggest the importance of parental level of human wealth. Ayub has a high school diploma and is working as a government officer. Ayub also own 5.6 acres of irrigated land which was given by his father in 1969. He is obviously rich, although his wife is totally illiterate, which is not surprising in NWFP. After the deaths of a seven year old second son and a thirteen year old third daughter, he and his wife are left with four sons and three daughters. Amazingly, these seven children all graduated primary school and all except the second eldest daughter have finished at least middle school level education. For example, the third son, 27 year old Muhammad, has completed a college level education, which is the exceptionally high educational achievement in the Dir district of NWFP. He is now preparing for a nation-wide examination in order to enter university. Obviously, the affluence of household physical resources, probably combined with the high education level of the father, enabled the high level of investment in child education. In fact, there is rich and robust evidence which shows a positive relationship between the education of the parents and the child schooling performance [Berhman and Ii (1999); De Tray (1988); King and Hill (1997); King and Lillard (1987); Levison (1991); Deolalikar (1993); Parish and Willis (1993); Rosenzweig and Wolpin (1982)]. According to the conventional theories of production function, parental education affects child educational outcomes by improving the technical or allocative efficiency [Schultz (1964); Welch (1970)]. Moreover, the more educated mother and father are better able to perceive the benefit of education than uneducated parents. This implies the positive incentive effects of educating children due to

higher precision of estimating return to education. Home teaching seems to be important as well. Better-educated mothers, for example, are superior teachers in the home, and more educated mothers produce children with higher levels of education [Behrman, Foster, Rosenzweig and Vashishtha (1997)].[11]

We should also note that Pakistani households face considerable income instabilities. Risks of disaster such as large income shortfalls, sickness, and sudden death of an adult member impose serious constraints on household's resources since there is a severe limitation on formal and/or informal credit availability in rural areas. To clarify this aspect, we can compare the family of Mohad in Attock district with the above Ayub's family. Mohad was similarly rich with two sons and three daughters. Mohad was a well-educated person, working as a government official and partly operating 4 acres of his own land. Unfortunately Mohad passed away on July 17, 1994. The loss of income-earning household member was permanent, which caused an immense exogenous negative shock to the family's economic resources. The education of his nineteen year old son Muhammad was affected significantly by the sudden death of his father. Muhammad was studying in a college (F.A. level) when his father died. However, after his father's death, Muhammad could not continue his education because of the sharp decline in the family's income. Fortunately, Muhammad got an apprenticeship in Pakistan Oil Field Limited and is now receiving 1,000 rupees per month. Inactivity due to sickness or sudden death would decrease household income substantially, both for farm and non-farm households. The case of Ayub's family indicates that the lack of insurance devices against exogenous negative shocks has non-negligible effects on the household's investment decisions. The household becomes a key economic decision unit in developing countries, since it can complement the lack of formal institutions by providing various kinds of informal insurance devices [Rosenzweig (1988)]. The lack of formal insurance devices, however, will lead to the use of perverse informal self-insurance devices such as the use of child labor income as parental income insurance, sacrificing accumulation of human capital [Jacoby and Skoufias (1997); Sawada (1997)].

Among the various aspects of intrahousehold resource allocation, gender gap and birth order effects in education are widely observed in the field. The education decisions of 65 year old Bashir in a Punjab village provide a good illustration of these issues. Bashir is landless farmer who got married about forty years ago. Bashir and his wife are totally illiterate. Although

[11] They posited other possible explanations. First, educated mothers might obtain greater command of resources within the household, so that they can allocate more resources to children. Second, mothers with higher levels of schooling may contribute more income to the household, resulting in higher investments in child education. Finally, men with greater preferences for schooling may marry educated women. As a

they had four sons and six daughters, the first son died at an early age a long time ago. Yet, all three sons have entered a primary school which is available in the village. On the other hand, among the six daughters, only the youngest daughter has entered primary education and the other five daughters are completely uneducated. Bashir's educational decisions might reflect his strong pro-male preference in terms of education. While the youngest daughter left education right after the primary school graduation because of her illness, there could be positive birth order effect in a daughter's education. Bashir implied that this youngest daughter's education was supported by the elder brother's resource extension effect. Out of three sons the two younger sons dropped out primary school before the graduation. Bashir told us that these two sons did not want to continue schooling because of a teacher's punishments and left education. The current eldest son, Rafiq, got the longest education in this family. Rafiq graduated middle school and entered secondary school. However, Rafiq could not finish secondary-level education because he did not pass the matriculate examination at the end of the term.

3.4.1 Caste System and Socio-Cultural Factors

We should also note that there are factors which affect the demand for schooling other than the aspects presented the above. Table 3.5 listed the reasons of the termination of a child's education among those children who entered primary school. Among others, in 13.4% of cases, households listed "the accomplishment of the desired education level" as the reason of a child's school exit. This is a purely subjective reason, implying that schooling choice may differ depending on language, ethnicity, network, and social status [Psacharopoulos and Woodhall (1985)]. For cultural reasons, households or groups may not accept formal education. Particularly, the structural characteristics of the Pakistani society may be an important reason for the pro-male bias in education, since parents have a strongly negative perception toward female education due to the practice of *purdah*. Chaudry and Chaudry (1989), for example, provided evidence that low female enrollment in rural Pakistan reflects the conservative attitudes of parents who will not educate their daughters because of their traditions. In culturally conservative environments of rural Pakistan, if adolescent girls continue going to schools, they may be viewed as morally suspect. The importance of maintaining a daughter's good reputation, in order to let her marry early, leads to widespread withdrawal of girls from school at the age of puberty [Khan (1993)].

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result, they invest more in their children's education.

Besides gender, another socio-cultural issue is the caste system, called *biraderi*, which literally means brotherhood, relative, and kin.[12] Caste system indirectly constrains the educational opportunities of low-caste children. This system of social ranking originated not only in the custom of Muslim migrants from India after the independence of 1949 but also in the social status of the former Hindu Muslims in Punjab province. *Biradari* is based on patrilineal descent and can be identified by the current occupation that has been assigned traditionally [Eglar (1960)]. In Punjabi villages, there are two main castes: *zamindar* and *kammi*. *Zamindars* are the landowners. Agricultural and non-agricultural casual laborers such as wage laborers and artisans are called *kammi*. *Zamindars* are strictly separated from *kammi* and differ in their social status in accordance with the size of their landholdings.[13] Agricultural landless laborers are strictly distinguished from landowners. Non-agricultural laborers such as casual laborers and artisans are also differentiated from landowners [Eglar (1960)]. The agricultural tribe and non-agricultural tribe were clearly distinguished even under the British rule. The system of caste has prevailed as social norms that traditionally define the desirable behaviors of all village dwellers. Members of each social class, *zamindars* and *kammis*, are expected to act according to their social and economic status. Whether or how much to invest in education is not an exception.[14] Interestingly, by analyzing a data set from a village in the central Pubjab, Ahmad (1977, Chapter 3) concluded that village social structure can best be described in terms of occupation and that occupation categories are linked with socio-economic status, pattern of group behavior, and cultural activities.

Comparisons of the above mentioned households also imply the important nature of occupation, which is traditionally related to social status. Indeed in the villages, we found the significant socio-cultural factors in education. The household headed by seventy year old Mehr in Faisalabad district provides an example. Mehr is a landless worker. He belongs to a low-caste

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[12] Strictly speaking, Eglar (1960) defined *biraderi* as patrilineage [Eglar (1960, pp.75-81)]. Alternatively, the concept of *quom*, which literally means a hereditary group or tribe, might be treated as castes [Ahmad (1977, pp.72-73); Barth (1981, pp.16-19)].

[13] Traditionally, *zamindar* and *kammi* have maintained the system of informal labor contract, called *Seyp* [Eglar (1960)]. *Kammis* work as a casual labor (*musalli*) or an artisan such as barber, carpenter, or tailor (laborer). Every *zamindar* household has a contract with a family of each of the *kammis*, and *kammis* also have contracts among themselves. To meet the basic needs of the community, the works of these *kammis* are defined by custom and usage [Eglar (1960), p.p.32-33].

[14] Moreover, class-specific child educational behaviors might interact with the pro-male bias in education. Eglar (1960), for instance, indicates that gender gap in education has been disappearing among children of *zamindars*; both sons and daughters are being educated. On the other hand, among *kammis*, there is significant pro-male bias in educational investments. This finding is similar to the Behrman (1988)'s finding from Southern Indian villages, which shows there is significant pro-male bias during the lean years which evaporates during surplus seasons among bottom castes, while top caste shows some pro-female bias.

kammi group and engages himself in non-farm casual service. It is not surprising that he and his wife are totally illiterate. Out of their nine children, two daughters and two sons died young. Nobody except the eldest son, Boota, received any formal education. Boota quit school after completing the first year of middle school. This case study of the Mehr's family is consistent with the hypothesis that the lack of child education can be attributed to the insufficient household resources combined with social status according to occupation and land ownership.

Strictly speaking, in the *Pukhtun* society of NWFP, caste status, *quom*, and occupational status, *kasb* or *kar*, are not identical, but each caste position is identified with an occupational position [Barth (1981, p.22)]. In the traditional *Pukhtun* social system, *gasabgars*, who pursue a craft or profession such as barbers and carpenters, are supposed to serve the *Pukhtuns*, traditionally land holding class. Hence, professionally, *gasabgars* may be equated to the *kammis* in Punjabi villages [Ahmed (1980, pp.168-169)]. By and large, only members of the *Pukhtun* or saintly castes own land. Among these, most land is concentrated in the hands of a small number of prominent chiefs and landlords who do not themselves engage in manual labor [Barth (1981, pp.32-24); Ahmed (1980, pp.171-173)]. Traditionally, *Pukhtuns* are patron to the *gasabgar* clients. Thus the *Puktuns* in NWFP may be equated to the *zamindars* in Pubjab. Therefore, even in NWFP, we can describe social structure and a household's desired behaviors in terms of land ownership and occupation.

3.4.2 School Supply Constraints

So far, we have discussed the demand side of education. In fact, according the interviewees' responses, about 35% of school termination decisions were attributed to the household and child economic constraints (Table 3.5). There are, however, supply constraints such as the lack of access to primary and/or middle schools inside the village, high transportation costs of schooling due to inconvenient school location, the lack of teachers and school facilities, and inefficient class schedule. The community-level school availability indeed appears to be important in determining the level of schooling in the surveyed villages. According to our survey data, in 32.5% of school termination decisions, the households listed the supply side problems including inaccessibility to school and the low teacher quality as the reason of their decision (Table 3.5).

School availability within a walking distance seems to be the key. For example, in a village of Fasalabad district, 55 year old Nazra complained about the excessively long distance to

the nearest middle school. Nazra is a rich farmer, cultivating four acres of irrigated land. He has four sons and four daughters. Although he and his wife are totally illiterate, two of their sons are educated; the eldest son, Iqbal, dropped out before middle school graduation, and the second son, Nawaz, dropped out right before finishing secondary school. The main reason for their dropouts was the excessively long distance to reach schools. Iqbal and Nawaz spent about an hour to go to middle and high schools by bicycle, since only a primary school is available in their village.

Differences in the supply of schools are strongly associated with the gender and regional schooling gaps [Alderman, Behrman, Khan, Ross, Sabot (1995)]. A significant portion of gender gap in Pakistani education can be explained by supply side quantity and quality constraints. Although socio-cultural factors generate the needs for single-sex schools, the lack of school availability affects female education more seriously than male education [Shah (1986)]. The number of girls' schools is always insufficient in Pakistan. Female school enrollment is negatively correlated with distance to school because parents are unwilling to send daughters to school if a female school is not available nearby. Since allowing girls to cross a major road or a river on the way to school often involves the risk that daughters will break *purdah*, parents will choose not to let daughters go to school.

The family of Ghulam in Attock reveals these peculiar socio-cultural aspects of education in Pakistani villages. Ghulam had no formal education and his wife is totally illiterate. He, however, is a relatively rich farmer, cultivating 8 acres of rainfed land. Ghulam has a son and two daughters currently, after having a daughter who died. His only son and the eldest child, Mushtad, graduated intermediate college. The elder daughter, Falak, also finished post-secondary education because her school performance was extremely good. Female middle school, however, was not available in the village. Interestingly, Falak did her middle and secondary education privately at home. A local schoolmaster was her private tutor. She got first position in the middle school graduation examination and passed the secondary school examination at the second position in the local school division. Finally, she entered a teacher's college where a school dormitory for female students was available. Obviously, this indirect way of educating daughter is a reflection of *purdah*.

Moreover, socio-cultural forces create the needs not only for single-sex schools but also for women teachers to teach female students in the village. Therefore, even if a girl's school is available in the village, a chronic shortage of women teachers imposes serious constraints on female education. Chaudhary and Chaudhary (1989), for example, found that girls are not attending school where there are male teachers. Irrespective of the monetary or non-monetary

incentives in the form of scholarship, girls will come only if schools are opened with female teachers in each village. Although the supply of teachers is constrained in part by the shortage of women candidates,[15] the village environment mainly prevents expansion of female teachers in rural areas. Under the joint family system of Pakistan, women teachers need to live with their family or relatives in a place that is sufficiently close to school. But most teachers have no relatives in villages. Attracting and retaining female teachers from outside villages poses a different set of problems, since they must relocate, gain local acceptance, and clear the difficult hurdle of finding suitable accommodations. Houses available in villages are often poorly located and lack the watchman and boundary walls female teachers require for their safety. The realistic fears about being robbed, raped, or kidnapped in villages make teaching there less attractive to women. Moreover, for female teachers, teaching and taking care of domestic chores will be a quite painful duty. As a result, even locally recruited teachers could be chronically absent from school because of their household chores [Khan (1993)]. Nevertheless, there is not enough monetary compensation to attract women to be teachers. Provincial governments, for instance, provide teachers in villages with lower allowances for house rent than teachers in urban areas.

3.5 The Econometric Framework

There are two empirical approaches for investigating the schooling decision making process, based on the extended theory of the basic investment model which is represented by equation (4).[16] First, the traditional approach in sociology and economics employs a simple linear regression model for years of schooling with various household background variables as explanatory variables [Taubman (1989)]. The problem of this approach is that the linear

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[15] Very little research, however, has examined the impact of gender of the teachers mediated by other factors, relating to classroom practices [Jatoi (1991)]. In fact, students of female teachers in Pakistan's primary schools have significantly lower scores on two mathematics achievement tests than students of male teachers. The gender gap in mathematics achievement arises more from the location of schools and the education of teachers than from teaching practices on which men and women differ [Warwick and Jatoi (1994)]. There might be a school quality problem which is originated in the teacher's low level of education.

[16] In fact, there will be the third approach by applying the structural estimation framework for a dynamic stochastic discrete choice model. For the literature survey, see Amemiya (1996) and Eckstein and Wolpin (1994, 1989a). Applications of this framework to development issues include Ahn (1995)'s estimates of the gender- and age- specific values of Korean children, Fafchamps (1993)'s analysis of sequential farm labor decisions using Burkina Faso's data, Fafchamps and Pender (1997)'s well investment decisions in India, Rosenzweig and Wolping (1993)'s Bullock accumulation decisions of Indian farmers, and Wolpin (1984)'s analysis of fertility decision using Malaysian data.

regression model combines the sequential schooling decision process into an estimation of time-invariant parameters and therefore parameters in the model cannot be interpreted well.

The second approach formalized the process of schooling as a stochastic decision making model. The model explicitly investigates the determinants of sequence of grade transition probabilities. In other words, the probability of schooling at τ^{th} grade conditional on completing schooling at τ-1^{th} grade is empirically estimated. Hence, the model has a substantial advantage over the linear regression approach. The statistical foundation of estimating this sequential decision making model was first provided by Amemiya (1975). The model framework was then applied to the unemployment decision making process by Kahn and Morimune (1979). Using a data set of white American males, Mare (1980) estimated the schooling transition probabilities with family background characteristics as determinants of these probabilities. Using a Malaysian data set, Lillard and Willis (1994) estimated the similar sequential discrete-time hazard model, controlling for individual unobserved heterogeneity. Cameron and Heckman (1997; 1998) constructed an alternative choice-theoretic model to examine how household background affect the school transition probabilities. Other papers focus on only one transition out of the many sequences of schooling process, e.g., the transition probability of high school graduates [Willis and Rosen (1979)].

We will follow the second econometric approach and estimate the sequential schooling decision model.[17] First, consider the five levels of education in Pakistan; none, primary, middle, secondary, and post-secondary (Table 3.2). Educational outcomes are assumed to result from the following seven sequential decisions, which are represented by Figure 3.8. The first decision is whether to enter primary school. For those who attended primary school, the second decision is whether to finish primary school. Then the third decision for primary school graduates is whether to continue to middle school or stop in the grade 5. For those who attended middle school, the fourth decision is whether to stop in grades 6-7 or to graduate. For those who graduate middle school, the fifth decision is whether to enter secondary school. The sixth decision is whether to

[17] Although duration models with time-varying explanatory variables are conceptually straightforward in the hazard function and may be an alternative framework for sequential decisions, the application is limited due to computational difficulty. The practical problems of specifying, estimating, and interpreting models with time-varying explanatory variables are still important areas of active current research [Kiefer (1988; pp.670-671)]. On the other hand, a parametric, non-parametric, or semi-parametric estimation of standard duration model with time-constant covariates is not appropriate to address effects of shocks, which is a function of time, to household resources on educational decision making. The model in this chapter can be interpreted as the discrete duration model with a particular way of discretizing time domain. We utilized this framework as an estimation method of the discrete duration model with time-varying explanatory variables, mainly because of its computational feasibility.

finish secondary school or to dropout before graduation. The final decision is whether to continue beyond secondary school, i.e., to enter college, technical or teaching school.

In order to formalize the above schooling process, we can define an indicator variable of *no* schooling:

$$\delta_{i\tau} = 1 \text{ if } S^*_{i\tau} \leq 0$$
$$= 0 \text{ otherwise.}$$

where τ indicates the τ^{th} stage of education. Note that $\delta_{i\tau} = 1$ if there is *no* schooling at the τ^{th} stage of education. We discretize the years of schooling into seven categories and thus τ takes on seven values. The sequential process of schooling decision is described as follows: children are born with zero years of schooling. If children become the age of six or so, some children enter primary school, while other children stay uneducated. The uneducated children with *no* primary school entry, $S^*_{i1} = 0$, is represented by the indicator variable $\delta_{i1} = 1$. Having entered primary school ($S^*_{i1} > 0$ and $\delta_{i1} = 0$), some children finish primary school ($\delta_{i2} = 0$ or $S^*_{i2} > 0$) while other children dropout from primary school ($\delta_{i2} = 1$ or $S^*_{i2} \leq 0$). Then, of those children who have finished primary school, some enter middle school ($\delta_{i3} = 0$ or $S^*_{i3} > 0$), while others do not ($\delta_{i3} = 1$ or $S^*_{i3} \leq 0$). Given entered middle school, some children finish middle school ($\delta_{i4} = 0$ or $S^*_{i4} > 0$), while other children do not ($\delta_{i4} = 1$ or $S^*_{i4} \leq 0$). Then, of those children who have finished middle school, some enter secondary school ($\delta_{i5} = 0$ or $S^*_{i5} > 0$), while others do not ($\delta_{i5} = 1$ or $S^*_{i5} \leq 0$). Among those who entered secondary school, some children finish secondary school ($\delta_{i6} = 0$ or $S^*_{i6} > 0$), while other children do not ($\delta_{i6} = 1$ or $S^*_{i6} \leq 0$). Finally, after finishing secondary school, some children enter post-secondary school ($\delta_{i7} = 0$ or $S^*_{i7} > 0$), although others do not ($\delta_{i7} = 1$ or $S^*_{i7} \leq 0$).

Based on equation (4), the estimation equation for child i can be represented by

$$S^*_{i\tau} = X_{i\tau}\beta_\tau + \varepsilon_{i\tau}, \ \tau = 1, 2, \cdots, 7. \tag{7}$$

where X is assumed to include gender indicator variable, school supply variables, determinants of the household preference, household shock variables, and the sibling composition variable. We assume that expectation error, ε, is independently distributed with cumulative distribution function $F(\varepsilon)$. Then this sequential schooling process can be investigated by estimating the

following sequence of conditional probabilities of leaving education [Amemiya (1975: 1981: 1985)]:

$$
\begin{aligned}
q_{i1}(X_{i1}) &= Pr\,(S^*_{i1} \le 0 \mid X_{i1}) \\
&= Pr\,(\varepsilon_{i1} \le -X_{i1}\beta_1 \mid X_{i1}) \\
&= 1 - F(X_{i1}\beta_1).
\end{aligned}
$$

For $\tau > 1$, we have conditional probabilities of school exits, using a slightly different calculation:

$$
\begin{aligned}
q_{i\tau}(X_{i\tau}) &= Pr\,(S^*_{i\tau} \le 0 \mid S^*_{i\tau-1} > 0, X_{i\tau}) \\
&= Pr\,(\varepsilon_{i\tau} \le -X_{i\tau}\beta_\tau,\ \varepsilon_{i\tau-1} > -X_{i\tau-1}\beta_{\tau-1} \mid X_{i\tau}) \,/\, \Pr\,(\varepsilon_{i\tau-1} > -X_{i\tau-1}\beta_{\tau-1} \mid X_{i\tau}) \\
&= Pr\,(\varepsilon_{i\tau} \le -X_{i\tau}\beta_\tau \mid X_{i\tau}) \\
&= 1 - F(X_{i\tau-1}\beta_{\tau-1}),
\end{aligned}
$$

Note that these probabilities represent discrete hazard rates of school dropout. For example, $q_{i2}(X_i)$ represents a probability of dropout from primary school given the child entered primary school. Sequential probabilities $Pr\,(\delta_{i2} = 1 \mid \delta_{i1} = 0, X_{i2})$, $Pr\,(\delta_{i3} = 1 \mid \delta_{i2} = 0, X_{i3})$, $Pr\,(\delta_{i4} = 1 \mid \delta_{i3} = 0, X_{i4})$, and so forth, are analogous to transition probabilities in a two-state Markov model with exogenous variables. However, certain transitions, such as $Pr\,(\delta_{i2} = 0 \mid \delta_{i1} = 1, X_{i1})$, are ruled out by nature of schooling process, i.e., a child cannot graduate from primary school if he or she did not enter primary school.

The likelihood function of estimating coefficients is given by

$$
L \equiv \prod_{\tau=1}^{\tau} \prod_{i \in n_\tau} [1 - F(X_{i\tau}\beta_\tau)]^{\delta_{i\tau}} F(X_{i\tau}\beta_\tau)^{1-\delta_{i\tau}} .
$$

where n_τ indicates the children who has completed at least the τ-1 stage of education and n_0 is the total number of children in our data. Let $\beta_{k\tau}$ represent the k-th element of the coefficient vector β_τ. It is then straightforward to show that

$$
\frac{\partial \ln L}{\partial \beta_{k\tau}} = \frac{\partial \ln L_\tau}{\partial \beta_{k\tau}}, \text{ where } L_\tau \equiv \prod_{i \in n_\tau} [1 - F(X_{i\tau}\beta_\tau)]^{\delta_{i\tau}} F(X_{i\tau}\beta_\tau)^{1-\delta_{i\tau}} .
$$

Hence, the set of parameter values that maximize the likelihood function L becomes exactly the same as the set of coefficients that maximize the components of the likelihood function, L_r. The likelihood functions for these models, therefore, can be estimated by maximizing the likelihood functions of dichotomous models repeatedly [Amemiya (1975)]. In sum, this sequential model is easily estimated provided we make the expectation error at each stage, which affects probability of choice, independent of the error at the previous stage. The case of sequential-response models is, therefore, very efficient in terms of actual computation.

The parameters β_1 for X_{i1} can be estimated from the entire sample by dividing it into two groups: not enter primary school and enter primary school. The parameters β_2 can be estimated from the subsample of primary school graduates by dividing it into two groups: not finish primary school and finish primary school. The parameters β_3 can be estimated from the subsample of primary school graduates by dividing it into two groups: not enter middle school and enter middle school, and so on. In each case, the binary models can be estimated successively by the discrete choice model.

3.5.1 Variables

In this section, we will proceed to an estimation of the above sequential schooling model. We start with inspecting the basic data characteristics. Figure 3.9 represents the age distribution of sampled children of the household head, through our retrospective surveys. Although the average age of children is 20.5, there is a large variation of age. Some members are older than sixty and seventy. This figure indicates that there will be a potentially large cohort effect, and thus the empirical model needs to control for it. Figure 3.10 indicates that there is a high infant mortality rate. Especially, a high percentage of children have died before reaching the age of four or five, which is not a surprising finding in rural Pakistan. The high infant mortality rate implies the lack of sufficient health and medical services in villages. In fact, our village level surveys show that no village has active basic health units. Yet, the modes of number of male and female siblings are both four. High number of siblings with high infant mortality rate indicates the high fertility rate in rural Pakistan and the resultant large number of children (Figure 3.11).

According to the median age of school entry, children enter primary schools at the age of six, middle schools at the age of eleven, secondary schools at the age of fourteen, and post-secondary schools at the age of seventeen (Table 3.3). Moreover, our survey data shows that the

average duration of primary, middle, and secondary education are five, three, and three years, respectively. Since the formal length of the secondary-level schooling is two years in Pakistan, an additional year in a secondary education in our sample indicates that a grade repetition or a delay of secondary school entry is quite common in the villages.

Table 3.6 summarizes descriptive statistics of variables used as the discrete dependent variable S_j and covariates of conditional probabilities, X, in the sequential model of the equation (7). According to our theoretical model (4), X is assumed to include gender gap indicator variables, school supply variables, social class variables which reflect a household's preference, and the determinants of the household income change and the sibling composition effects. Moreover, dummy variables for different age groups are included in order to control for the possible unobserved cohort effects.

The gender gap indicator variables are divided into two subgroups according to province. The first gender variable is for Punjab province which is a dummy variable taking 1 for females in Punjab province and 0 otherwise. Similarly, the second gender dummy variable for NWFP takes 1 for females in NWFP and 0 otherwise. These female dummy variables indicate that while the fraction of female students declines for primary and middle school, the share of female students is fairly constant or even increases at the secondary and post-secondary level of education (Table 3.6).

The second block of dependent variables contains the gender specific school supply variables. The first supply variable takes 1 only if the child is male and there is a male school within the same village of the child's residence. Otherwise, this variable takes 0. The second supply dummy variable takes 1 only if the child is female and there is a female school within the same village of a household. After a series of calculations, we can see that for primary and middle school level, more than 50% of male children do not face supply constraints, whereas only 10-20% of girls have access to female schools in the same village (Table 3.6). Moreover, as can be see in Table 3.6, no village in our sample has secondary and/or post-secondary education. This implies that supply constraints such as the accessibility of schools are severe at higher levels of education.

Third, the social class is identified by dummy variables for farmers with land, landless farmers or non-farm casual laborers, and business and government officials. The default variable is those who are unemployed or stay at home because of sickness etc. More than 50% of our sample is composed of farmers for all schooling processes (Table 3.6). At higher schooling stages, the fraction of children from landless farmers or casual laborers declines significantly. On

the other hand, the share of children of farmers with land ownership increases after middle school.

The fourth set of variables is composed of household human and physical asset variables. The first two variables are dummy variables for father and mother's education which are time-invariant. We can easily verify that parents' education level and children's level of education have a positive relationship. Other household asset variables include the amount of land ownership and a dummy variable for tractor ownership. We can easily see that all these four variables increase as the education level increases (Table 3.6). This implies that children who are studying at higher levels of education are from relatively rich households of educated parents.

For the transitory shock variables, the model includes good or bad year dummy variables based on household's subjective assessment of agricultural production, wage earnings, and livestock income. The health shock effects are also considered by including the household head and wife's inactive dummy variables which take 1 if they are physically inactive and take 0 otherwise. As Jacoby and Skoufias (1997) pointed, a distinction between unanticipated and anticipated components of transitory income movements might be important. The health shocks might be interpreted as the unanticipated components, while income movements include both anticipated and unanticipated components. Note that the health shock variables are interacted with the female dummy variable, so that we can estimate the gender difference in sensitivity toward the household income shocks.

As sibling variables, simply number of elder brothers and sisters are utilized. Although we can incorporate different sibling composition variables, the advantage of our *elder* sibling variables is that they are predetermined and thus we can regard these variables as being exogenous. Note that there is a negative relationship between education level and number of elder brothers and sisters (Table 3.6). This observation can be a result of resource competition or birth order effects.

3.5.2 Estimation Results of Sequential Probit Model

To estimate the model represented by equations (7) and (8), we assume that ε_{it} follows the normal distribution. Thus we can employ the standard probit model. However, as is the case in nonlinear regression models, the parameters of the model are not necessarily the marginal effects we are interested in. Hence, the reported coefficients in the tables represent marginal

effects of change in explanatory variables on conditional probabilities, utilizing the standard formula,

$$\frac{\partial q_{ij}}{\partial X_{ij}^{k}} = \beta_{jk}\phi(Z_j),$$

where k indicates the variable interested, Z_j is defined as $Z_j \equiv X_{ij}\beta_j$ and $\phi(\bullet)$ denotes the distribution function of normal distribution. Since these marginal effects will vary with the values of independent variables, we calculate them at the means of regressors. For the discrete independent variables, we utilized the formula, $\Phi(Z_{j1}) - \Phi(Z_{j0})$, where $\Phi(\bullet)$ is the cumulative distribution function of normal distribution, and Z_{j1} and Z_{j0} are associated with the dummy variables with values of 1 and 0, respectively.

Estimation results of the sequential schooling decision probit model for primary school level, middle school level, and secondary and post-secondary school levels are summarized in Table 3.7. First, coefficients on gender dummy variable indicate that daughters have lower school entrance probability and higher school dropout probability at the primary level. The coefficient, however, is smaller for the exit stage, which implies that once a daughter enters primary school, the gender gap in education becomes relatively small among those who are studying in primary schools. The gender gap coefficients are larger in Punjab province than in NWFP. This regional differences seem to be largely due to the different degree of socio-cultural constraints or the custom of seclusion of women, *purdah*. At the middle school entry level, daughters' school entrance probability are also lower than sons. Yet, at the middle school exit level, the gender gap disappears among the middle school students. Moreover, we found a pro-female bias in the middle school exit stage in Punjab province. Notably, the coefficients on female dummy variable are not statistically significant after the secondary school entry. The gender gap in education disappears among the students who are studying at secondary and post-secondary level schools. Schooling progression rates therefore become comparable between male and female students.

The school availability coefficients are negative and significant at the primary school entry. Moreover, the magnitude of the coefficient is clearly larger for females than for males. The supply side constraints of education in the village significantly constrain primary level education. While the supply side effects disappear for males at the primary school exits and the middle school level, the negative supply effect due to lack of primary and middle schools in the

village clearly impedes female education.

The overall estimated coefficients of social class variable indicate that children of the business or government official households have the highest schooling probability among the households considered. Second, if we take into account the difference in land ownership, the farmers with large land ownership have higher educational investments than landless farmers or casual labor households. Although the intercept coefficients of farmers with land are higher than landless farmers or casual laborers at the middle school entry and the post-secondary entry levels, the land ownership coefficients are significantly negative. These results imply that the occupation, which is traditionally related to the social status, affects the amount of educational investments. Interestingly, however, there is no class difference in the secondary school level. This may indicate some kind of educational specialization within the family at the higher level of education.

For the household background variables, father and mother's education variables have consistently negative coefficients in all levels of schooling, indicating both affect a child's schooling positively. Particularly, at the primary and middle school education, these coefficients are all statistically significant. These estimation results indicate the important complementality between the education of the parents and the child schooling investments. Parental education positively affects child education, possibly through the positive incentive effects of educating children, improved technical or allocative efficiency, or superior home teaching process.

Several negative coefficients on the land and tractor variables indicate that asset ownership increases primary school, middle school, and post-secondary school entry probabilities. It seems that the household's physical asset ownership affects entry probabilities significantly. Physical asset ownership, however, might not relate with secondary school decision making process. Yet, we may conclude that, for educated parents and households with assets, the schooling probability of children is systematically higher.

There is evidence that income shocks and parental health shocks both affect school decisions significantly at the primary school entry and exit, the middle school entry, and the secondary school exit. Negative shocks to parents' health and the household income seem to decrease primary school entry probability and increase school dropout probability. Interestingly, at the middle school entry level, a negative health shock affects a son's education slightly positively, while a daughter suffers from the shock significantly. This implies that a daughter's education is more sensitive to the negative parental income shocks, as suggested by our theoretical framework. The middle school exit and secondary school exit probabilities are also

affected significantly by parental income and health shocks.

Table 3.8 reports formal joint test results of household shock variables. The shock variables jointly and significantly affect probabilities of the primary school entry and exit, the middle school entry, and the secondary school exit. Therefore, a general conclusion derived from this block is that, except the middle school exit, secondary school entry, and post-secondary school entry decisions, parental income shocks affect child human capital accumulation negatively and there is evidence of the gender gap in the response toward the shocks. The finding for the secondary school entry decision is consistent with the low hazard rate at the time of secondary school entry, conditional on middle school graduation as can be seen from Table 3.4a. According to Table 3.4a, more than ninety percent of the middle school graduates entered secondary school. This school continuation probability is especially high for females.[18] A close inspection of the field survey data indicates that 88% of female students went to middle and secondary schools from their homes. The rest of female students went to schools from either a relative's home or from a school dormitory, although these cases account only 12 %. On average, female students spent 21.1 minutes getting to middle schools and 23.9 minutes getting to secondary schools. 42% of these females went both schools on foot, while another 25% used *Suzuki* (commuter bus) and others used *Tonga* (stagecoach) or bicycle. Yet, it is notable that almost all girls went to middle and secondary schools with other female friends, female neighbors, or family members. These statistics suggest that the high secondary school continuation rate was achieved since the secondary schools and middle schools were equally accessible in most cases. Moreover, daughters' commuting to schools with other females and/or family members might reduce parents' negative perception toward female education.

According to the estimated coefficients in the sibling variables block, the number of elder sisters seems to be associated with more primary education possibility for both men and women. This finding is consistent with Greenhalgh (1985) and Parish and Willis (1993) using Taiwanese data. Elder sisters may extend the household's resource availability, either by marrying early or by providing domestic labor. This suggests that households are not discriminating against all daughters, although the elder daughters might bear a large portion of burden under binding resource constraints [Strauss and Thomas (1995)]. We should also note that primary and middle school dropout probabilities are systematically lower for daughters if they have elder sisters. This observation suggests that daughters may gain from having elder sisters instead of brothers as

[18] Moreover, the high secondary school entry probability is not affected by our explanatory variables (Table 3.7).

suggested by Garg and Morduch (1998). The birth order effect may be largely gender specific.

Moreover, at the secondary school exit and the post-secondary entry levels, the number of elder brothers, instead of the number of elder sisters, increases schooling probabilities. These results suggest that once a child is picked as a 'winner' of educational investment within the family, his or her education at the secondary and post-secondary level education might be supported by the elder brother's resource extension effects, since the working elder brothers can contribute substantially to household resources. At these higher levels of education, elder brother's farm or non-farm monetary income contribution to household resources might be more important and significant than daughter's non-market wage contribution to the household.

3.6 Conclusions and Policy Implications

This chapter investigated the sequential educational investment process of Pakistani households by integrating observations from the field, economic theory, and econometric analysis. The most striking features discovered in the field is the unexpectedly high educational retention rate, conditional on school entry. This observation implies that there might be an increasing-returns-to-scale or an investment momentum existing in schooling. Then we constructed a formal economic model. The basic theoretical implications are extended through examining observations from the field. Finally, we estimated the full sequential schooling decision model using the field data.

We can summarize our empirical results as follows. First, while we found a strong gender gap in education and it's regional difference at the primary school education, the gender gap in education disappears among the students at the secondary and post-secondary schools. Schooling progression rates therefore become comparable between male and female students. Second, the supply side constraints of education in the village significantly constrain the primary level education. Moreover, the lack of female school in the village seems to be a serious obstacle for the female primary and middle school level education. Third, we found the significant effect of social status on education. The results are consistent with a conventional view that occupation is traditionally related to social status in Pakistan, which affects the amount of educational investments. The fourth finding is that parental physical and human asset ownership systematically contributes to the schooling probability of children. Moreover, income shocks and parental health shocks both affect child school decisions significantly, as suggested by our

theoretical framework, although there are education stage specific differences. Also, there is evidence of the gender gap in the response toward the shocks. Finally, we found the gender specific birth order effects which take a different form at the different levels of education.

In sum, our empirical results indicate that the Pakistani household's sequential schooling behavior is significantly affected by household and child socio-economic background, gender considerations, social status of parents, household's intertemporal and intrahousehold resource allocation decisions, and school supply side constraints.

3.6.1 Policy Implications

Although the demand for education cannot be controlled directly by the government, the supply side interventions through quantity and quality improvements of public schools will produce significant impacts on human capital accumulation process in rural Pakistan. Indeed, our estimation results suggest that, in addition to household demand considerations, both the availability of local schooling and the quality of those schools are significant factors in understanding the observed patterns, including the gender and regional gaps. Especially, our results suggest that raising the quantity and quality of primary schools has a substantially higher rate of return than expanding the availability of middle schools (Table 3.7).

In order to increase overall school attendance and decrease gender gap in education, the government can intervene in rural education in two primary ways. First, the government can increase the number of primary schools of a given quality. Indeed, the push to expand access to schooling by increasing the supply of schools has dominated the agenda for education development since the 1960's [Lockeed et. al. (1991)]. Yet, remote and inappropriate school locations and resultant high schooling costs seem to be still serious in rural Pakistan. Although the Pakistani government emphasizes the supply improvements of basic education, there are both quantity and quality constraints of supply, especially for girls education. For the quantity side of supply of education, provincial authorities usually decide upon and plan the construction of new primary and middle schools. Around ninety five percent of the costs of construction for these new schools are usually financed by the government. However, land for a new school is sometimes donated by the community or a landlord and, in some cases, they choose inappropriate locations for the new school.

Secondly, besides the constructions of new schools, the quality of existing schools can be

improved. There are several different forms of improving educational supply. Such forms include expansion and renovation of the existing schools, multiple shifts to increase enrollment and reduce unit costs, multigrade classes to improve access in rural communities, biennial intakes of students, and non formal and/or adult schooling. Teacher quality improvements seem to be important as well. Government officials and researchers, for example, listed the teacher's excessive punishments on students as one of the major problems contributing to low teaching quality.[19] Interestingly, there is less punishment for female students since women teachers usually do not implement physical sanctions on students. To maintain quality of schooling and teaching, the Pakistani government and its district educational offices should continue regular monitoring of teaching performance and curriculum. At the same time, better teacher training curriculum should be developed.[20]

Moreover, targeting female education might be more effective than targeting male education according to our analysis. Ismail (1996) also shows that the effective cost of primary education to households is higher for girls than for boys and the number of teachers and of schools is substantially below optimal levels for girls. On the other hand, he also found that there appears to be an excessive number of schools for boys. Moreover, there is some evidence that price and income elasticities of human capital investments are higher for girls relative to boys [Alderman and Gertler (1997)]. These estimated results imply that price policy through supply side interventions has significant potential for reducing gender biases in human capital investment. The cost effectiveness of providing primary education can be significantly improved if the allocation of funds is shifted towards recurring expenditures for employment of more female teachers and away from unbalanced allocations for construction of new schools in the context of boy's education at the primary school. The Pakistani government has been emphasizing the supply improvements of basic education and formally targeted improvement of

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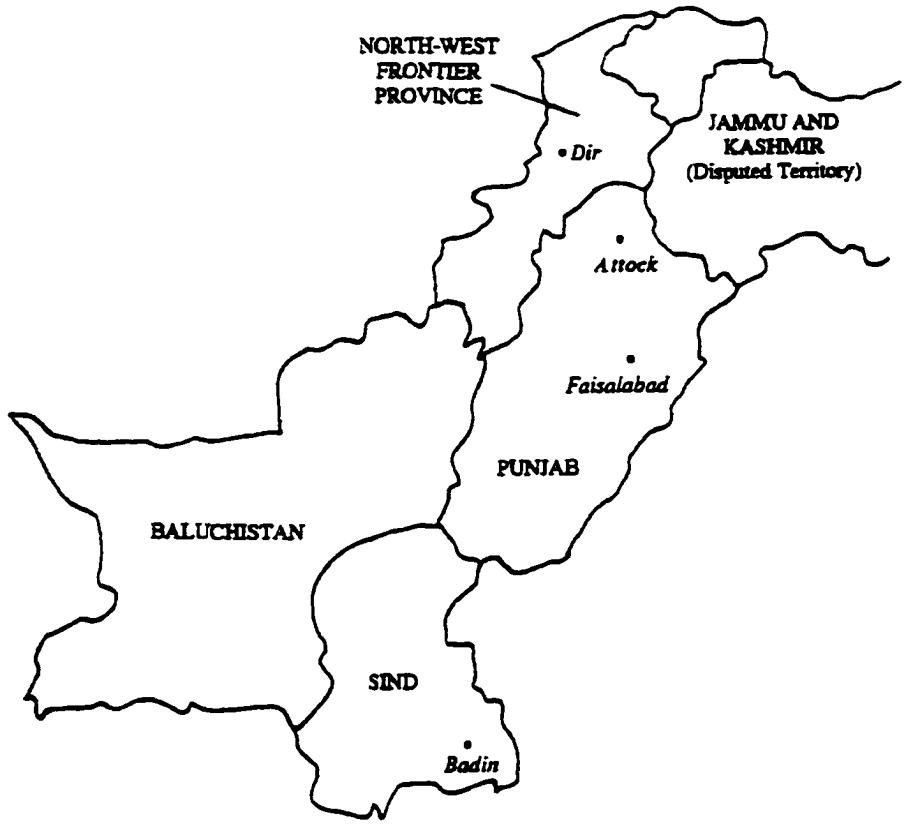
[19] I would like to thank Dr. Habib Khan, director general and Dr. Haroona Jatoi, deputy director of the Academy of Educational Planning and Management, Pakistani Ministry of Education, for pointing out these issues. In fact, according to the author's survey, 3% of respondents directly listed and another 24% indirectly indicated that teachers' punishments are the reason of school repetition or dropout of their children (Table 3.5).

[20] World Bank studies strongly support an increased role for private delivery of schooling services to poor households [Alderman, Orazem, and Patemo (1996)]. Low-income households in Lahore, for example, have a favor toward private education, although private schools are more expensive than government schools. Actually, private schools maintain better quality of education, and it can be said that private schools are more efficient than government schools, especially in urban area. This is partly because these schools can attract better teachers by offering higher salaries and can use better materials. Although private schools are more costly to parents, high demand for private education and high profits rate for private schools imply that there is much room for further development of private schools. Basically the government is encouraging expansion of private schools.

girls' primary education. There are, however, various administrative, political and cultural obstacles, which prevent proper policy implementations.

Figure 3.1

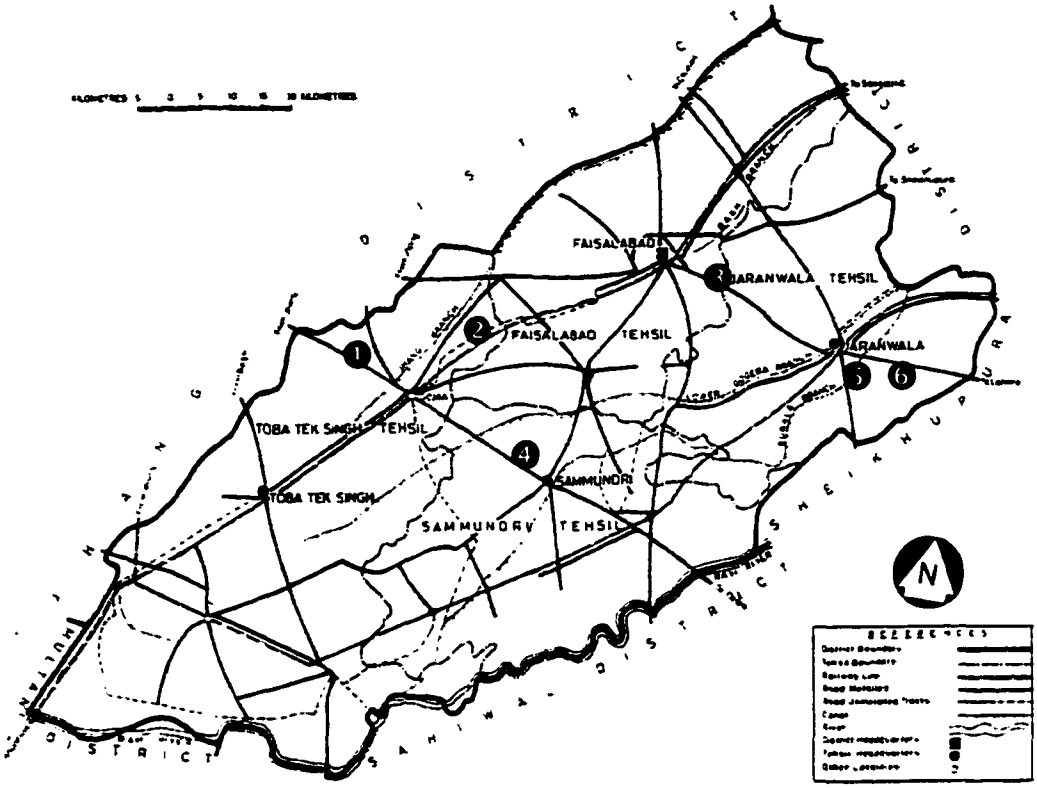
Map of the Surveyed Districts



Source) Alderman and Garcia (1993)

Figure 3.2

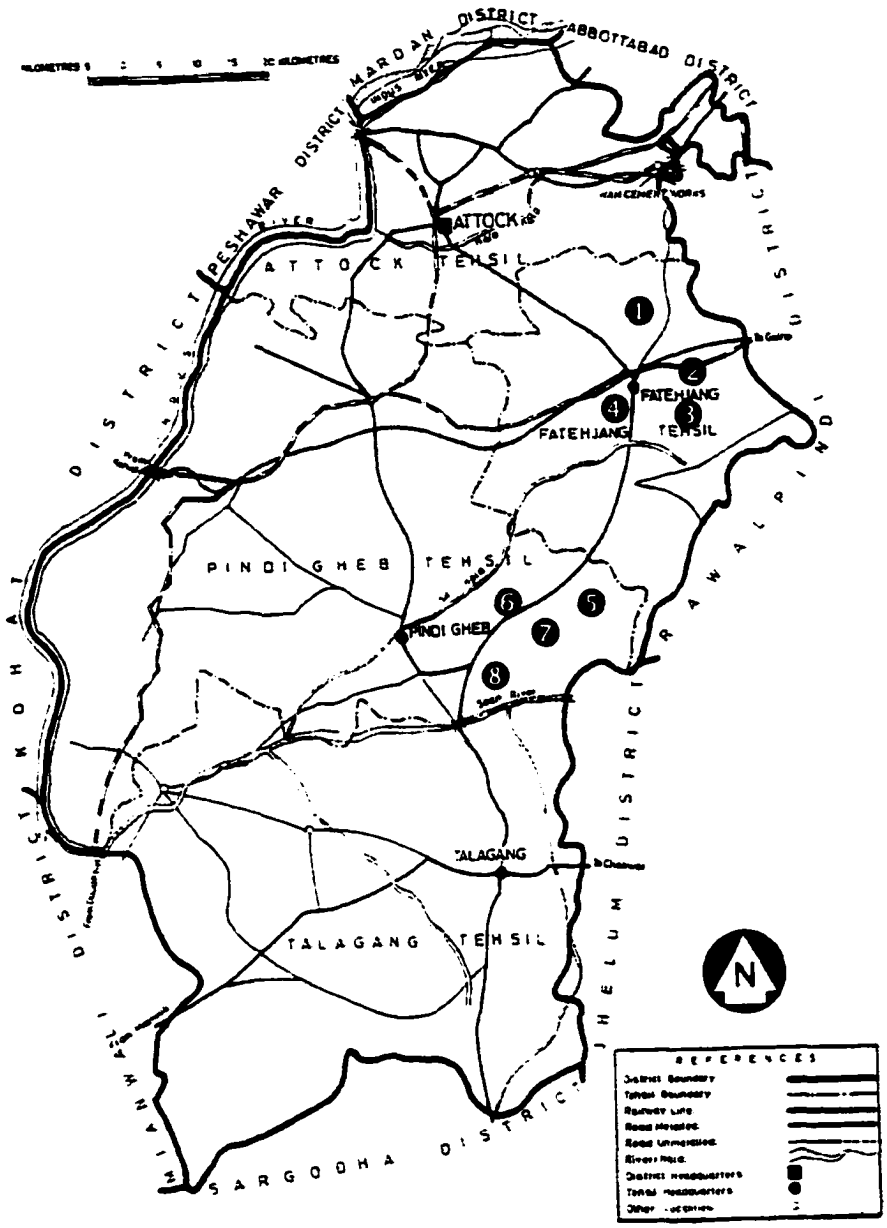
Map of the Surveyed Villages in the Faisalabad District



Village Names: 1. 356JB: 2. 363JB: 3. 206RB: 4. 43GB: 5. 240GB: 6. 534GB
Source) 1981 District Census report of Faisalabad. Population Census Organization. Government of Pakistan

Figure 3.3

Map of the Surveyed Villages in the Attock District

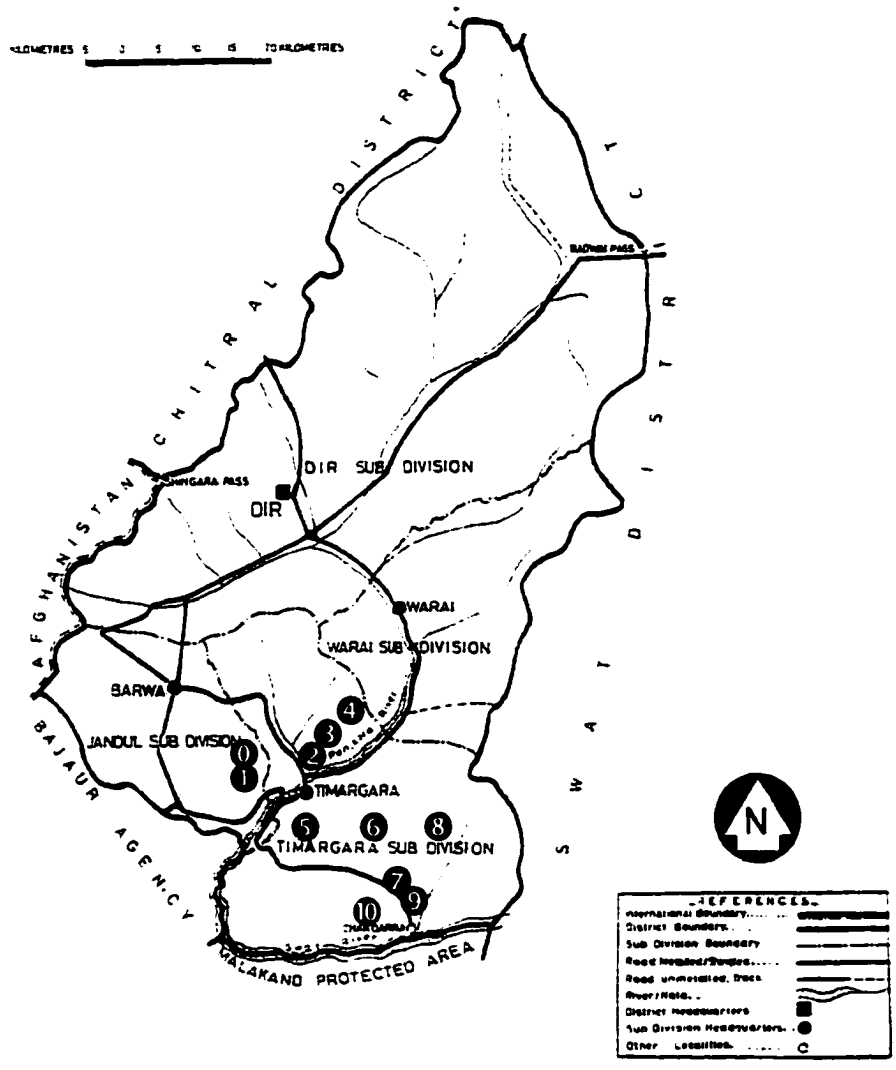


Village Names: 1. Kareema; 2. Hattar; 3. Thatti Gujran; 4. Khirala Kalan; 5. Dhoke Qazi; 6. Makyal; 7. Dhoke Mohammad; 8. Gulyal

Source) 1981 District Census report of Attock. Population Census Organization. Government of Pakistan

Figure 3.4

Map of the Surveyed Villages in the Dir District



Village Names: 0. Khazana: 1. Khema: 2. Malakand: 3. Sheh Zadi: 4. Munjai: 5. Kamangara: 6. Kotigram: 7. Batan: 8. Khanpur: 9. Shah Alam Baba: 10. Bakandi

Source) 1981 District Census report of Dir. Population Census Organization. Government of Pakistan

Figure 3.5

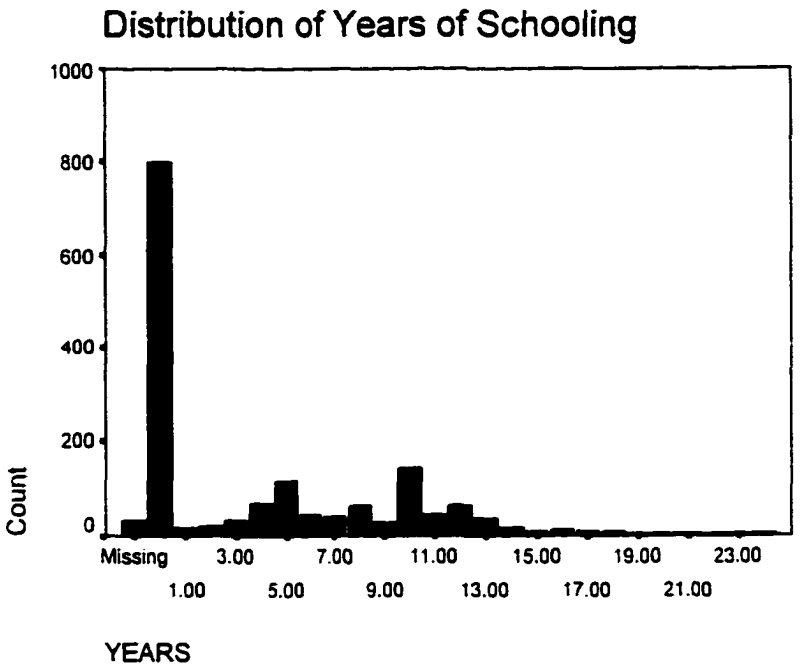


Figure 3.6. Determination of the optimal schooling

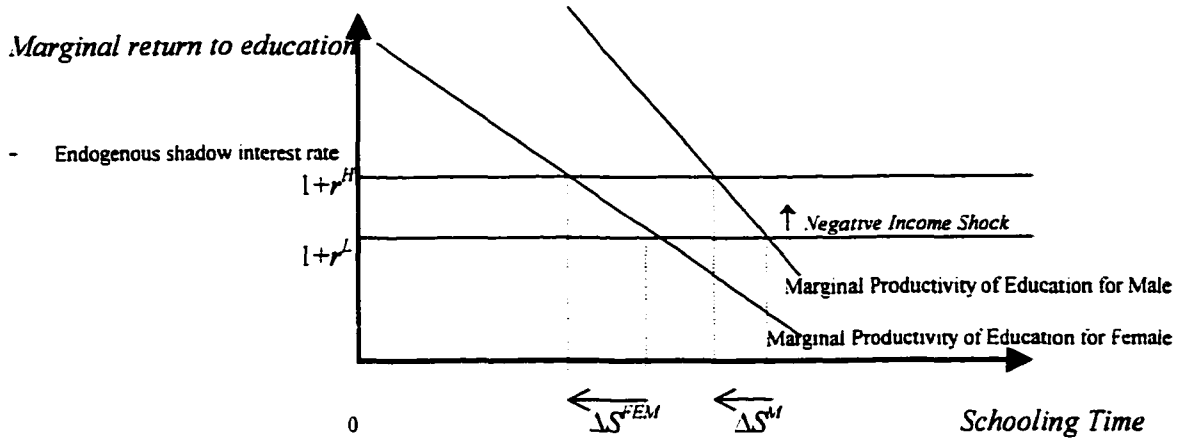


Figure 3.7. Determination of the optimal schooling

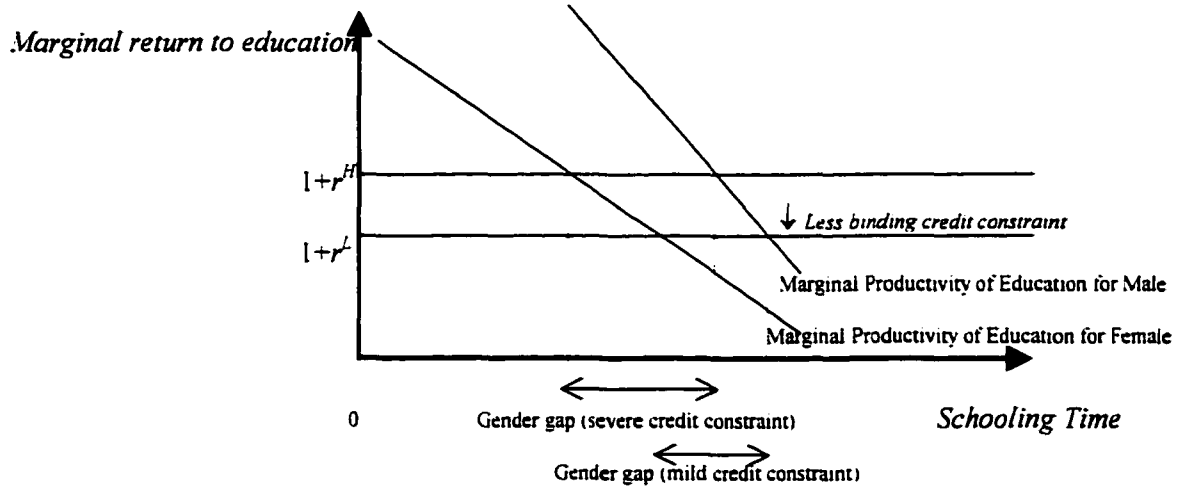


Figure 3.8

Sequential Schooling Decision Process

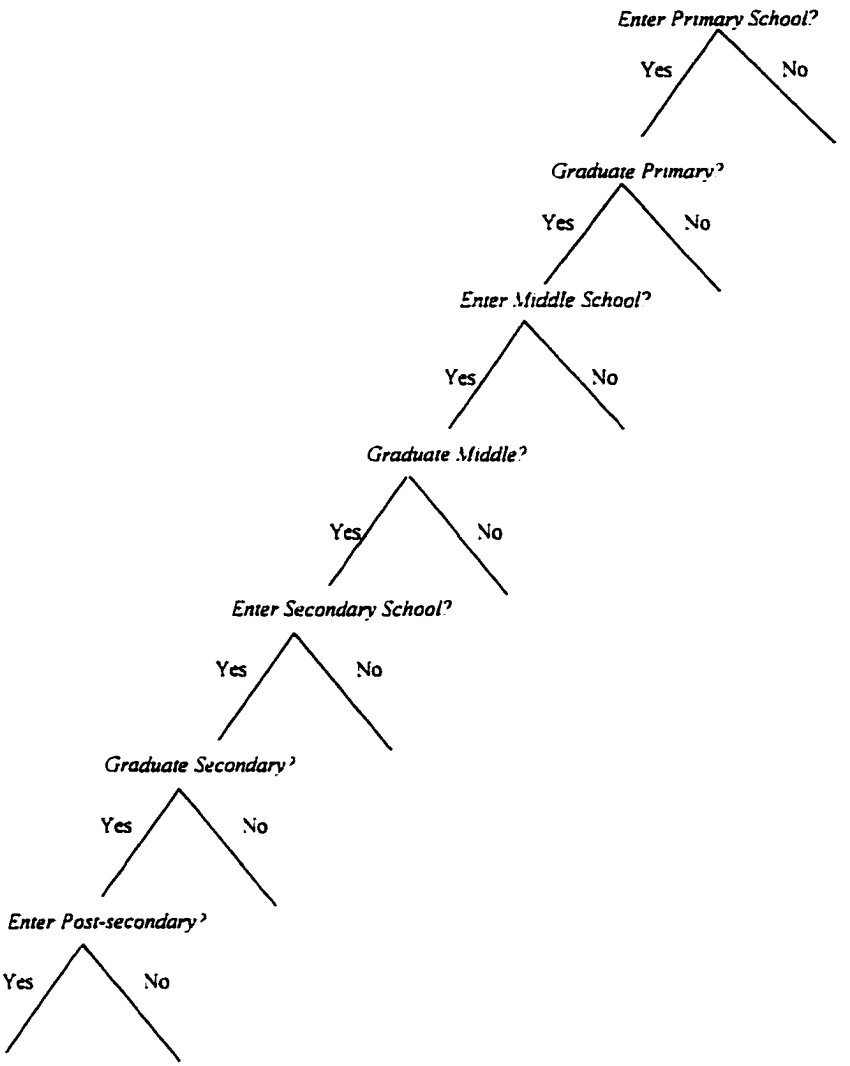


Figure 3.9
Age Distribution of the Sample

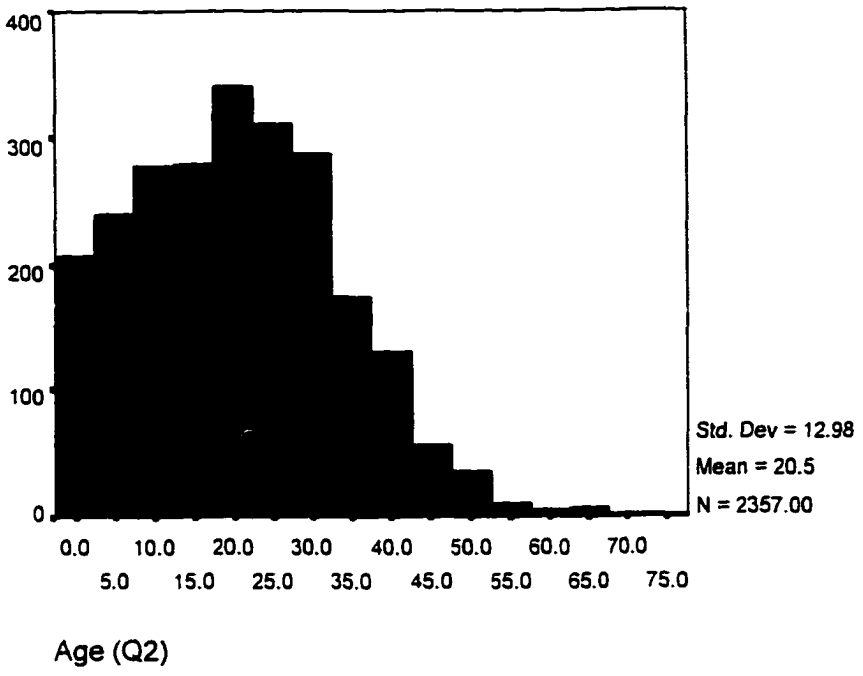


Figure 3.10
Age Distribution of Died Children at Death (in month)

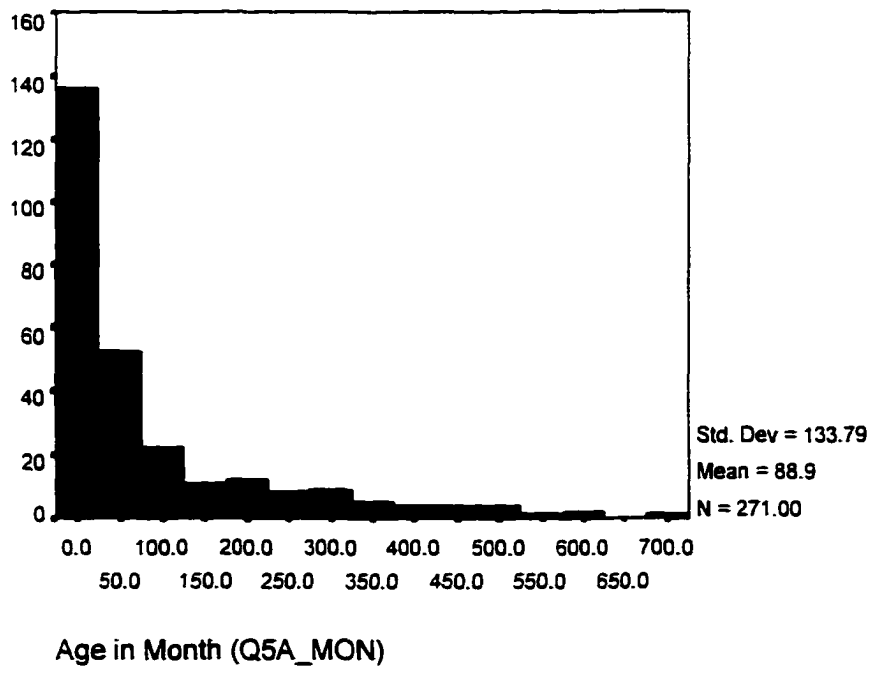
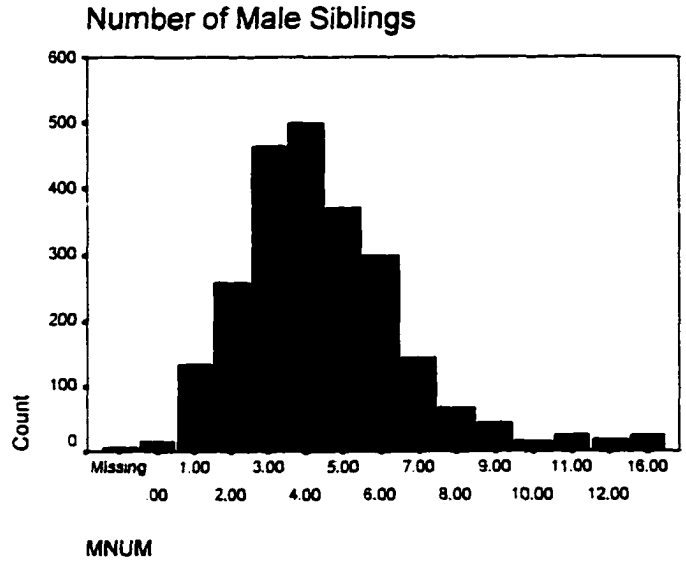


Figure 3.11
Distribution of Number of Male and Female Siblings



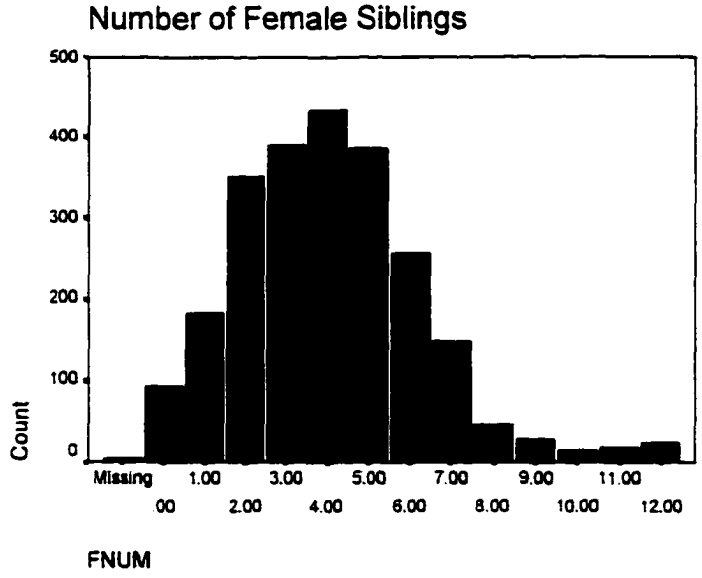


Table 3.1
Composition of Average Houhold Income
(Average over years between 1987 and 1991)

	Livestock Icome	Crop Income	Non farm income (including transfer income)	Transfer Income
Faisalabad	17.5	30.1	52.5	7.8
Attock	15.2	10.2	74.5	13.5
Badin	17.6	46.2	36.2	4.5
Dir	15.5	20.1	64.4	20.2

(Source) IFPRI data files

Table 3.2
Education System in Pakistan

Grade	"Model" Age	Typical School Type	Other Type	Note
	3 - 5	Nursery or Kindergarten (Kachi)		
1 - 5	5 - 10	Primary School		
6 - 8	10 - 13	Middle School		
9 - 10	13 - 15	Secondary (high) School		matriculate exam at the end
11 - 12	15 - 17	Intermediate College (F.A.)	Technical, Teacher etc.	division wide board exam
13 - 14	17 - 18	Degree College (B.A.)		division wide entrance exam
15 - 16	18 -	(M.A.)		
17 -		M.Phil		equivalent to international level M.A.

(Source) Ministry of Education and the Author's Interview

Table 3.3
Distribution of Age at School Entry

Percentailes	Primary school	Middle school	Secondary school	Post-secondary school
Youngest 10%	5	10	13	16
25%	6	11	14	16
Median	6	11	14	17
75%	7	12	15	18
90%	8	13	16	20
Mean age (Std deviation)	6.43 (1.74)	11.64 (1.73)	14.69 (2.11)	17.23 (2.54)
Coefficient of variation	0.2706	0.1486	0.1436	0.1474
Number of Observations	1150	685	451	177

Table 3.4a
Discrete Hazard Rate of Leaving Education
(Whole Sample)

		Code	Male	Female
Primary School Entry	$Pr(S^*_{i1} \leq 0)$	S1	0.300 (1172)	**0.669 (1008)**
Primary School Graduate	$Pr(S^*_{i2} \leq 0 \mid S^*_{i1} > 0)$	S2	0.155 (723)	**0.259 (247)**
Middle School Entry	$Pr(S^*_{i3} \leq 0 \mid S^*_{i2} > 0)$	S3	0.056 (612)	**0.373 (185)**
Middle School Graduate	$Pr(S^*_{i4} \leq 0 \mid S^*_{i3} > 0)$	S4	0.164 (517)	0.108 (83)
Secondary School Entry	$Pr(S^*_{i5} \leq 0 \mid S^*_{i5} > 0)$	S5	0.095 (433)	0.079 (76)
Secondary School Graduate	$Pr(S^*_{i6} \leq 0 \mid S^*_{i6} > 0)$	S6	0.197 (361)	0.119 (76)
Post-Secondary School Entry	$Pr(S^*_{i7} \leq 0 \mid S^*_{i7} > 0)$	S7	0.435 (292)	0.426 (54)

Number of children in parentheses

Table 3.4b
Discrete Hazard Rate of Leaving Education
(By District)

			Faisalabad		**Attock**		**Dir**	
		Code	Male	Female	Male	Female	Male	Female
Primary School Entry	$Pr(S^*_{i1} \leq 0)$	S1	0.285 (288)	0.561 (221)	0.283 (244)	0.5625 (208)	0.314 (640)	0.748 (579)
Primary School Graduate	$Pr(S^*_{i2} \leq 0 \mid S^*_{i1} > 0)$	S2	0.222 (171)	0.233 (73)	0.123 (163)	0.250 (72)	0.139 (389)	0.284 (102)
Middle School Entry	$Pr(S^*_{i3} \leq 0 \mid S^*_{i2} > 0)$	S3	0.023 (133)	**0.536 (56)**	0.098 (143)	**0.333 (54)**	0.051 (336)	**0.280 (75)**
Middle School Graduate	$Pr(S^*_{i4} \leq 0 \mid S^*_{i3} > 0)$	S4	0.216 (116)	0.000 (19)	0.208 (120)	0.080 (25)	0.125 (281)	0.179 (39)
Secondary School Entry	$Pr(S^*_{i5} \leq 0 \mid S^*_{i5} > 0)$	S5	0.088 (91)	0.052 (19)	0.158 (95)	0.087 (23)	0.072 (247)	0.088 (34)
Secondary School Graduate	$Pr(S^*_{i6} \leq 0 \mid S^*_{i6} > 0)$	S6	0.320 (75)	0.071 (14)	0.205 (78)	0.105 (19)	0.149 (208)	0.154 (26)
Post-Secondary School Entry	$Pr(S^*_{i7} \leq 0 \mid S^*_{i7} > 0)$	S7	**0.451 (51)**	**0.231 (13)**	**0.613 (62)**	**0.444 (18)**	**0.369 (179)**	**0.522 (23)**

Number of children in parentheses

Table 3.5
The Most Important Reason of a Child's School Termination

	Frequency	Percent (%)
Subjective Reason		
Accomplished the desired level	97	13.4
Economic Reasons		
Too high education costs (tuition)	128	17.7
Needed at farm or home	72	9.9
Got a job	55	7.6
Child Specific Reasons		
Child is ill	23	3.2
Marriage	21	2.9
Child failed in exam	55	7.6
Supply Side Reasons		
School is too far	44	6.1
Child does not want to go to school (Mainly, teacher's punishments)	191	26.4
Other	38	5.2
Total	724	100

(Source) Author's interview

Table 3.6
Descriptive Statistics

		Primary entry	Primary exit	Middle entry	Middle exit	Secondary entry	Secondary exit	Post-Sec. entry
	code	S1	S2	S3	S4	S5	S6	S7
Dependent variable								
Dummy variable which takes 1 if S_j=1; takes 0 if S_j=0, where j=1, 2, ..., 7	S_j+	0.472	0.182	0.131	0.159	0.094	0.188	0.432
Gender variable								
Dummy variable =1 if female in Punjab	pu_gen+	0.198	0.151	0.139	0.074	0.084	0.080	0.091
Dummy variable =1 if female in NWFP	nw_gen+	0.265	0.106	0.095	0.066	0.068	0.063	0.068
School supply variable								
Dummy variable =1 if male and there is a male school within the village	p_sup_m+	0.399	0.644	0.242	0.293	0	0	0
Dummy variable =1 if female and there is a female school within the village	p_sup_f+	0.209	0.203	0.039	0.037	0	0	0
Social class variable								
Dummy variable =1 if household head is farmer with land	farm_wl+	0.295	0.354	0.352	0.381	0.365	0.389	0.368
Dummy variable =1 if household head is landless farmer or casual laborer	casual+	0.414	0.323	0.307	0.251	0.287	0.278	0.274
Dummy variable =1 if household head run business or officer	bus_gov+	0.202	0.261	0.272	0.327	0.261	0.239	0.265
Household human and physical assets								
Dummy variable =1 if father has finished primary	fed+	0.236	0.327	0.349	0.327	0.355	0.336	0.359
Dummy variable =1 if mother has finished primary	med+	0.040	0.055	0.063	0.061	0.070	0.070	0.079
Amount of land ownership	p_land	14.741 (42.064)	17.574 (48.846)	18.197 (46.002)	20.2812 (48.694)	21.570 (49.044)	21.817 (50.551)	22.31 (53.848)
Dummy variable =1 if own tractor	p_trac+	0.02	0.033	0.035	0.030	0.038	0.041	0.044
Household's shock variables								
Dummy variable =1 if good year	p_good+	0.070	0.063	0.039	0.153	0.056	0.123	0.065
Dummy variable =1 if bad year	p_bad+	0.067	0.071	0.042	0.142	0.040	0.109	0.065
Dummy variable =1 if household head is inactive	p_hinact+	0.050	0.055	0.022	0.143	0.032	0.080	0.024
Dummy variable =1 if wife of household head is inactive	p_winact+	0.052	0.051	0.019	0.135	0.022	0.089	0.038
Sibling variables								
Number of elder brothers	m_old	1.938 (1.931)	1.882 (1.895)	1.849 (1.768)	1.735 (1.643)	1.731 (1.614)	1.671 (1.579)	1.668 (1.562)
Number of elder sisters	f_old	1.679 (1.752)	1.666 (1.688)	1.658 (1.658)	1.568 (1.574)	1.578 (1.600)	1.541 (1.604)	1.503 (1.554)
Cohort variables								
Dummy variable =1 if above age of 40	age40+	0.091	0.073	0.074	0.086	0.088	0.097	0.103
Dummy variable = if age between 35 and 40	age3540+	0.081	0.086	0.084	0.099	0.106	0.111	0.118
Dummy variable = if age between 30 and 35	age3035+	0.105	0.124	0.125	0.143	0.153	0.167	0.162
Dummy variable = if age between 25 and 30	age2530+	0.140	0.176	0.183	0.212	0.207	0.210	0.209
Dummy variable = if age between 20 and 25	age2025+	0.147	0.200	0.202	0.221	0.219	0.249	0.256
Dummy variable = if age between 15 and 20	age1520+	0.139	0.217	0.221				
Dummy variable = if age between 10 and 15	age1015+	0.126						
Number of observations	N	2167	961	789	593	502	414	340

+ indicates dummy variable. Numbers in parentheses are standard deviation

Table 3.7
Probit Model of Sequential Decision Making

		Primary entry	Primary exit	Middle entry	Middle exit	Secondary entry	Secondary exit	Post-Sec. entry
		S1	S2	S3	S4	S5	S6	S7
	s1	dF/dx (Z-stat.)	dF/dx (Z-stat.)	dF/dx (Z-stat.)	dF/dx (Z-stat.)	dF/dx (Z-stat.)	dF/dx (Z-stat.)	dF/dx (Z-stat.)
Gender variable								
Dummy variable =1 if female living in Punjab	pu_gen+	0.466 (11.517)***	0.309 (2.680)***	0.401 (4.681)***	-0.095 (2.152)**	0.046 (0.542)	-0.097 (1.380)	-0.061 (0.429)
Dummy variable =1 if female living in the NWFP	nw_gen+	0.538 (15.717)***	0.350 (2.983)***	0.367 (3.530)***	0.042 (0.340)	0.102 (0.958)	-0.068 (0.809)	0.062 (0.352)
School supply variable								
Dummy variable =1 if male and there is a male school within the village	p_sup_m+	-0.133 (2.905)***	-0.042 (0.667)	0.043 (1.324)	-0.051 (1.623)			
Dummy variable =1 if female and there is a female school within the village	p_sup_f+	-0.355 (9.970)***	-0.097 (2.098)**	-0.058 (3.877)***	0.083 (0.512)			
Social class variable								
Dummy variable =1 if household head is farmer with land	farm_wl+	-0.110 (2.386)**	0.068 (1.067)	0.143 (1.981)**	0.227 (2.286)**	0.024 (0.491)	0.108 (1.367)	-0.080 (0.746)
Dummy variable =1 if household head is landless farmer or casual laborer	casual+	-0.008 (0.174)	0.093 (1.433)	0.088 (1.332)	0.260 (2.360)**	0.013 (0.260)	0.009 (0.123)	-0.181 (1.811)*
Dummy variable =1 if household head run business or officer	bus_gov+	-0.222 (4.458)***	0.028 (0.424)	0.096 (1.279)	0.221 (1.842)*	-0.013 (0.274)	-0.086 (1.344)	-0.312 (3.310)***
Household human and physical assets								
Dummy variable =1 if father has finished primary	fed+	-0.357 (11.291)***	-0.093 (3.367)***	-0.059 (3.259)***	-0.094 (3.102)***	-0.002 (0.073)	-0.011 (0.231)	-0.111 (1.580)
Dummy variable =1 if mother has finished primary	med+	-0.295 (4.067)***	-0.102 (2.445)**	-0.066 (4.810)***	-0.118 (3.423)***	-0.023 (0.538)	-0.127 (3.660)***	-0.285 (3.111)***
Amount of land ownership	p_land	0.000 (0.923)	0.000 (0.423)	-0.001 (1.728)*	-0.001 (1.300)	0.000 (1.058)	0.000 (0.673)	-0.002 (2.149)**
Dummy variable =1 if own tractor	p_trac+	-0.293 (3.691)***	-0.004 (0.060)	-0.028 (0.857)	-0.051 (0.799)	-0.035 (0.774)	-0.084 (1.169)	-0.233 (2.014)**

+ indicates that dF/dx is for discrete change of dummy variable from 0 to 1
* significant at 10%; ** significant at 5%; *** significant at 10%

Table 3.7 (continued)
Probit Model of Sequential Decision Making

		Primary entry	Primary exit	Middle entry	Middle exit	Secondary entry	Secondary exit	Post-Sec. entry
		S1	S2	S3	S4	S5	S6	S7
	s1	dF/dx (Z-stat.)	dF/dx (Z-stat.)	dF/dx (Z-stat.)	dF/dx (Z-stat.)	dF/dx (Z-stat.)	dF/dx (Z-stat.)	dF/dx (Z-stat.)
Household's shock variables								
Dummy variable =1 if good year	p_good+	-0.025 (0.339)	0.057 (0.877)	0.035 (0.683)	-0.074 (1.875)*	0.076 (0.922)	0.036 (0.481)	-0.005 (0.042)
Dummy variable =1 if bad year	p_bad+	-0.077 (1.016)	0.121 (1.723)*	0.060 (0.857)	0.041 (0.460)	0.148 (1.111)	0.193 (1.953)*	-0.089 (0.795)
Dummy variable =1 if household head is inactive	p_hinact+	-0.054 (0.488)	0.220 (2.190)**	-0.070 (6.790)***	-0.044 (0.755)	#	0.409 (3.130)***	-0.049 (0.225)
(gender interaction term)	lfXp_h_1+	0.110 (0.675)	0.024 (0.187)	0.934 (97.008)***	0.292 (1.187)	#	-0.150 (7.710)	#
Dummy variable =1 if wife of household head is inactive	p_winact+	0.336 (3.994)***	0.022 (0.273)	#	0.078 (0.710)	0.136 (0.685)	0.107 (1.001)	0.031 (0.193)
(gender interaction term)	lfXp_w_1+	-0.130 (0.841)	-0.026 (0.245)	#	-0.058 (0.652)	#	0.230 (0.656)	#
Sibling variables								
Number of elder brothers	m_old	0.000 (0.022)	0.003 (0.390)	-0.009 (1.326)	-0.005 (0.493)	0.008 (0.830)	-0.050 (3.050)***	-0.058 (2.377)**
(gender interaction term)	lfXm_o_1	-0.016 (1.062)	-0.014 (0.943)	-0.001 (0.061)	0.029 (0.841)	-0.035 (1.513)	0.094 (2.406)**	0.055 (0.982)
Number of elder sisters	f_old	-0.039 (3.189)***	0.003 (0.390)	-0.022 (2.484)**	-0.007 (0.643)	-0.012 (1.442)	0.002 (0.173)	-0.010 (0.451)
(gender interaction term)	lfXf_o_1	0.021 (1.219)	-0.035 (1.949)*	0.023 (1.820)*	-0.095 (2.047)**	0.005 (0.174)	-0.068 (1.196)	-0.033 (0.404)
Cohort variables								
Dummy variable =1 if above age of 40	age40+	-0.382 (10.959)***	-0.036 (0.516)	0.008 (0.144)	-0.108 (3.686)***	0.110 (1.099)	-0.079 (1.357)	-0.222 (2.128)**
Dummy variable = if age between 35 and 40	age3540+	-0.441 (17.058)***	0.002 (0.032)	-0.014 (0.313)	-0.121 (4.728)***	0.156 (1.639)	-0.097 (1.925)	-0.085 (0.738)
Dummy variable = if age between 30 and 35	age3035+	-0.402 (12.849)***	-0.014 (0.280)	0.024 (0.478)	-0.127 (4.858)***	0.143 (1.727)*	-0.039 (0.605)	-0.011 (0.100)
Dummy variable = if age between 25 and 30	age2530+	-0.422 (13.975)***	-0.032 (0.726)	-0.010 (0.274)	-0.069 (1.979)**	0.190 (2.524)**	-0.017 (0.282)	-0.130 (1.372)
Dummy variable = if age between 20 and 25	age2025+	-0.432 (14.271)***	-0.011 (0.258)	0.030 (0.676)	-0.049 (1.354)	0.035 (0.693)	-0.024 (0.411)	0.049 (0.494)
Dummy variable = if age between 15 and 20	age1520+	-0.438 (15.195)***	-0.021 (0.501)	-0.037 (1.267)				
Dummy variable = if age between 10 and 15	age1015+	-0.428 (14.623)***						
Number of observations		2167	961	774	567	482	414	338
Pesudo R^2		0.334	0.107	0.280	0.107	0.128	0.224	0.112
Observed P	obs. P	0.472	0.182	0.133	0.166	0.098	0.188	0.429
Predicted P	pred. P	0.463	0.160	0.067	0.134	0.079	0.148	0.408

+ indicates that dF/dx is for discrete change of dummy variable from 0 to 1

* significant at 10%; ** significant at 5%; *** significant at 10%

# indicates that it is infeasible to estimate coefficients due to collinearity and thus dropped from estimation.

Table 3.8
Wald Test Statistics
for the Hypothesis that Households' Shock Variables are Jointly Zero

	Primary entry	Primary exit	Middle entry	Middle exit	Secondary entry	Secondary exit	Post-Sec. entry
	S1	S2	S3	S4	S5	S6	S7
Wald Statistics	17.75	34.75	27.62	6.42	5.23	43.34	0.68
[p-value]	[0.007]	[0.000]	[0.000]	[0.377]	[0.156]	[0.000]	[0.954]

Appendix 3.1

QUESTIONNAIRES

EDUCATION AND HOUSEHOLD WELFARE PROJECT 1997-98
at _____ District of _____ Province, Pakistan

GENERAL INFORMATION FOR ENUMERATORS

We are interested in information of households surveyed by IFPRI. It is important that

1) the person interviewed really belongs to the household interviewed before by IFPRI.

2) the interview is about the household interviewed before by IFPRI

3) if the household head cannot be interviewed, e.g., because he/she is not at home or he/she is too old, then another person within the family has to be interviewed. So also when you interview for example his oldest son, ask for the age, the main occupation of the household head (i.e., his father), his/her children and their education etc.

4) we can identify the person interviewed, i.e., that we know whether it is a brother of the person at the label, a son, etc. Furthermore, it is important that we know who is the current decision maker. This may be another person then is described on the label.

DEFINITIONS

1) With 'relative', we mean: all descendants from the grandfather and persons married to them. Relatives include family. Relatives are: father, mother, grandfather, grandmother, brother, sister, son, daughter, grandchild, uncle, aunt, cousin, nephew.

2) For the education questionnaire, it is important that it is clear what is meant with primary school, secondary school etc. Therefore use the following list:

Grade	Typical School Type	Other	Note
	Nursery or Kindergarten (Kachi)		
1 - 5	Primary School		
6 - 8	Middle School		
9 - 10	Secondary School		matriculate exam at the end of 10th
11 - 12	Intermediate Collage (F.A.)	Technical, Teachers	division wide board entrance exam
13 - 14	Degree Collage (B.A.)		division wide entrance exam
15 - 16	(M.A.)		
17 -	M.Phil		

EDUCATION AND HOUSEHOLD WELFARE PROJECT 1997-98
at _____ District of _____ Province, Pakistan

Interview Date _____ Interviewer Name _____
Interviewer Signature _____

(attach label here)

A. IDENTIFICATION QUESTIONS

We want to find the household which was interviewed ten years ago for the Pakistan Rural Household Survey by International Food Policy Research Institute (IFPRI).

1. Check the label and if different, please overwrite the label.
   Are you mister? — *see name label*
   What is your age? — *check with label*
   What was your occupation ten years ago? — *check with label*
2. Did you (enumerator) interview person mentioned on the label?
   1_yes
   2_no

If you have found the person mentioned on the label, then go on with next page, B. Basic Questions. If the person mentioned on the label is not available or he is too old, then try to find his successor or otherwise another family member who is knowledgeable about this household and go on with the following questions.

3. What is your relation with mister —see label: Are you his
   1_oldest son
   2_other son
   3_brother
   4_cusin
   5_nephew
   6_other (specify)

4. What is your age?
   ___ (number)

5. Are you the head (decision maker) of the household?
   1_yes
   2_no

If the answer is yes, then go on with "B. Basic Questions"; if the answer is no then answer the following question No.6

6. Why did you not interview the household head (decision maker)?
   1_was away from home
   2_it is a female headed household
   3_other (specify)

B. BASIC QUESTIONS ('YOU' indicates household head)

1. What is the closest city? What is the distance from the closest city?
   Name of the city _____.
   _____km, _____min by (circle one: Walk, Bicycle, Tonga, Suzuki, Car, Bus, Other)

2. To which biradari do you belong to? _____

3. To which biradari do most of the people in this village belong to?

4. Have you ever married before?
   1_yes
   2_no

5. When did you marry? (multiple answers are OK)
   _____, _____, _____.

6. How many children have ever had (including died children)?
   Son total: ____ = alive now: ____ + died: ____.
   Daughter total: ____ = alive now: ____ + died: ____.

7. What is your, your wife's, and your parents' age and highest schooling level?

	Whether he/she still alive? 1=yes 2=no	If died, when? (In calendar year)	Age (If died, please enter age when he/she died)	Highest Schooling Finished (None means he/she did not finish the 5th grade) 1 = None, cannot write nor read sentences 2 = None, can write but cannot read sentences 3 = None, cannot write but can read sentences 4 = None, can write and can read sentences 5 = Primary (5th grade) 6 = Middle (8th grade) 7 = Secondary (10th grade) 8 = College/University 9 = Technical/Apprentice 10 = Other
You				
Your Wife				
(Your Wife: second)				
(Your Wife: third)				
Your Father				
your Mother				

If the total number of sons and daughters is at least one, then continue with the following questions. If none, then go to the next household.

I. HOUSEHOLD ROSTER

Child No. (ID)	1. Name What are the names of all the children of you (the household head)? If there is no name, enter 'BOY' or 'Girl'	2. AGE What is the age of (Name) ? If died, age or month/days at death.	3. SEX 1=Male 2=Female	4 How much did you spend for (Name's) birth ceremony?	5a Is (Name) still alive? 1=YES →Q 6a 2=NO If No (died), when did (Name) died (in calendar year)? After how many months, did (Name) died?	5b If (Name) has already died, how much did you spend for the funeral ceremony?	6a Has (Name) ever lived separately from the household (more than 1 month)? 1=YES 2=NO If Yes, from when to when?	6b What is the reason of the separation? 1=school is far away from here (education) 2=Work place is far away from here 3=Marriage 4=Other (specify)	6c Marital status 1=Never married → Q7 2=Married 3=Married but Divorced 4=Separated (because of quarrel etc.) 5=Widowed	6d When married last time? (in calendar year)	6e How much of total Dowry or Jahez (from bride) /Mahar (from bridegroom) did you paid for (Name's) last marriage? (If paid by goods, please calculate the value in monetary term)	6f How much did you spend for (Name's) wedding ceremony (meal and transportation etc.)
UNIT	Name	Code	Code	Rs	Code / Year / months	Rs	code/ year to year	code	code	Calendar Year	From this family /From counterpart	Rs
01					/ /		/ to				/	
02					/ /		/ to				/	
03					/ /		/ to				/	
04					/ /		/ to				/	
05					/ /		/ to				/	
06					/ /		/ to				/	
07					/ /		/ to				/	
08					/ /		/ to				/	
09					/ /		/ to				/	
10					/ /		/ to				/	
11					/ /		/ to				/	
12					/ /		/ to				/	

II a. PRIMARY SCHOOL EDUCATION

Child No. (ID)	7. Has (Name) ever been to school? 1=YES 2=NO → Next child	8. Did (Name) attend Katchi class? 1=YES 2=NO If Yes, how many years in Katchi class?	8a. What is the (Name's) highest Education completed? (in grade) 1-5 primary 6-8 middle 9-10 secondary 11-12 intermediate collage 13-14 Degree collage 15-16 MA 17-M Phil	8b. Did (Name) repeat any grade(s)? 1=YES 2=NO	9a Did (Name) enter primary school? 1=YES → Q.9c 2=NO If NO, did (Name) enter Mosque School? 1=YES → Q.9b 2=NO → Next Child	9b How many years did (Name) attend Mosque School? → Next Child	9c When did (Name) enter primary school (1st grade)? Please enter a calendar year	10a. How was (Name's) study performance at the 1st and 2nd class? 1=Good 2=Average 3=Bad	10b. How was (Name's) study performance at the 4th and 5th class? 1=Good 2=Average 3=Bad [If (Name) left primary school before 4th grade enter 'NA']	11a From where did (Name) go to primary school usually? 1=Here 2=Relative's house 3=Friend's house 4=Boarding school 5=other	11b. What was the (Name's) typical mode of transportation to go to primary school? 1=By foot (Paidal) 2=Tonga 3=Bicycle 4=Suzuki, Car or Bus 5=Other	11c. Can (Name) go to primary school by him/herself? 1=YES 2=NO	11d. (1) Did (Name) go to primary school by him/herself most of the time (usually)? 1=YES →Q.12 2=NO (2) If NO, usually go to school with 1=sibling(s) 2=other family member or relatives 3=neighbors or friends 4=other [multiple answers are OK]
UNIT	Code	Code / Year	Number	Code	Primary/ Mosque	Number	Calender Year	Code	Code	Code	Code	Code	(1) Code / (2) Code
01		/			/								/
02		/			/								/
03		/			/								/
04		/			/								/
05		/			/								/
06		/			/								/
07		/			/								/
08		/			/								/
09		/			/								/
10		/			/								/
11		/			/								/
12		/			/								/

II a. PRIMARY SCHOOL EDUCATION (continued)

Child No. (ID)	12 (1) In the typical case, how long did it take for (name) to go to primary school from (Q11a.)? [minutes, one-way trip] (2) How much did you 'pay' money for the trip per month during (primary) schooling months? (if you did not pay money, e.g., used own bicycle, enter 'zero')	13a. What are the characteristics of the (Name's) school? (1) Gender 1=BOY school 2=GIRL school 3=Co-education (2) Government/Private 1=Government 2=Private (3) Classes are given in 1=AM 2=PM 3=Both AM and PM	13b (1) What was the typical number of student per teacher of the (Name's) primary school? If don't know, enter 'NA' (2) What was the typical level of teacher's education of that (Name's) school? 1=Primary 2=Middle 3=Secondary 4=PTC(J.V.) 5=F.A.,B.A.,M.A. 6=Other 7=Don't know	14a On average, how much did you pay for (Name's) primary school fees and expenses (tuition, books, and uniforms) per year? If don't remember, enter 'NA'	14b On average, how much did you give (Name) per day during primary schooling seasons (excluding holidays) for daily right entertainment and refreshments (bubble gams, candy, drinks etc)? How many schooling days were there per year?	14c Have you ever had difficulty to finance (name's) primary schooling costs? 1=YES (difficult) →Q14d 2=NO (not difficult) →Q15	14d (1) Could you have borrowed or received money and paid school fees and expenses for (Name's) primary schooling? 1=YES 2=NO →Q15 (2) If YES, from where? 1=Relatives 2=Neighbors 3=Friends 4=Shopkeeer 5=Other (specify)	15 Did (Name) repeat any grade(s) in primary school? 1=YES 2=NO If yes, list up the grades repeated.	15a Did (Name) dropout, graduate, or still attending school? 1=Still attending primary school →Next child 2=Dropout before finishing 5th class →Q15b 3=Graduate (finished the 5th class) and did not enter middle school (6th grade) →Q39 4=Graduate (finished 5th class) and enter middle school →Q16	15b. If dropout before passing 5th grade, what was the highest grade did (name) completed? →Q39
UNIT	Min / Rs per month	(1) / (2) / (3)	(1) / (2)	tuition/ books / uniforms	Rs / Days	Code / Year	(1) / (2)	code/grade(s)	Code	Grade number
01	/	/ /	/	/ /	/	/	/	/		
02	/	/ /	/	/ /	/	/	/	/		
03	/	/ /	/	/ /	/	/	/	/		
04	/	/ /	/	/ /	/	/	/	/		
05	/	/ /	/	/ /	/	/	/	/		
06	/	/ /	/	/ /	/	/	/	/		
07	/	/ /	/	/ /	/	/	/	/		
08	/	/ /	/	/ /	/	/	/	/		
09	/	/ /	/	/ /	/	/	/	/		
10	/	/ /	/	/ /	/	/	/	/		
11	/	/ /	/	/ /	/	/	/	/		
12	/	/ /	/	/ /	/	/	/	/		

II b. MIDDLE SCHOOL (6th-8th grade) EDUCATION

Child No. (ID)	16. When did (Name) enter middle school (6th grade)? Please enter a calendar year	17a How was (Name's) study performance at the 6th and 7th class? 1=Good 2=Average 3=Bad	17b How was (Name's) study performance at the 8th class? 1=Good 2=Average 3=Bad [If (Name) left middle school before 4th grade enter 'NA']	18a From where did (Name) go to middle school usually? 1=Here 2=Relative's house 3=Friend's house 4=Boarding school 5=hostel/rental house (live by him/herself) 6=other	18b What was the (Name's) typical mode of transportation to go to middle school? 1=By foot (Paidal) 2=Tonga 3=Bicycle 4=Suzuki, Car or Bus 5=Other	18c Can (Name) go to middle school by him/herself? 1=YES 2=NO	18d (1) Did (Name) go to middle school by him/herself most of the time (usually)? 1=YES →Q.19 2=NO (2) If NO, usually go to school with 1=sibling(s) 2=other family member or relatives 3=neighbors or friends 4=other [multiple answers are OK]	19 (1) In the typical case, how long did it take for (name) to go to middle school from (Q18a.)? [minutes, one-way trip] (2) How much did you 'pay' money for the trip per month during (middle) schooling months? (if you did not pay money, e.g., used own bicycle, enter 'zero')
UNIT	Year/Month	Code	Code	Code	Code	Code	(1) Code / (2) Code	Min / Rs per month
01	/						/	/
02	/						/	/
03	/						/	/
04	/						/	/
05	/						/	/
06	/						/	/
07	/						/	/
08	/						/	/
09	/						/	/
10	/						/	/
11	/						/	/
12	/						/	/

II a. MIDDLE SCHOOL (6th-8th grade) EDUCATION (continued)

Child No. (ID)	20a What are the characteristics of the (Name's) school? (1) Gender 1=BOY school 2=GIRL school 3=Co-education (2) Government/Private 1=Government 2=Private (3) Classes are given in 1=AM 2=PM 3=Both AM and PM	20b (1) What was the typical number of student per teacher of the (Name's) middle school? If don't know, enter 'NA' (2) What was the typical level of teacher's education of that (Name's) school? 1=Primary 2=Middle 3=Secondary 4=PTC(J.V.) 5=F.A.,B.A.,M.A. 6=Other 7=Don't know	21a On average, how much did you pay for (Name's) middle school fees and expenses (tuition, books, and uniforms) per year? If don't remember, enter 'NA'.	21b On average, how much did you give (Name) per day during middle schooling seasons (excluding holidays) for daily right entertainment and refreshments (bubble gams, candy, drinks etc)? How many schooling days were there per year?	22 Have you ever had difficulty to finance (name's) middle schooling costs? 1=YES (difficult) →Q23 2=NO (not difficult) →Q24.	23 (1) Could you have borrowed or received money and paid school fees and expenses for (Name's) middle schooling? 1=YES 2=NO →Q24 (2) If YES, from where? 1=Relatives 2=Neighbors 3=Friends 4=Shopkeeer 5=Other (specify)	24 Did (Name) repeat any grade(s) in primary school? 1=YES 2=NO If yes, list up the grades repeated.	24a Did (Name) dropout, graduate, or still attending school? 1=Still attending middle school →Next child 2=Graduate (passed) 8th class and enter secondary (high) school (9th class) →Q26 3=Graduate (passed) the 8th class and did not enter secondary (high) school (9th class) →Q39 4=Dropout before finishing 8th class →Q25	25. If dropout before passing 8th grade, what was the highest grade did (name) completed? →Q39
UNIT	(1) / (2) / (3)	(1) / (2)	tuition/ books / uniforms	Rs / Days	Code / Year	(1) / (2)	code/grade(s)	Code	Grade number
01	/ /	/	/ /	/	/	/	/		
02	/ /	/	/ /	/	/	/	/		
03	/ /	/	/ /	/	/	/	/		
04	/ /	/	/ /	/	/	/	/		
05	/ /	/	/ /	/	/	/	/		
06	/ /	/	/ /	/	/	/	/		
07	/ /	/	/ /	/	/	/	/		
08	/ /	/	/ /	/	/	/	/		
09	/ /	/	/ /	/	/	/	/		
10	/ /	/	/ /	/	/	/	/		
11	/ /	/	/ /	/	/	/	/		
12	/ /	/	/ /	/	/	/	/		

II c. SECONDARY (HIGH) SCHOOL (9th-10th grade) EDUCATION

Child No. (ID)	26. When did (Name) enter secondary (high) school (9th class)? Please enter a calendar year	27a. How was (Name's) study performance at the 9th class? 1=Good 2=Average 3=Bad	27b. How was (Name's) study performance at the 10th class? 1=Good 2=Average 3=Bad [If (Name) left secondary (high) school before 4th grade enter 'NA']	28a. From where did (Name) go to secondary (high) school usually? 1=Here 2=Relative's house 3=Friend's house 4=Boarding school 5=hostel/rental house (live by him/herself) 6=other	28b. What was the (Name's) typical mode of transportation to go to secondary (high) school? 1=By foot (Paidal) 2=Tonga 3=Bicycle 4=Suzuki, Car or Bus 5=Other	28c. Can (Name) go to secondary (high) school by him/herself? 1=YES 2=NO	28d. (1) Did (Name) go to secondary (high) school by him/herself most of the time (usually)? 1=YES →Q.29 2=NO (2) If NO, usually go to school with 1=sibling(s) 2=other family member or relatives 3=neighbors or friends 4=other [multiple answers are OK]	29 (1) In the typical case, how long did it take for (Name) to go to secondary (high) school from (Q28a.)? [minutes, one-way trip] (2) How much did you 'pay' money for the trip per month during (secondary) schooling months? (if you did not pay money, e.g., used own bicycle, enter 'zero')
UNIT	Year/Month	Code	Code	Code	Code	Code	(1) Code / (2) Code	Min / Rs per month
01	/						/	/
02	/						/	/
03	/						/	/
04	/						/	/
05	/						/	/
06	/						/	/
07	/						/	/
08	/						/	/
09	/						/	/
10	/						/	/
11	/						/	/
12	/						/	/

II c. SECONDARY (HIGH) SCHOOL (9th - 10th grade) EDUCATION (continued)

Child No. (ID)	30a. What are the characteristics of the (Name's) school? (1) Gender 1=BOY school 2=GIRL school 3=Co-education (2) Government/Private 1=Government 2=Private (3) Classes are given in 1=AM 2=PM 3=Both AM and PM	30b. (1) What was the typical number of student per teacher of the (Name's) secondary (high) school? If don't know, enter 'NA' (2) What was the typical level of teacher's education of that (Name's) school? 1=Primary 2=Secondary (high) 3=Secondary 4=PTC(J.V.) 5=F.A.,B.A.,M.A 6=Other 7=Don't know	31a On average, how much did you pay for (Name's) secondary (high) school fees and expenses (tuition, books, and uniforms) per year? If don't remember, enter 'NA'	31b. On average, how much did you give (Name) per day during secondary schooling seasons (excluding holidays) for daily right entertainment and refreshments (bubble gams, candy, drinks etc)? How many schooling days were there per year?	32 Have you ever had difficulty to finance (Name's) secondary (high) schooling costs? 1=YES (difficult) →Q33 2=NO (not difficult) →Q34	33 (1) Could you have borrowed or received money and paid school fees and expenses for (Name's) secondary (high) schooling? 1=YES 2=NO →Q34 (2) If YES, from where? 1=Relatives 2=Neighbors 3=Friends 4=Shopkeeer 5=Other (specify)	34 Did (Name) repeat any grade(s) in primary school? 1=YES 2=NO If yes, list up the grades repeated	34a. Did (Name) dropout, graduate, or still attending school? 1=Still attending secondary (high) school →Next child 2=Graduate (finished) 10th class and enter 11th class →Q35 3=Graduate (finished) the 10th class and did not enter 11th class →Q39 4=Dropout before finishing 10th class →Q35	35. If dropout before passing 10th grade, what was the highest grade did (name) completed? →Q39
UNIT	(1) / (2) / (3)	(1) / (2)	tuition/ books / uniforms	Rs / Days	Code / Year	(1) / (2)	code/grade(s)	Code	Grade number
01	/ /	/	/ /	/	/	/	/		
02	/ /	/	/ /	/	/	/	/		
03	/ /	/	/ /	/	/	/	/		
04	/ /	/	/ /	/	/	/	/		
05	/ /	/	/ /	/	/	/	/		
06	/ /	/	/ /	/	/	/	/		
07	/ /	/	/ /	/	/	/	/		
08	/ /	/	/ /	/	/	/	/		
09	/ /	/	/ /	/	/	/	/		
10	/ /	/	/ /	/	/	/	/		
11	/ /	/	/ /	/	/	/	/		
12	/ /	/	/ /	/	/	/	/		

II d. F.A. and HIGHER EDUCATION (11th and HIGHER)

III Questions for the year when (NAME) finally left education

Child No. (ID)	36. When did (Name) enter the higher education (11th grade and higher/F.A. and higher)?	37. From where (Name) go to the higher school (collage etc.) usually? 1=Here 2=Relative's house 3=Friend's house 4=Boarding school 5=hostel/rental house (live by him/herself) 6=other	38. What is the (Name's) highest level of education completed? 1=F.A. 2=B.A. 3=M.A. 4=Professional (Engneer, Doctor) 5=Apprentice 6=Diploma 7=Other	38b Did (Name) dropout or graduate the highest education? 1=Dropout 2=Graduate 3=Continue	39 When did (Name) left education finally? (In calendar year)	40 What is the (Name's) age when first entered 1st grade and finally left education?	41. What was the reasons why (Name) left education finally? [Multiple answers are OK] 1=Accomplished the level expected 2=Fees too high 3=School is too far 4=Illness 5=Needed on farm 6=Needed at home 7=Got a job 8=Marriage 9=Punishment of teacher's on (Name) 10=(Name) don't want to go to school 11=(Name) failed exam(s) and depressed 12=Other [specify]	42. In the year of (Q39) when (Name) finally left education, what was the total income of your household if compared with the typical (average) year? 1=Very good 2=Good 3=Average (typical year) 4=Bad 5=Very bad	42a. Did (Name) work after quitting schooling? 1=YES 2=NO If YES, after how many weeks did (Name) first get a job?	42b. What was the (Name)'s first starting wage? (Please convert it into wage per day)
UNIT	Year	Code	Code	Code	Year	Entered / Left	Code	Code	Code / Weeks	Rs
01						/			/	
02						/			/	
03						/			/	
04						/			/	
05						/			/	
06						/			/	
07						/			/	
08						/			/	
09						/			/	
10						/			/	
11						/			/	
12						/			/	

HOUSEHOLD BACKGROUND INFORMATION 1

Note: The following questions are about household-level information.
Hence, the following questions should be asked for each household, not for each child

1. HARVEST AND INCOME MOVEMENTS

1-1 Good Harvest and Income

	43a Comparing with the typical year since your marriage, when was the very good harvest year(s) and season(s)? For season, 1=Kharif 2=Rabi	43c1 Comparing with the typical year since your marriage, when did you get large livestock income (sales of livestock, milk, gee etc)? How much did you get?	43c2 Comparing with the typical year since your marriage, when did you get large non-farm income (wage etc)? How much did you get?
	Year / Season	Year /Month/ Rs	Year /Month/ Rs
1	/	/ /	/ /
2	/	/ /	/ /
3	/	/ /	/ /
4	/	/ /	/ /
5	/	/ /	/ /
6	/	/ /	/ /
7	/	/ /	/ /
8	/	/ /	/ /
9	/	/ /	/ /

1-2 Bad Harvest and Income

43b Comparing with the typical year since your marriage, when was the very bad harvest year(s) and season(s)? For season, 1=Kharif 2=Rabi	43d1 Comparing with the typical year since your marriage, when did you lost large livestock income (livestock died etc)? How much did you get?	43d2 Comparing with the typical year since your marriage, when did you lost large non-farm income (wage etc.)? How much did you get?
Year / Season	Year /Month/ Rs	Year /Month/ Rs
/	/ /	/ /
/	/ /	/ /
/	/ /	/ /
/	/ /	/ /
/	/ /	/ /
/	/ /	/ /
/	/ /	/ /
/	/ /	/ /
/	/ /	/ /

HOUSEHOLD BACKGROUND INFORMATION 2

Note: The following questions are about household-level information.
Hence, the following questions should be asked for each household, not for each child

2. HEALTH STATUS OF HOUSEHOLD HEAD AND HIS WIFE

2-1 Household Head

	45a. Have you (household head) ever seriously ill (or insured), which made you inactive for more than one month? 1=YES 2=NO	45b. If YES, which year(s) and month(s) did you inactivated and how long have you been inactivated? [If permanently inactivated, enter P for the length]
	Code	Year /Month/Length in month
1		/ /
2		/ /
3		/ /
4		/ /
5		/ /
6		/ /
7		/ /
8		/ /
9		/ /

2-2 Household Head's Wife

46a Has your (household head's) wife ever seriously ill (or insured), which made your wife inactive for more than one month? 1=YES 2=NO	46b. If YES, which year(s) and month(s) did your (household head's) wife inactivated and how long have your wife been inactivated? [If permanently inactivated, enter P for the length]
Code	Year /Month/Length in month
	/ /
	/ /
	/ /
	/ /
	/ /
	/ /
	/ /
	/ /
	/ /

HOUSEHOLD BACKGROUND INFORMATION 3

Note: The following questions are about household-level information.
Hence, the following questions should be asked for each household, not for each child

3. AESSET INFORMATION

3-1 Land Ownership

	47a. Have you ever owned land? 1=YES 2=NO	47b. (1) When did you buy or acquire it? [Please attach asterisk "*" if bought] (2) From whom did you buy or acquire it? 1=Parents 2=Relatives 3=Neighbors 4=Friends 5=Other (specify) (3) How large is it? (4) What kind of land is that? 1=Rainfed 2=Irrigated 3=Orchard 4=Other (specify)	47c1 Did you sell (a part of) land? 1=YES 2=NO	47c2 If YES for Q 47c1, (1) when and (2) how large did you sell? (3) Which kind of land was it? 1=Rainfed 2=Irrigated 3=Orchard 4=Other (specify)
	Code	(1)Year/(2)From/(3)Kamal /(4)Kind	Code	(1)When/(2)Kamal/(3)Kind
1		/ / /		/ /
2		/ / /		/ /
3		/ / /		/ /
4		/ / /		/ /
5		/ / /		/ /
6		/ / /		/ /
7		/ / /		/ /
8		/ / /		/ /
9		/ / /		/ /

3-2 Tubewell Ownership

	48a1 Have you ever owned tubewell? 1=YES 2=NO	48a2 When did you buy or acquire it? [Please attach asterisk "*" if bought]	48b. Do you still have it? 1=YES 2=NO	48c. (1) If NO for Q48b, what did you do or did it happened with your tubewell? 1=Sold to others 2=Gave it to others 2= Broke down 4=Other (specify) (2) When did you do that or did it happened?
	Code	Year	Code	(1)Code / (2)Year
				/
				/
				/
				/
				/
				/
				/
				/
				/

HOUSEHOLD BACKGROUND INFORMATION 3 (continued) and 4

Note: The following questions are about household-level information.
Hence, the following questions should be asked for each household, not for each child

3. AESSET INFORMATION (continued)

3-3 Tractor Ownership

	49a1. Have you ever owned tractor? 1=YES 2=NO	49a2. When did you buy or acquire it? [Please attach asterisk "*" if bought]	49b. Do you still have it? 1=YES 2=NO	49c (1) If NO for Q48b, what did you do or did it happened with your tractor? 1=Sold to others 2=Gave it to others 2= Broke down 4=Other (specify) (2) When did you do that or did it happened?
	Code	Year	Code	(1)Code / (2)Year
1				/
2				/
3				/
4				/
5				/
6				/
7				/
8				/
9				/

4. TRANSFER AND REMITTANCES

50a1. Comparing with the typical year since your marriage, did you receive large remittances and transfers, including family/relatives transfers, remittances, gifts, government pension etc. (more than 20,000Rs)? 1=YES 2=NO	50a2 If YES for 50a2, when did you receive? If NO for 50a1, then go to the next household	50b. (1) From whom and (2) How much and did you receive remittances? [Code for (1)] 1=Zakat/Ushr 2=Pension 3=Son/Daughter 4=Relative 5=Neighbors 6=Friends 7=Other (specify)	50c. From where did he/she send money? [Please write down name of the place, where is the origin of the fund]
Code	Year / Month	(1) Whom / (2)How much	Name of the place
	/	/	
	/	/	
	/	/	
	/	/	
	/	/	
	/	/	
	/	/	
	/	/	
	/	/	

Village Level Questionnaire

Name of the Village _____ **Interview Date** _____ **Person Interviewed** _____ **Interviewer Name** _____

	Total Population of village	Total acres of canal /irrigated land	# of Mosque	# of Basic Health Units (BHU)	# of Rural Health Units (RHU)	# of Medical shops	# of Trade stores (shops)	# of political leaders such as union council member	# of army soldiers from the village	# of canal Patwari	# of revenue Patwari	# of *Active* Water Users Association (WUA)	# of Primary Schools	# of Primary School Teachers	# of Middle Schools	# of Middle Schools Teachers
Year													boy/girl	boy/girl	boy/girl	boy/girl
1970													/	/	/	/
71													/	/	/	/
72													/	/	/	/
73													/	/	/	/
74													/	/	/	/
75													/	/	/	/
76													/	/	/	/
77													/	/	/	/
78													/	/	/	/
79													/	/	/	/
80													/	/	/	/
81													/	/	/	/
82													/	/	/	/
83													/	/	/	/
84													/	/	/	/
85													/	/	/	/
86													/	/	/	/
87													/	/	/	/
88													/	/	/	/
89													/	/	/	/
90													/	/	/	/
91													/	/	/	/
92													/	/	/	/
93													/	/	/	/
94													/	/	/	/
95													/	/	/	/
96													/	/	/	/
97													/	/	/	/

Chapter 4

Do Community-Managed Schools Work? An Evaluation of El Salvador's EDUCO Program (with Emmanuel Jimenez)

4.1 Introduction

Central governments in developing countries usually play a major role allocating educational resources. Even when authority is delegated to sub-national levels such as provinces or municipalities, individual school administrators and parents play only a limited role. Such a centralized structure might make it easier to regulate and administer large systems uniformly; but it may also lead to ineffectiveness and high cost when school needs differ widely across communities and when there are diseconomies of scale. Moreover, it can stifle initiative among those who are most critical in affecting school outcomes -- teachers, principals and parents.

Despite the compelling reasoning, there is relatively little empirical evidence in developing countries to document the merits of school-based management.[1] The main reason is that these administrative arrangements have only recently begun to be implemented (World Bank 1994, 1995, 1996a). One celebrated example is El Salvador's Community-Managed Schools Program (more popularly known by the acronym, EDUCO, or *Educacion con Participacion de la Comunidad*), which is an innovative program for both pre-primary and primary education to decentralize education by strengthening direct involvement and participation of parents and community groups.

A prototype of the today's EDUCO schools emerged in the 1980s when public schools could not be extended to rural areas because of the country's civil war. Some communities took the initiative to organize their own schools, administered and financially supported by an association of households. While these early attempts were constrained by the low rural income base, they demonstrated a strong inherent demand for education, as well as a desire to participate in the governance of schools. In 1991, El Salvador's Ministry of Education (MINED), supported by aid agencies such as the World Bank, decided to use the prototype as the principal method of expanding education in rural areas through the EDUCO program.

[1] Two exceptions are James, King and Suryadi (1996) for Indonesia and Jimenez and Paqueo (1996) for the

The present EDUCO schools are managed autonomously by an elected Community Education Association (*Asociacion Comunal para la Educacion* or ACE) drawn from the parents of the students. In EDUCO schools, ACEs take a central role of administration and management; ACEs are contracted by MINED to deliver a given curriculum to an agreed number of students. The ACEs are then responsible for contracting and removing teachers by closely monitoring teachers' performance, and for equipping and maintaining the schools. The partnership between MINED and ACEs is expected to improve school administration and management by reflecting local demand more appropriately. In the future, MINED intends to introduce community management into all traditional schools.

The EDUCO program was conceived as a way to expand educational access quickly to remote rural areas. Initial evidence indicates that it has accomplished this (El Salvador, MINED 1995; Reimers 1997). The question is whether this expansion has come at the expense of learning. Professional administrators in the center are less involved in the day-to-day running of schools, which are now in the hands of local communities where many of the parents are poor and have an inadequate education themselves. But, as mentioned above, moving away from traditional programs that provide education centrally could also improve outcomes through increased community and parent involvement.

This chapter assesses the EDUCO experience. It estimates school production functions using three measures of educational outcomes among third-grade students.[2] Two of these measure achievement through standardized tests in mathematics and language. While these measures may be good indicators of educational outcome, they may also be relatively unresponsive in the short-run to changes in school governance. We thus also analyze an indicator that can be considered more of an "intervening" variable in determining student achievement but would more likely exhibit a short-run response -- school-days missed by a student.

As with all comparisons of educational achievement, the key is to quantify how much of the differential in academic achievement can be explained by differences in household background, the school's quantitative inputs and, most importantly, organizational factors attributable to intangible differences in the way that traditional and decentralized schools are run.[3] We also address parents' endogenous school choice by explicitly considering how the

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Philippines. Both studies conclude that there are efficiency gains from community-based involvement.

[2]This is part of a larger effort by the World Bank to distill the lessons of decentralized education (see World Bank 1996a). Eventually, we seek to answer whether students in EDUCO achieve higher educational outcomes and at comparable costs relative to their counterparts in traditional public schools. This particular chapter has a more limited objective in using school production functions to compare three measures of educational outcomes among third grade students.

government chose which areas would first have EDUCO schools.

The rest of this chapter is organized as follows. Section 4.2 presents the production function model with endogenous participation and the empirical framework for estimating that model. Section 4.3 discusses the data, including the sample design. Sections 4.4 and 4.5 discuss the results of the student achievement and student absence results respectively. Section 4.6 concludes with a discussion of policy implications.

4.2 Conceptual and Empirical Framework

4.2.1 The Basic Model

The production of educational outcomes is a complex interaction of the behavior of various agents who participate in the schooling process. Students' characteristics and motivation are key, but so also are the actions of individual parents, groups of parents (such as parent-teacher associations, PTAs), teachers and administrators at various levels, from the school up to the education ministry. In addition, agents not directly connected to the educational system may affect these outcomes if they influence the environment in which students learn. For example, decisions about road infrastructure in a locality may affect access to certain types of schools; or, the provision of electricity in a municipality could affect the ability of students to study at night.

It would be intractable to model the structural relationships that capture the behavior of each relevant agent.[4] Instead, we postulate a simple reduced form model of educational outcomes (Y). Most studies measure output by students' achievement scores, school attendance rates, repetition rates, school continuation or dropout rates. These variables are thought to capture prospects of future earnings in the labor market. In this chapter, we focus on two components of Y -- student scores in standardized achievement tests (S) and student absence from school (A).

Education production function studies have had a mixed record in explaining S (for a review, see Hanushek 1995). Aside from measurement and estimation issues, the outcome may be determined by endogenous choices. For example, some of the explanatory policy variables that determine S, such as school type, may themselves be systematically related to unobservable characteristics which may not be random across the observations, leading to possible bias. As explained below, we attempt to correct for this problem by also modeling and estimating the

[3] For a good review of these intangibles, see Levin (1997).
[4] An interesting simple model of the interaction of parental and school preferences in determining outcomes is presented in McMillan (1999)

choice of school type and using the result to hold constant for participation in the production function. Although it is often difficult to identify such models, we are able to use the participation rule used by the Salvadorean authorities as the identifying restriction that affects choice but not outcome directly.

In addition, it may take time for a policy change such as decentralization to manifest itself in school performance, which tends to be a cumulative measure. We thus also consider an important intervening variable which eventually influences student outcomes -- student absence from school (A). Students must show up to get anything out of school. They may be absent for a number of reasons. They may be ill, which has nothing to do with decentralization. But other reasons may be tied to school organization and management. They (or their parents) may not be motivated to ensure regular attendance because quality is poor or because parents do not feel involved in the education process. Another reason is teacher absence, which is an important reason why students do not attend school in El Salvador. If teachers are absent, classes are usually cancelled and there is no tradition of using substitute teachers. Although teacher absence can be attributed to legitimate reasons, such as sickness, it is more often due to simple dereliction of duty. Teacher absence is an issue, not only in El Salvador:

> Lack of motivation and professional commitment produce poor attendance and unprofessional attitudes towards students. Teacher absenteeism and tardiness are prevalent in many developing countries...;absenteeism is especially acute in rural areas. Students obviously cannot learn from a teacher who is not present, and absenteeism among teachers encourages similar behavior a among students. In some countries, ... parents react to high rates of teacher absenteeism by refusing to enroll their children in school. (Lockheed et al. 1991, p. 101).

The student absences due to teacher absences could be affected by school governance through appropriate teacher monitoring devices. We would expect that, in a decentralized school, parental involvement would mitigate such behavior.

We assume that the components of $Y = [S\ A]$ can be independently estimated. While A will likely affect S, we assume an implicit recursive process $S = S(A)$ in which the residuals from the different equations are independent of each other and the matrix of coefficients of endogenous variables is triangular. Each structural equation can thus be estimated by OLS, equation-by-equation (Greene 1997, pp.736-737).

For the ith student then, one simple model is for the i-th student in the n-th school in m-th community:

(1a) $$Y_{inm} = f(X_{inm}, C_m, D_{nmi})$$

where X is a vector of student and household characteristics, C is a vector of community variables which is represented by municipality m's characteristics, and D is the type of school attended by the i-th student, in this case whether it is a decentralized EDUCO school or not. In this model, the latter is assumed to determine most of the school characteristics which affect student outcome. This is the ultimate reduced form -- it assumes that the effects on achievement of a school's observed school characteristics, such as class size, teacher characteristics, etc., are fully determined by its management structure (i.e., whether it is a decentralized EDUCO school or not) and the characteristics of the students and their parents who fully participate in the decision-making in the school.

The effects of management structure can often be observed through differences in school and classroom inputs, such as teacher-pupil ratios, teacher remuneration or the educational background of teachers and administrators. But even if we were to enter as many school characteristics as we could observe in equation (1a), school type may still be significant because it captures unobserved managerial inputs (Levin 1997). Indeed, in reviewing 96 studies on the effects of five educational inputs on student performance in developing countries, Hanushek (1995) concluded that there are not clear and robust technical relationships between key school inputs and student performance.[5] This implies that differences in resources proxied by these production function studies might not be important determinants of school outputs, and schools in developing countries are paying for things that have little consistent or systematic payoff in terms of student performance. If so, unobserved managerial inputs may be critical in determining outcomes. More importantly, we identify the intangible effect through community participation from the other unobserved effect by explicitly taking into account the differences in the level of community group involvement. Accordingly, we also postulate an alternative model:

(1b) $$Y_{inm} = f(X_{inm}, C_m, D_{nim}, Z_{nm}, P_{mn})$$

[5] Some evidence in Hanusek (1995), however, suggests that minimal level of basic school resources such as the availability of text books and the provision of minimal facilities are important in student achievement.

where Z represents a vector of observed school and classroom-level characteristics and P is the intensity of community participation. Since Z and P will vary by school rather than by student, (1b) really expresses achievement for the i-th student in the n-th school. To simplify notation, in the rest of this chapter, we drop the school and community subscripts.

4.2.2 Empirical Specification

By linearizing and adding a stochastic term, which represents a well-behaved measurement error term, to equation (1a), we have a regression formula as follows:

$$Y_i = X_i\beta + C_m\gamma + D_i\alpha + u_i \tag{2}$$

D takes a value of 1 if the ith student is in a decentralized EDUCO school and 0 otherwise, that is, if the student attends a traditional centralized rural school. By assumption, $E(u_i)=0$ and $Var(u_i)=\sigma_u^2$. We add school and classroom characteristics and the intensity of community participation to correspond to the empirical version of (1b).[6]

Observed household and student characteristics reflect the ability of parents to provide an adequate and supporting environment for the students. If capital markets are perfect, then life-cycle consumption and human capital investments can be determined independently. Parents would simply borrow to finance needed home inputs to maximize learning outcomes. But since credit markets are far from perfect in El Salvador, the economic circumstances of the household would be important. In this chapter, we use asset variables to control for these economic effects (home ownership, the availability of electricity, sanitary services and piped water) which are hypothesized to be positively correlated with outcomes. In addition, parents' education may also reflect standards of living, as well as affecting preferences for education directly, and thus is positively correlated with outcomes.

We cannot measure innate student ability directly. However, student-level effects which may be important include gender, which may reflect differential parental or teacher inputs between boys or girls, the child's age (while older students are more mature and are more likely to score higher, they may also be self-selected as underachievers left behind by their cohort), and the number of siblings (the greater the number, the less time parents would have to devote to any

[6] We do not add the error terms associated with the school and municipal-level variables to simplify notation. The former will be handled by the program participation model described below and the latter are

one of them – i.e., resource competition effects).

The community characteristics are captured by municipality-level fixed effects. Municipalities (*municipios*) are the second lower administrative division in the country after the national level. There are substantial variances in the distribution of resources across these units, which could affect the ability of individual students to have access to ancillary services, such as the availability of electricity by which to study, that could affect individual outcomes.

4.2.3 Endogenous Program Participation

A key estimation issue may be endogenous program participation. This arises because households choose which school type their children go to (conditional on having chosen to go to school, since we do not have information on children not in school).[7] If this participation is systematically based on unobserved characteristics that may also influence achievement, then the estimated effect of EDUCO through OLS regressions would be biased. In equation (2), α may not accurately measure the value of being in EDUCO.

The direction of the bias is ambiguous. If the important unobserved characteristics are student motivation to learn and parent commitment to education, and these variables are positively correlated with EDUCO participation, then comparing outcomes, even after holding constant for observed characteristics, would overestimate the EDUCO effect. This effect, however, may be mitigated by the fact that economically disadvantaged communities are targeted as priorities for the introduction of EDUCO programs as mentioned the above.

To take these effects into account, we explicitly model program participation (i.e., whether or not a student enrolls in an EDUCO rather than a traditional school). Following a familiar method for obtaining so-called "treatment effects," we then estimate this model to obtain the parameters we need to correct equation (2).[8]

What determines program participation? We assume that governments select which municipalities are on the priority list to receive an EDUCO program. Households then use that

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handled by the fact that we use a fixed-effects model with respect to municipalities.

[7] While EDUCO sections were targeted to those areas where primary school coverage was limited, parents still would have had a choice whether or not to attend: they could have had their children commute, albeit over long distances (child fosterage for schooling is not uncommon in developing countries; see Ainsworth 1992 and Glewwe and Jacoby 1994); or they could have changed residences (Salvadorean migration rates are high). Unfortunately, the school-based nature of the sample precluded including non-attendance as an option.

[8] See Greene 1997, pp. 981-982 for a clear discussion of this estimation strategy for correcting for endogenous treatment effects.

information, as reflected in the relative availability of EDUCO schools in their municipality, in judging the relative merits of one program versus another. In particular, households choose the type of school which maximizes their lifetime indirect utility, V. This, in turn, will depend on the benefits and costs of EDUCO versus other types of schools. The benefits of choosing EDUCO depend on household perceptions of the virtues of a decentralized program. Some of these preferences can be captured by measurable household characteristics, X, but others are unobserved.

The cost of entering an EDUCO program relative to a traditional one depends on direct costs such as tuition payments, books, and other fees.[9] These costs are largely the same for decentralized EDUCO and traditional rural programs for the most important components of cost -- all schools and books are free in grades 1 to 6. There are differences in the other direct costs. EDUCO students pay no registration fee (a "matricula"), do not buy uniforms, and receive a basic package of school supplies ("canasta basica"), such as pencils, rulers, markers, etc. Traditional rural students must incur all of these costs. On the other hand, EDUCO parents must provide a substantial amount of time by providing school meals, building and maintaining the school and administering it.[10]

The principal cost differential between EDUCO and traditional schools has to do with access, because of the relative paucity of schools in rural areas. We do not have information regarding the schooling options confronted by households (such as the distance from the house to feasible EDUCO or traditional schools) because the data are school-based. However, we assume that a household is more likely to choose EDUCO if a municipality is considered a priority by the government and thus EDUCO schools are available in the community. The government gives priority to those municipalities which are considered "neediest," according to a classification system developed by MINED and the Ministry of Health (MOH).[11] The key variables in the targeting system are the incidence of severe malnutrition (the percentage of undersize children in the municipality), the repetition rate, the percentage of over-age students and the net enrollment rate. Except for the last category, higher levels of the variables are accorded more points in the

[9] We are grateful for Diane Steele of the World Bank for this information which she received from a phone interview with MINED staff.

[10] We do not have direct observations on the magnitudes of these costs -- we assume in this chapter that these cost differentials are roughly offsetting for the decentralized and traditional schools. We plan to verify this with data from surveys which will be fielded in 1999.

[11] Uneven access to social services by municipalities has always been serious issue in El Salvador, although poverty is more widespread in the smaller municipalities. These small municipalities usually suffer from lack of financial and institutional capacity to administer and manage social services. The EDUCO program was developed in 78 of the country's poorest municipalities. It started in 1991 with six ACEs in three

priority listing of municipalities. The result of this prioritization, which is exogenously determined by government, is what we use as the instrument in identifying program effects. We discuss the precise form of the variables in the next section.

More formally, we construct the model of program participation as follows.[12] A household chooses the school type which yields the highest level of indirect utility, V_j. In this case, there are two options, so that j = D (Decentralized EDUCO school), or T (traditional rural school). As discussed above, V_j depends on the relative benefits and costs of being in EDUCO, as perceived by parents who will choose EDUCO if for the ith student:

$$D_i^* = V_{Di} - V_{Ti} > 0. \tag{3}$$

D* is a latent variable which describes the likelihood that a child is in a decentralized setting. It is determined by:

$$D_i^* = W_i \omega + \varepsilon_i$$
$$D_i = 1 \text{ if } D_i^* > 0 \text{ and zero otherwise.} \tag{4}$$

where $E(\varepsilon_i)=0$, $Var(\varepsilon_i)=\sigma_\varepsilon^2$, $W_i = [X_i \quad R_i]$, a vector capturing the benefits and costs of attending EDUCO, which are proxied by household characteristics and R, a vector of school density variables (the percentages of EDUCO and traditional schools out of all primary schools in a municipality) and $\omega = [\delta \quad \pi]'$. This can be estimated as a probit model under the assumption that ε_i is normally distributed.

The essence of the endogenous participation problem is that the errors in equations (2) and (4) are correlated, $E(u_i, \varepsilon_i) \neq 0$, leading to bias.[13] If we assume that u_i and ε_i are jointly normally distributed, the expected value of the outcome variable for each of the EDUCO and Traditional cases would be:

$$E(Y_i \mid D_i = 1) = X_i\beta + C_m\gamma + \alpha + \sigma_{u\varepsilon}\lambda_{Di} \tag{5}$$

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departments; by the end of 1992, the program had extended to all 14 departments.

[12] The basic model structure follows the standard treatment of program participation (Greene 1997, pp.981-982). The econometric model of self-selection is also closely related (Willis and Rosen 1979, Cox and Jimenez 1991). Readers who are not interested in the technical discussion of EDUCO participation can proceed to the next section.

[13] Note that: $E(u_i \mid D_i^* > 0) = E(u_i \mid W_i\omega + \varepsilon_i > 0) \neq 0$.

(6) $$E(Y_i \mid D_i = 0) = X_i\beta + C_m\gamma - \sigma_{u\varepsilon}\lambda_{Ti}.$$

where λ_{Di} and λ_{Ti} are selection terms estimated from Mills ratios.[14] The difference in expected performance between EDUCO participants and non-participants, conditional on having chosen a school type, can be obtained by subtracting equation (6) from equation (5):

(7) $$E(Y_i \mid D_i = 1) - E(Y_i \mid D_i = 0) = \alpha + \sigma_{u\varepsilon}(\lambda_{Di} + \lambda_{Ti}).$$

where "α" is the EDUCO intercept coefficient and is usually referred to as the "true" program effect (see Maddala 1983).

Thus, if we define $e_i = u_i - \sigma_{u\varepsilon}\lambda_{D_i} D_i + \sigma_{u\varepsilon}\lambda_{Ti}(1-D_i)$, a term whose expectation is zero for each of the cases D = 1, 0, the following regression would yield unbiased estimators:

(8) $$Y_i = X_i\beta + C_m\gamma + D_i\alpha + \sigma_{u\varepsilon}[\lambda_{Di} D_i - \lambda_{Ti}(1-D_i)] + e_i.$$

If the selection correction terms in brackets [.] were omitted from this regression, the difference in (7) would be what is estimated by the least squares coefficient on the treatment dummy variable. But this expression would over or underestimate the treatment effect, depending on the direction of the participation bias.

To estimate this model, we employ a two-step method.[15] In the first step, equation (4) is estimated as a probit model which is ued to calculate the inverse Mills ratios λ_D and λ_T. In the second step, the estimated inverse Mills ratios are used to form the participation terms in equation (9), which is then estimated with municipal dummies to capture regional fixed-effects.

If the error terms in the probit and outcome equations are negatively correlated, i.e., $\sigma_{u\varepsilon} < 0$ (this would be so if an unobserved variable, such as student motivation, affected the likelihood of attending EDUCO negatively but student achievement positively), then equation (7) implies that the predicted score of a student drawn randomly from the population would be underestimated if we use sample mean scores. This can be easily verified by the relationship, $E(Y_i \mid D_i = 1) < X_i\beta + C_m\gamma + \alpha$ if $\sigma_{u\varepsilon} < 0$. Similarly for equation (8) in the case of traditional

[14] Assuming joint normality between u_i and ε_i, we have: $E(u_i \mid W_i\omega + \varepsilon_i > 0) = E(u_i \mid D_i^* > 0) = \sigma_{u\varepsilon}\lambda_{Di}$, where $\lambda_{Di} = \phi(W_i\omega)/\Phi(W_i\omega)$, the inverse Mills ratio. Similarly, $E(u_i \mid D_i^* < 0) = E(u_i \mid W_i\omega + \varepsilon_i < 0) \neq 0$, which we can rewrite as: $E(u_i \mid D_i^* < 0) = -\sigma_{u\varepsilon}\lambda_{Ti}$, where $\lambda_{Ti} = \phi(W_i\omega)/[1-\Phi(W_i\omega)]$.

[15] An alternative way to estimate program participation on unobservables is to use a maximum likelihood method without focusing on Mills ratios, although this is computationally more burdensome.

schools.

In a linear model, estimation and parameter identification are possible only if the vectors $[X, C_m]$ and W have elements that are not in common and are linearly independent. However, in the model above, even if $[X, C_m]$ and W are identical, the equation (9) is estimable. This is because the first-stage estimation results are entered as nonlinear function in the second-stage equation (9). The nonlinearity helps identify the model (see the discussion below on identification).

4.3 Data Description

4.3.1 Sampling and questionnaire design

The data were collected by MINED of El Salvador with the assistance of the World Bank and USAID in October 1996. The survey covered 162, out of the country's 262 municipalities. These municipalities share responsibility with the central government for the delivery of social services.

Since EDUCO was introduced only in 1991, it was not possible to give achievement tests in 1996 to those students who were about to finish primary education in EDUCO schools and to compare their scores with those in traditional schools. Instead, MINED decided to compare outcomes for third graders. The sampling scheme is designed so that the survey is nationally representative. Moreover, the sample was selected in such a way as to allow for four types of schools -- pure EDUCO, pure traditional, mixed, and private schools -- to be considered. In this study, we dropped students from private schools and traditional public urban schools from the sample since their students are not comparable with the EDUCO students. In "mixed" schools, there are both EDUCO sections run by ACE and traditional sections. Some EDUCO programs rented space from traditional schools, there are a small number of students who attend classes in "mixed" schools. They are students either in EDUCO or non-EDUCO classes located in traditional schools. Since by their administrative and management settings, "mixed" schools are different from "pure" EDUCO and traditional schools and thus unknown management and school-level cross-effects should be controlled, we could not include "mixed" school samples into "pure" school samples. Neither could we isolate them as a separate category because of the small sample size. To ensure the robustness of our results, we estimated all the results for "pure"

schools only.[16] This left us with 605 students in 30 pure EDUCO schools and 101 pure traditional rural schools, while five students were selected from all schools in the original survey.

The survey is composed of five questionnaires: student, parents, school director, teacher, and parents association questionnaires. The student level data contain information about the student's relationship with his or her guardian, school type, gender, and achievement test results. The parents' data file contains information on family background and living standards, such as parents' education level, household's living standard, and asset ownership. The parents' questionnaire also contains detailed socio-economic information on the student including age, schooling and health status. The school director questionnaire consists of school-level questions about the director, student enrollment, teachers' quality and quantity, school facilities and finances. The teacher data files contain teacher-specific information such as educational background, years of experience and salaries, as well as classroom-specific information such as the availability of school materials and the frequency of the community association's visits to the classroom. The community and parents' association questionnaire contains qualitative information on the way the association is organized and on the practices regarding their members' participation in school administration and management. The information was collected from ACEs in the case of decentralized EDUCO schools and from their traditional school counterpart organizations, the SdPF (*Sociedad de Padres de Familia*), in the case of traditional schools.

Table 4.1 lists average values for the variables used in the analysis. The columns of table 4.1 represent variable codes, means and standard deviations of variables for the entire sample, as well as for each school type; i.e., for EDUCO versus traditional school students.

4.3.2 Dependent Variables

The achievement tests were applied by MINED on October 1996 with the assistance of the Intercultural Center for Research in Education (El Salvador, MINED 1997). These were applied nationally in the 3rd, 4th and 6th grades, but because EDUCO students had reached only the 3rd grade at the time of the data collection, we use only the third-grade results in the analysis. Also, we focus only on the results for the mathematics and language tests; we do not use the results from the social studies, science, health and environment components.

The mathematics section is composed of 30 questions for ten key subjects, that is, three items for each subject. A student has achieved an objective if she/he got two questions right out

[16] However, the results with both "mixed" and "pure" samples, which are not reported here, are basically

of three questions. For the language test, there are 36 questions on nine objectives, that is, four items each. A student has achieved an objective if she/he got three questions right out of four questions. According to Table 4.1, for our sample, the average student was able to master 3.7 out of 10 subjects in math, but only 1.75 out of 9 in languages. These results are not out of line when compared to national averages (El Salvador, MINED 1997).

Of greater interest are the comparative average values for EDUCO and traditional schools. Students in EDUCO schools score marginally lower than their traditional school counterparts in both subjects, although the differences are not statistically significant (Table 4.1). The main issue addressed in this chapter is whether this similarity in learning achievement will persist when we hold constant for student and community characteristics, participation and school characteristics.

Besides test scores, we examine another dependent variable that comes from the parents' questionnaire. This is the response to the following question: "In the last 4 weeks, how many days did the child miss school?" As mentioned earlier, we interpret this variable to be an important intervening variable which eventually influences student outcomes. Since we hold constant for student illness, we believe the variable captures motivational factors discussed earlier. Our comparison of sample means themselves, however, indicates that, on average, EDUCO students missed 0.95 days out of the past four weeks, compared to the same average days for their traditional counterparts.

4.3.3 Explanatory variables

In the previous section, we discussed the set of variables we include in the production function analysis. The means of these variables show the following: Students are divided equally by gender. A fairly large portion of them live without parents, with a slightly higher proportion among EDUCO students. EDUCO students also have a slightly higher number of siblings and are slightly older, although the differences are not significant.

Parents of traditional school students have more education than those of EDUCO students. Fifty four percent of mothers or female guardians of traditional students have some basic education, compared to 50% for EDUCO students. The same is true of fathers. The education differences are reflected also in the asset indicators. Fewer EDUCO parents have access to home-ownership, electricity, sanitary services and running water. These all suggest that

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consistent with the results for "pure" schools only.

EDUCO students come from poorer background than traditional school students.

The socioeconomic characteristics of students are consistent with the pattern for school characteristics. While teacher-pupil ratios and the availability of sanitary facilities are similar in both types, fewer EDUCO schools have access to electricity or piped water. On the other hand, more EDUCO teachers have finished university education but are less experienced. The EDUCO teaching corps consists of relatively young recent graduates who receive a "bonus" for teaching in the program. There are no differences in access to textbooks in the two types of schools. A very large difference is that EDUCO parent associations visit classrooms more than once a week, which is almost 3-4 times more often than their traditional counterparts.

The overall picture then is of poor communities who have succeeded in mobilizing parents to be more involved despite their lower standard of living. What we now address is whether these differences persist when we hold constant for participation and student characteristics – how much of the differences, if any, are due to EDUCO? Before presenting the results for student achievement and student absenteeism, we first discuss how we identify our correction for program endogeneity.

4.3.4 Identification

As discussed earlier, we correct for possible program endogeneity by explicitly modeling the likelihood of participation in EDUCO and using that information to correct the production function. The main challenge with such corrections is to specify the identifying restriction that would allow us to estimate the model.

We include the percentages of EDUCO and traditional schools out of all primary schools available within each municipality to capture relative access cost of EDUCO and traditional schooling. These arguably affect the likelihood that a student is in an EDUCO program without affecting directly the education production functions at the student level. But to isolate general community effects on achievement from the cost-of-access effect, geographic variables also enter the achievement equation -- through municipal fixed effects in the educational output equation (2)). Although this means that the percentages of EDUCO program are linear combinations of these municipal dummies, we achieve identification because of the nonlinear functional form of the probit participation equation.

In order to test the robustness of our results and we also estimated specifications that do not rely exclusively on functional form for identification. We included, for example, in place of

the variable measuring the proportions of EDUCO schools in each municipality, the values of the specific variables that are used by the government to prioritize program placement among municipalities -- the presence of malnutrition in the municipality, the presence of overage students, repetition rates and net enrollment rates. The prioritization formula is exogenously determined by government and these variables can arguably be used as an identifying restriction when used as explanatory variables in the participation equation. They are not included in the achievement equations since, to the extent that local geographic conditions affect achievement, the municipal fixed-effects will already have captured their influences. Since the basic qualitative results in this chapter do not change (we discuss where they do in the next section), and to conserve space, we do not report these results in the chapter, although they are available upon request from the authors.

4.4 Empirical Results: Student Achievement

4.4.1 Overall EDUCO Effects

The first stage of the analysis is to estimate the determinants of EDUCO participation in order to correct for possible endogeneity. The most significant variables are mother's education, household assets and the geographical variables that capture the relative cost of schooling at EDUCO schools to that at traditional schools. As shown in table 4.2, education of mother, house ownership, and the availability of water are negatively correlated with EDUCO participation. Households who are better off have a higher likelihood of being in a traditional school. As expected, the availability of pure EDUCO schools within each municipality significantly increases the probability of enrolling in EDUCO schools.

The next question is whether a student in an EDUCO program (as captured by an EDUCO dummy variable) achieves different scores from students in traditional programs. Table 4.3 presents the regression results for an equation with math and language achievement as dependent variables and student and community (captured by municipality fixed effects) characteristics as explanatory variables. These estimation results include the participation correction as outlined in the earlier section. The negative coefficient of the Mills indicates that the error terms of the participation and achievement equations are negatively correlated (from equation (8)). This means there is negative participation into EDUCO schools -- EDUCO students have unobserved characteristics that are systematically negatively correlated with achievement test scores.

EDUCO's unconditional effect on language test results is positive and significant, while its effects on math performance is positive and not significant. EDUCO's effect on child learning is not any worse than that of traditional schools after correcting for participation. Language results may in fact be considerably better. The results are summarized in the first column of Table 4.5. We should note that our measure of the extent of the EDUCO advantage in language may be imprecise. The estimate of the EDUCO coefficient is sensitive to the specification of the participation equation – it becomes insignificant when we use in the first stage the municipal prioritization variables instead of the proportion of EDUCO in each municipality.[17]

Some of EDUCO's effects can be explained by observed differences in observed school input and community participation variables. In order to see by how much, we also estimated a model (Table 4.4) which includes school, classroom and community participation effects. The effect on the EDUCO coefficient is shown in the last two columns of Table 4.5. In that table, the EDUCO effect decreases with the addition of these additional independent variables, indicating that some of the score difference can be explained by school inputs and the degree of community involvement. The latter effect is captured by the coefficient on the number of parental association visits to classrooms which is consistently positive and significant for the basic model with EDUCO dummy variables. This suggests that a high intensity of community participation will be a crucial device to improve students' achievements in EDUCO schools. An additional classroom visit per week by a parental association could increase mathematics and language test scores by about 15% and 25%, respectively.[18] Teacher monitoring by parental associations might work to improve the quality of education, particularly in EDUCO schools.

We also tried to distinguish among cohort years by including dummy variables for when schools entered the EDUCO program -- prior to 1995, in 1995 or in 1996. Our hypothesis was that the EDUCO effect may be stronger for those schools which entered the program earlier as they have learned better how to operate the system. An alternative hypothesis of course is that more recent entrants would have better outcomes if there is a "Hawthorne" effect -- that schools that have more recently entered the program have staff and students who are motivated and ready to undertake more reforms; but that this enthusiasm may wane over time. As shown in Table 4.3 and 4, the coefficients for EDUCO are greater for more recent entrants in 1995 into the program and in fact show a significantly positive effect in 1995 for a half of specifications. This is

[17] However, the qualitative results described in the text are all maintained, including the decline in the coefficients as a result of including school input and participation variables. The results are available upon request from the authors.

[18] By estimating separate regressions, which is not reported in this chapter, we found that there are

consistent with the hypothesis of Hawthorne effects, but most of the coefficients are not statistically significant. Our conclusion from the OLS then is that the EDUCO program has not had a deleterious effect on student achievement, despite its rapid expansion.

4.4.2 Household Background

Female students do significantly worse than their male counterparts in math. In contrast, there are no differences across gender in language results. Parental education coefficients are not statistically significant. Perhaps this is because this is likely to be highly correlated with some of the asset variables. Those with greater assets or access to infrastructure tend to have better outcomes. For example, performance in mathematics increases by almost 15% of the mean achievement for those students who come from households where sanitation is available. It is not surprising that home ownership is not significant -- even poor rural households tend to own their own dwellings in El Salvador.

Children with more siblings perform worse in both math and language tests, although the coefficients are not statistically significant. This may indicate that parents devote less time to their individual needs. Older children do better in math than younger ones even though they are in the same grade. However, age does not matter in determining language scores.

The EDUCO effect can be mediated through school and classroom-level indicators and through the intensive involvement of parental group. To capture these effects, we enter school and classroom-level characteristics and a community participation variable in the equation and show the results in Table 4.3.[19] The EDUCO effect is lower than that in regressions without school-level variables, indicating that a significant portion of the difference between EDUCO and traditional schools can be captured by observable school characteristics and/or difference in community involvement. The EDUCO coefficient, however, is still statistically insignificant. The basic results for the effects of socioeconomic characteristics do not change.

Most of the school-level variables are insignificantly different from zero. The two exceptions are teacher's base salary, which has negative coefficient, and the availability of classroom library (for language score), which is positively related to achievement scores. EDUCO teachers receive a piece wage rate which is determined by ACEs, while traditional schools employ a

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significant EDUCO interaction effects of the participation variable as well.

[19] We enter them linearly but also interactively with the EDUCO dummy -- EDUCO may change the character of school provision. To conserve space, we do not show the regressions with the interaction terms; they are available from the authors.

fixed teacher wage scheme (World Bank 1995). The former results on teacher salary might capture the inefficiency of teacher wage scheme in traditional schools. The latter classroom library effect on language score also is supported by the past evaluation of EDUCO program (World Bank 1995, pp.19-20). There may be the positive impact of classroom libraries in completing teacher strategies and in stimulating student interests and reading habits which affect language score significantly.

Most notably, the community participation variable has a positive and statistically significant coefficient consistently for the basic specification with the EDUCO dummy variable (Table 4.4). This finding indicates that the intensity of community involvement has significantly related with students' academic achievements. There might be a positive peer effect and/or teacher monitoring force of community participation.[20]

4.5 Empirical Results: Student Absence

As mentioned earlier, parents' negative perceptions toward education and teacher absenteeism are important issues, and not only in El Salvador. Uneducated parents usually underestimate the value of child education and thus do not send children to schools in many rural areas. The reasons can be varied over cultural, social, and economic aspects. The main problem, however, seems to be the wrong incentive scheme or poor information structure imposed on parents. Teacher absenteeism also is a chronic problem in the public schools of many developing countries. While the excuse is sometimes legitimate, such as sickness, it is more often due to simple dereliction of duty. When these teachers are absent, classes are usually canceled since there is often no tradition of using substitute teachers. Our hypothesis is that in a decentralized setting, parents are better able and motivated to send children and to monitor teacher behavior. In fact, EDUCO parents and association have been contributed to schools by sending students to schools and teacher absenteeism is less prevalent in EDUCO schools (World Bank, El Salvador Evaluation Team 1997). Children would be sent by parents most of time and teachers would miss fewer days in EDUCO schools, which in turn implies, fewer days missed by the students consequently.

The dependent variable in the regression of Table 4.6 is the "number of school days missed by the child" in the past month. To control for student absence due to health problems, we added an additional indicator variable which takes on a value of one if a child had respiratory or

[20] Reimers (1997) describes community associations as being composed of literate members of the community who are given basic training in school management. These associations meet periodially with teachers and also are identified as a source of materials.

flu in the last two weeks and zero otherwise. The principal result is that the EDUCO dummy variable coefficients are consistently negative and statistically significant especially if we control for participation bias. A student in an EDUCO program is less likely to miss school days even after we hold constant for household, school, and participation characteristics.[21]

An important finding is that mother's education has a negative and statistically significant coefficient in all specifications, indicating that an educated mother will decrease child absence from school approximately by 70%. This implies that the mother's positive perception toward education due to her own educational experiences might contribute to better child school attendance.

Table 4.6 also differentiates the EDUCO dummy variables by year. This is the "vintage" effect. The EDUCO dummy variable for 1991-94 is insignificant -- a student in third grade in EDUCO schools during those years is just as likely as a traditional public school student to miss school. However, the EDUCO coefficients are negative and significant for schools that entered the program in 1996 with participation correction (Table 4.6). Curiously, the EDUCO effect is stronger for the schools of a more recent vintage, which is consistent with the "Hawthorne effects" described earlier. This implies that, while more experience in EDUCO might lead schools to perform better, the negative effects from overtime decay of staff and students' early enthusiasm could dominate the overall performance.

The coefficient of the participation correction term is positive although not significant, according to Table 4.6. This means that there is a positive participation into EDUCO with respect to student absences; that is, unobserved characteristics of EDUCO students make them more likely to miss school.

[21] Indeed, teacher's days of absence are larger for traditional school (1.4 days per month) than for EUDOC schools (1.16 days per month). This evidence implies that parent association monitoring works. Chapter 5 extensively investigates the transmission mechanism from community participation to educational output improvements in EDUCO schools by estimating teacher compensation and effort functions, and input demand functions. We should note that this finding contrasts with that of an earlier study by Reimers (199x) which conducted interviews of 140 schools in 1993. That study was done on a earlier vintage than the schools in this study and did not correct for other variables that may affect outcomes.

4.6 Conclusions

El Salvador's EDUCO program has been remarkably successful in expanding educational opportunities for the poor in rural areas. Decentralization has also been instrumental in getting families and communities more involved in their children's schooling. But has the program delivered more? This chapter has addressed its contributions in terms of better educational outcomes by raising achievement scores and lowering student absence.

The average scores in standardized mathematics and language of EDUCO students are lower than those of their rural traditional school counterparts. This is not surprising since EDUCO students come from distinctly disadvantaged backgrounds. What is interesting is that, after we hold constant for that background and take into account possible participation bias in the samples, these differences all but disappear. In fact, the average performance of EDUCO students in language tests are slightly better than that of traditional students (Table 4.5). The similarity in outcomes holds regardless of how long a school has been in the EDUCO program, although more recent joiners do show an advantage that is not necessarily statistically significant different from zero.

There is considerable variance in performance even after holding constant for type of school. The most important socioeconomic background determinants that had a positive effect on student achievement were being male, coming from a family with access to sanitary service, being an older third grade student, and having fewer siblings. At the school level, the availability of classroom library had a positive effect on achievement. Most importantly, with respect to achievement test scores, coefficients of the parental participation variable are positive and statistically significant in the two specifications with the EDUCO dummy (Table 4.4). Test results are significantly positively related to the number of visits by ACEs or their equivalent.

The number of days missed is due to intangible EDUCO effects. In a decentralized setting, parents will be better motivated to send children to schools and able to monitor teacher behavior as well. We find support for this since parents' education, especially mother's education, has a positive impact on student's days of attendance. Moreover, teachers tend to miss fewer days due to peer monitoring by parental associations, which, in turn, implies fewer days missed by the students.

We conclude that the rapid expansion of rural education through EDUCO's decentralized mechanism did not hurt achievement levels in El Salvador compared to the performance in traditional settings, even in the neediest parts of the country. In fact, they have even helped language scores. The important transmission mechanisms is likely to be the monitoring system of community involvement set by the EDUCO program. Moreover, greater parental involvement in

children's education may inspire children to attend school and put pressure on providers to deliver observable inputs. Indeed, our results indicate that the EDUCO program significantly lowers the number of days missed by students. These results imply that although teachers, parents and parents' associations were not given direct incentives to raise standardized test scores in mathematics and languages, the EDUCO program has an overall positive impact not only in the short-run but also in the long-run. Our results support the notion that parents' participation in school-based management is an appropriate strategy to provide poor communities with better education.

Table 4.1
Definition, mean, and standard deviation of variables by school type

Variable definitions	Code	All schools	EDUCO	traditional
Output variables				
Achievement test score, math (number of subjects taken)	ma3mas	3.70 (2.54)	3.59 (2.77)	3.73 (2.47)
Achievement test score, language (number of subjects taken)	le3mas	1.75 (1.71)	1.73 (1.85)	1.76 (1.67)
Days of child absence from school in the last four weeks	attend	0.95 (0.10)	0.95 (0.11)	0.95 (0.10)
Child and Household Variables				
Gender (female=1)	a_d_1d	0.51	0.51	0.51
Child's age	childage	10.58 (1.76)	11.01 (1.97)	10.44 (1.66)
Live without parent(s)=1	a_c_1d2	0.14	0.16	0.13
Child had respiratory/flu in the last two weeks=1	pa_f152d	0.60	0.63	0.59
Number of siblings (age of 4-15)	pa_b3	2.01 (1.54)	2.11 (1.50)	1.98 (1.56)
Mother enter basic education=1	edl_m	0.53	0.50	0.54
Mother's education missing=1	ed_mm	0.08	0.06	0.09
Father enter basic education=1	edl_p	0.39	0.38	0.40
Father's education missing=1	ed_pm	0.04	0.03	0.04
Own house=1	pa_e1d	0.72	0.68	0.73
Electricity available=1	pa_e81d	0.58	0.28	0.67
Sanitary service available=1	pa_e82d	0.18	0.06	0.22
Water available=1	pa_e85d	0.06	0.01	0.08
School Variables				
Teaher-pupil ratio (school level)	d_p_all	0.04 (.056)	0.05 (.09)	0.03 (.041)
If sanitation/latrine available at shool=1	d_d11d	0.93	0.89	0.94
If electricity available at school=1	d_d12d	0.68	0.30	0.80
If piped water available at school=1	d_d21d	0.32	0.12	0.38
Teacher and Classroom Variables				
=1 if teacher finish University education	predu_un	0.46	0.75	0.37
years of teacher experience	pr_year	7.83 (6.44)	4.37 (2.71)	8.89 (6.87)
Monthly base salary of teacher	pr_c2	3035.21 (523.38)	2919.23 (269.40)	3070.71 (574.84)
If teacher receive bonus=1	pr_bonu	0.64	0.74	0.61
If all students have math textbook=1	pr_math	0.61	0.58	0.62
If math textbook information missing=1	math_m	0.11	0.25	0.07
If all students have language textbook=1	pr_lang	0.59	0.59	0.59
If language textbook information missing=1	lang_m	0.12	0.28	0.07
If teacher teaches in multigrade classroom=1	pr_d15d	0.24	0.39	0.20
If multigrade information missing=1	pr_d15m	0.01	0.04	0.00
# of books in classroom library	books	74.32 (197.59)	114.63 (272.84)	61.98 (166.42)
=1 if classroom library information missing	book_m	0.47	0.24	0.54

Note: Standard errors in parentheses. Variable=1 indicates that the variable is binary variable.
* Number of observations is N-1 due to a missing observation

Table 4.1 (continued)
Definition, mean, and standard deviation of variables by school type

Variable definitions	Code	All schools	EDUCO	traditional
Community Paricipation Variable				
# of ACE/SpDF's visits to classroom in the last month	pr_d11	2.52 (4.82)	5.65 (6.59)	1.56 (3.63)
Regional School Distribution				
Fraction of pure EDUCO schools to all primary schools within municipality	feduco	0.21 (0.34)	0.75 (.29)	0.04 (0.11)
Fraction of pure traditional schools to all primary schools within municipality	ftrad	0.69 (0.37)	0.15 (0.28)	0.86 (.20)
Participation Correction				
Inversed Mills Ratio	i_mills	0.00 (0.33)	0.24 (0.47)	0.07 (0.22)
Number of Observations	N	605	142	463

Note: Standard errors in parentheses
* Number of observations is N-1 due to a missing observation

Table 4.2
Probit analysis:
Dependent variable - school choice: EDUCO (=1), Traditional (=0)

Variables	Code	Coef. (z-stat)
Child and Household Variables		
Gender (female=1)	a_d_1d	-0.14 (0.54)
Child's age	childage	0.11 (1.39)
Live without parent(s)=1	a_c_1d2	0.05 (0.12)
Child had respiratory/flu in the last two weeks=1	pa_f152d	-0.47 (1.72)*
Number of siblings (age of 4-15)	pa_b3	0.04 (0.43)
Mother enter basic education=1	edl_m	-0.54 (1.75)*
Mother's education missing=1	ed_mm	-1.29 (2.07)**
Father enter basic education=1	edl_p	-0.37 (1.18)
Father's education missing=1	ed_pm	-0.48 (0.63)
Own house=1	pa_e1d	-0.59 (2.08)**
Electricity available=1	pa_e81d	-0.17 (0.61)
Sanitary service available=1	pa_e82d	0.19 (0.46)
Water available=1	pa_e85d	-3.00 (1.88)*
Regional School Distribution (Cost variables)		
Fraction of pure EDUCO schools to all primary schools within municipality	feduco	5.96 (7.14)***
Fraction of pure traditional schools to all primary schools within municipality	ftrad	-1.66 (2.63)***
Constant	_cons	-1.19 (1.11)
Number of observations	N	605
Log Likelihood	ln L	-62.42
Pseudo R-squared		0.81

Note: The symbols *, **, and *** indicate statistical significance at 10%, 5%, and 1% levels, respectively

Table 4.3 Municipality Fixed Effects Regression without School Inputs and Participation Dependent Variable: Mathematics or Language Tests

Tests		Math		Lang	
Variables	code	Coef. (t-stat)	Coef. (t-stat)	Coef. (t-stat)	Coef. (t-stat)
=1 if EDUCO; =0 otherwise	e_w	0.45 (0.33)		2.17 (2.32)**	
=1 if EDUCO built in 91-94; =0 otherwise	ed91_94		0.74 (0.46)		2.16 (1.91)*
=1 if EDUCO built in 95; =0 otherwise	ed95		1.68 (1.05)		2.91 (2.62)***
=1 if EDUCO built in 96; =0 otherwise	ed96		-0.37 (0.26)		1.73 (1.72)*
=1 if year missing; =0 otherwise	ed_miss		-0.64 (0.35)		2.27 (1.77)*
Child and Household Variables					
Gender (female=1)	a_d_1d	-0.69 (3.19)***	-0.69 (3.18)***	0.01 (0.08)	0.02 (0.12)
Child's age	childage	0.19 (2.91)***	0.19 (2.88)***	0.04 (0.80)	0.04 (0.80)
Live without parent(s)=1	a_c_1d2	0.38 (1.04)	0.35 (0.97)	0.43 (1.73)	0.42 (1.68)
Child had respiratory/flu in the last two weeks=1	pa_f152d	0.33 (1.42)	0.32 (1.39)	0.16 (0.98)	0.14 (0.90)
Number of siblings (age of 4-15)	pa_b3	-0.05 (0.65)	-0.05 (0.65)	-0.02 (0.40)	-0.02 (0.37)
Mother enter basic education=1	edl_m	-0.09 (0.35)	-0.05 (0.20)	0.06 (0.32)	0.07 (0.39)
Mother's education missing=1	ed_mm	-0.06 (0.13)	-0.06 (0.14)	0.33 (1.11)	0.30 (1.01)
Father enter basic education=1	edl_p	-0.05 (0.19)	-0.04 (0.16)	0.19 (1.16)	0.20 (1.21)
Father's education missing=1	ed_pm	0.54 (0.91)	0.43 (0.72)	-0.46 (1.10)	-0.49 (1.19)
Own house=1	pa_e1d	-0.14 (0.53)	-0.17 (0.65)	0.13 (0.72)	0.13 (0.70)
Electricity available=1	pa_e81d	0.07 (0.24)	0.06 (0.21)	0.01 (0.03)	0.006 (0.03)
Sanitary service available=1	pa_e82d	0.55 (1.76)*	0.49 (1.56)	0.25 (1.13)	0.22 (0.99)
Water available=1	pa_e85d	-0.31 (0.61)	-0.25 (0.50)	-0.35 (1.01)	-0.32 (0.91)
Inverse Mills Ratio	i_mills	-0.46 (0.56)	-0.27 (0.33)	-1.16 (2.03)**	-1.05 (1.80)*
Constant	_cons	1.82 (2.17)**	1.85 (2.18)**	0.51 (0.88)	0.50 (0.84)
Number of Observations	N	605	605	605	605
Number of municipalities	M	90	90	90	90
Overall R-squared	R^2	0.0242	0.0126	0.0002	0.0001

Note: The symbols *, **, and *** indicate statistical significance at 10%, 5%, and 1% levels, respectively

Table 4.4
Municipality Fixed Effects Regression with School Inputs and Participation
Dependent Variable: Mathematics or Language Tests

Tests		Math				Lang			
Variables	**code**	**Coef. (t-stat)**	**Coef. (t-stat)**	**Coef. (t-stat)**	**Coef. (t-stat)**	**Coef. (t-stat)**	**Coef. (t-stat)**	**Coef. (t-stat)**	**Coef. (t-stat)**
=1 if EDUCO; =0 otherwise	e_w	0.40 (0.27)	-0.77 (0.47)			1.57 (1.51)	0.74 (0.65)		
=1 if EDUCO built in 91-94; =0 otherwise	ed91_94			-1.93 (0.97)	-1.87 (0.94)			0.82 (0.59)	0.83 (0.60)
=1 if EDUCO built in 95; =0 otherwise	ed95			3.21 (1.75)*	5.50 (1.59)			3.26 (2.55)	3.85 (1.59)
=1 if EDUCO built in 96; =0 otherwise	ed96			-0.49 (0.28)	-0.11 (0.06)			0.43 (0.35)	0.53 (0.42)
=1 if year missing; =0 otherwise	ed_miss			-4.41 (1.49)	-4.82 (1.60)			0.45 (0.22)	0.34 (0.16)
Child and Household Variables									
Gender (female=1)	a_d_1d	-0.57 (2.61)***	-0.53 (2.40) **	-0.51 (2.31)**	-0.51 (2.33)**	0.07 (0.47)	0.10 (0.67)	0.11 (0.69)	0.10 (0.68)
Child's age	childage	0.17 (2.57)**	0.17 (2.62)***	0.18 (2.66)***	0.18 (2.65)***	0.02 (0.45)	0.02 (0.50)	0.02 (0.52)	0.02 (0.52)
Live without parent(s)=1	a_c_1d2	0.42 (1.17)	0.42 (1.17)	0.40 (1.11)	0.39 (1.08)	0.46 (1.85)*	0.46 (1.85)*	0.44 (1.73)*	0.43 (1.72)*
Child had respiratory/flu in the last two weeks=1	pa_f152d	0.23 (1.01)	0.22 (0.94)	0.20 (0.88)	0.20 (0.86)	0.09 (0.56)	0.08 (0.48)	0.06 (0.39)	0.06 (0.38)
Number of siblings (age of 4-15)	pa_b3	-0.04 (0.57)	-0.03 (0.38)	-0.02 (0.29)	-0.02 (0.33)	-0.02 (0.34)	-0.01 (0.14)	-0.01 (0.16)	-0.01 (0.17)
Mother enter basic education=1	edl_m	-0.02 (0.09)	-0.02 (0.09)	-0.02 (0.07)	-0.02 (0.06)	0.07 (0.43)	0.08 (0.43)	0.08 (0.46)	0.08 (0.47)
Mother's education missing=1	ed_mm	-0.14 (0.32)	-0.12 (0.28)	-0.07 (0.15)	-0.07 (0.16)	0.34 (1.09)	0.35 (1.13)	0.33 (1.06)	0.33 (1.05)
Father enter basic education=1	edl_p	-0.07 (0.31)	-0.07 (0.30)	-0.06 (0.25)	-0.05 (0.23)	0.15 (0.90)	0.15 (0.92)	0.16 (0.96)	0.16 (0.97)
Father's education missing=1	ed_pm	0.57 (0.94)	0.55 (0.92)	0.54 (0.89)	0.53 (0.89)	-0.37 (0.89)	-0.38 (0.92)	-0.42 (1.00)	-0.42 (1.00)
Own house=1	pa_e1d	-0.19 (0.74)	-0.21 (0.80)	-0.23 (0.89)	-0.23 (0.88)	0.05 (0.26)	0.04 (0.19)	0.04 (0.21)	0.04 (0.21)
Electricity available=1	pa_e81d	-0.02 (0.07)	-0.06 (0.18)	-0.15 (0.50)	-0.18 (0.57)	-0.01 (0.03)	-0.03 (0.15)	-0.06 (0.28)	-0.07 (0.31)
Sanitary service available=1	pa_e82d	0.59 (1.84)*	0.54 (1.68)*	0.55 (1.73)*	0.57 (1.78)*	0.28 (1.25)	0.24 (1.09)	0.24 (1.05)	0.24 (1.07)
Water available=1	pa_e85d	-0.26 (0.50)	-0.24 (0.47)	-0.24 (0.48)	-0.24 (0.47)	-0.39 (1.10)	-0.38 (1.07)	-0.36 (1.01)	-0.36 (1.01)
School Variables									
Teaher-pupil ratio (school level)	d_p_all	-27.39 (1.16)	-19.66 (0.82)	-28.18 (1.17)	-33.42 (1.33)	5.77 (0.35)	11.30 (0.68)	9.84 (0.59)	8.50 (0.49)
If sanitation/latrine available at shool=1	d_d11d	0.42 (0.52)	0.38 (0.47)	0.32 (0.39)	0.35 (0.42)	0.18 (0.31)	0.15 (0.26)	0.24 (0.42)	0.25 (0.43)
If electricity available at school=1	d_d12d	0.16 (0.30)	0.34 (0.60)	0.95 (1.48)	1.09 (1.64)*	0.27 (0.69)	0.39 (1.00)	0.57 (1.27)	0.60 (1.30)
If piped water available at school=1	d_d21d	-0.19 (0.37)	-0.22 (0.43)	-0.13 (0.24)	-0.09 (0.18)	-0.21 (0.58)	-0.23 (0.64)	-0.19 (0.50)	-0.18 (0.47)

Note: The symbols *, **, and *** indicate statistical significance at 10%, 5%, and 1% levels, respectively

Table 4.4 (continued)
Municipality Fixed Effects Regression
with School Inputs and with Participation
Dependent Variable: Mathematics or Language Tests

Tests		Math				Lang			
Teacher and Classroom Variables									
=1 if teacher finish University education	predu_un	-0.57	-0.80	-0.66	-0.48	-0.15	-0.31	-0.06	-0.02
		(1.33)	(1.79)*	(1.29)	(0.87)	(0.50)	(1.00)	(0.17)	(0.04)
years of teacher experience	pr_year	0.06	0.05	0.05	0.05	0.03	0.02	0.03	0.03
		(1.35)	(1.16)	(1.15)	(1.27)	(1.07)	(0.87)	(1.08)	(1.11)
Monthly base salary of teacher (in thousand colones)	pr_c2	-0.78	-0.72	-0.81	-0.87	-0.53	-0.49	-0.58	-0.59
		(1.71)*	(1.56)	(1.70)*	(1.80)*	(1.67)*	(1.52)	(1.75)*	(1.77)*
If teacher receive bonus=1	pr_bonu	0.53	0.51	0.53	0.55	0.49	0.48	0.46	0.47
		(1.16)	(1.12)	(1.09)	(1.13)	(1.54)	(1.51)	(1.36)	(1.37)
If all students have math textbook=1	pr_math	0.68	0.73	0.44	0.35	0.05	0.09	0.01	-0.01
		(1.01)	(1.08)	(0.63)	(0.49)	(0.11)	(0.18)	(0.03)	(0.02)
If math textbook information missing=1	math_m	2.29	1.90	-5.89	-8.42	0.40	0.13	-2.54	-3.19
		(1.27)	(1.05)	(1.48)	(1.64)*	(0.32)	(0.10)	(0.92)	(0.89)
If all students have language textbook=1	pr_lang	-0.75	-0.76	-0.95	-1.02	-0.16	-0.16	-0.25	-0.27
		(1.14)	(1.16)	(1.42)	(1.52)	(0.34)	(0.36)	(0.55)	(0.58)
If language textbook information missing=1	lang_m	-0.87	-0.54	7.82	10.65	0.28	0.52	3.55	4.27
		(0.47)	(0.29)	(1.90)*	(1.94)*	(0.22)	(0.40)	(1.24)	(1.12)
If teacher teaches in multigrade classroom=1	pr_d15d	0.75	0.93	0.68	0.55	0.49	0.62	0.53	0.50
		(1.30)	(1.58)	(1.12)	(0.88)	(1.23)	(1.51)	(1.25)	(1.14)
If multigrade information missing=1	pr_d15m	-0.01	-0.75	0.40	1.33	1.72	1.19	2.52	2.75
		(0.00)	(0.33)	(0.16)	(0.48)	(1.10)	(0.75)	(1.45)	(1.43)
# of books in classroom library (in thousands books)	books	0.91	0.90	0.70	0.63	1.54	1.53	1.47	1.45
		(0.89)	(0.87)	(0.68)	(0.61)	(2.14)**	(2.13)**	(2.05)**	(2.01)**
=1 if classroom library information missing	book_m	0.40	0.36	0.40	0.45	0.30	0.27	0.40	0.42
		(0.73)	(0.67)	(0.69)	(0.76)	(0.79)	(0.73)	(0.99)	(1.01)
Community Paricipation Variable									
# of ACE/SpDF's visits to classroom	pr_d11		0.14		-0.11		0.10		-0.03
			(1.72)*		(0.78)		(1.77)*		(0.29)
Inverse Mills Ratio	i_mills	-0.58	-0.20	-0.05	-0.12	-1.09	-0.82	-0.73	-0.75
		(0.68)	(0.22)	(0.06)	(0.13)	(1.84)*	(1.34)	(1.20)	(1.22)
Constant	_cons	3.97	3.45	4.13	4.47	1.12	0.74	0.83	0.92
		(1.71)*	(1.47)	(1.75)*	(1.87)*	(0.69)	(0.45)	(0.51)	(0.55)
Number of Observations	N	605	605	605	605	605	605	605	605
Number of municipalities	M	90	90	90	90	90	90	90	90
Overall R-squared	R^2	0.0153	0.0129	0.0173	0.0175	0.0186	0.0010	0.0108	0.0077

Note: The symbols *, **, and *** indicate statistical significance at 10%, 5%, and 1% levels, respectively

Table 4.5 Summary of EDUCO effect $\hat{\alpha}$

	Without School Inputs and Community Participation Variables	With School Inputs but Without Community Participation Variables	With School Inputs and Community Participation Variables
Mathematics	0.45 (0.33)	0.40 (0.27)	-0.77 (0.47)
Language	2.17 (2.32)**	1.57 (1.51)	0.74 (0.65)

Note: *t*-statistics in parentheses. The symbol, **, indicates statistical significance at 5% level
Source: Table 4.3 and 4.4.

Table 4.6
Municipality Fixed Effects Regression
Dependent Variable: Days of Child Absence from School in the Last Four Weeks

Variables	code	Coef. t	Coef. T	Coef. t	Coef. T
=1 if EDUCO; =0 otherwise	e_w	-3.01 (1.79)*		-3.93 (1.91)*	
=1 if EDUCO built in 91-94; =0 otherwise	ed91_94		-3.11 (1.53)		-3.55 (1.41)
=1 if EDUCO built in 95; =0 otherwise	ed95		-2.64 (1.32)		-0.93 (0.21)
=1 if EDUCO built in 96; =0 otherwise	ed96		-3.20 (1.76)*		-4.23 (1.84)*
=1 if year missing; =0 otherwise	ed_miss		-3.89 (1.69)*		-5.89 (1.55)
Child and Household Variables					
Gender (female=1)	a_d_1d	-0.08 (0.29)	-0.08 (0.30)	-0.03 (0.10)	-0.03 (0.13)
Child's age	childage	0.17 (2.10)**	0.17 (2.07)**	0.16 (1.98)**	0.17 (2.04)**
Live without parent(s)=1	a_c_1d2	-0.12 (0.27)	-0.12 (0.28)	-0.16 (0.36)	-0.21 (0.46)
Child had respiratory/flu in the last two weeks=1	pa_f152d	-0.29 (1.02)	-0.29 (1.02)	-0.26 (0.89)	-0.26 (0.90)
Number of siblings (age of 4-15)	pa_b3	-0.11 (1.23)	-0.11 (1.23)	-0.08 (0.86)	-0.08 (0.86)
Mother enter basic education=1	edl_m	-0.70 (2.24)**	-0.68 (2.17)**	-0.67 (2.13)**	-0.66 (2.09)**
Mother's education missing=1	ed_mm	-0.23 (0.44)	-0.22 (0.40)	0.13 (0.23)	0.16 (0.28)
Father enter basic education=1	edl_p	0.41 (1.38)	0.41 (1.38)	0.36 (1.21)	0.35 (1.18)
Father's education missing=1	ed_pm	-0.58 (0.79)	-0.61 (0.81)	-0.68 (0.91)	-0.75 (0.99)
Own house=1	pa_e1d	-0.17 (0.53)	-0.20 (0.60)	-0.24 (0.74)	-0.26 (0.79)
Electricity available=1	pa_e81d	-0.39 (1.07)	-0.39 (1.08)	-0.75 (1.93)*	-0.79 (2.02)**
Sanitary service available=1	pa_e82d	-0.20 (0.52)	-0.22 (0.56)	-0.29 (0.71)	-0.29 (0.72)
Water available=1	pa_e85d	-0.58 (0.93)	-0.57 (0.90)	-0.68 (1.06)	-0.68 (1.06)
School Variables					
Teaher-pupil ratio (school level)	d_p_all			27.18 (0.90)	23.95 (0.76)
If sanitation/latrine available at shool=1	d_d11d			-1.87 (1.84)**	-1.79 (1.73)*
If electricity available at school=1	d_d12d			1.38 (1.95)**	1.73 (2.06)**
If piped water available at school=1	d_d21d			0.09 (0.13)	0.25 (0.37)

Note: The symbols *, **, and *** indicate statistical significance at 10%, 5%, and 1% levels, respectively

Table 4.6 (continued)
Municipality Fixed Effects Regression
Dependent Variable: Days of Child Absence from School in the Last Four Weeks

Variables	code	Coef. t	Coef. T	Coef. t	Coef. T
Teacher and Classroom Variables					
=1 if teacher finish University education	predu_un			0.63	1.03
				(1.13)	(1.48)
years of teacher experience	pr_year			0.001	0.004
				(0.03)	(0.08)
Monthly base salary of teacher (in thousands colones)	pr_c2			1.08	0.90
				(1.88)*	(1.47)
If teacher receive bonus=1	pr_bonu			-0.17	-0.29
				(0.29)	(0.48)
If all students have math textbook=1	pr_math			1.31	1.09
				(1.54)	(1.23)
If math textbook information missing=1	math_m			1.50	-3.55
				(0.66)	(0.55)
If all students have language textbook=1	pr_lang			-0.73	-0.82
				(0.88)	(0.96)
If language textbook information missing=1	lang_m			-0.23	5.21
				(0.10)	(0.76)
If teacher teaches in multigrade classroom=1	pr_d15d			0.88	0.60
				(1.19)	(0.76)
If multigrade information missing=1	pr_d15m			-2.93	-0.98
				(1.02)	(0.28)
# of books in classroom library (in thousands books)	books			-0.24	-0.30
				(0.19)	(0.23)
=1 if classroom library information missing	book_m			-0.50	-0.26
				(0.74)	(0.35)
Community Paricipation Variable					
# of ACE/SpDF's visits to classroom	pr_d11			0.07	-0.05
				(0.74)	(0.26)
Inverse Mills Ratio	i_mills	0.96	1.02	1.48	1.59
		(0.93)	(0.98)	(1.34)	(1.43)
Constant	_cons	1.62	1.68	-2.30	-1.89
		(1.55(	(1.59)	(0.78)	(0.63)
Number of Observations	N	605	605	605	605
Number of municipalities	M	90	90	90	90
Overall R-squared	R^2	0.0022	0.0024	0.0067	0.0074

Note: The symbols *, **, and *** indicate statistical significance at 10%, 5%, and 1% levels, respectively

Chapter 5

Community Participation, Teacher Effort, and Educational Outcome: The Case of El Salvador's EDUCO Program

5.1 Introduction

Recently, social sector amelioration has become the focal point of micro-level policy reforms in developing countries. Since social services such as education, nutrition and health are directly related to improvement of households' welfare, economists and other social scientists have investigated the conditions that are necessary to enhance local public action to improve the well-being of the poor. Examples of intra-community cooperation include issues of forming irrigation and water user associations, providing communal health facilities, and enhancing community involvement in schools. The central question of social sector reform, therefore, is how rural communities in developing countries form associations to overcome weak formal institutions such as the lack of enforcement mechanism for formal contracts and various information problems.

Individuals in a community, however, are diversified with respect to their ability to cooperate in formation of community groups, local social service provision, and monitoring public agencies and officials. As a result, traditionally, the resource allocation process in developing countries' social sectors has been characterized by a highly centralized structure. In a education system, which is our focus, school administrators, teachers, students and parents traditionally play only a limited role in determining school resource allocation. Since monitoring, inspecting and enforcing detailed guidelines for individual schools are likely to be very costly, an education ministry sets rules, such as for the distributions of budgetary allocations between teachers' salaries and other inputs. Teachers are usually government employees and subject to highly regulated and hierarchical management systems. Teacher salaries are often fixed or negotiated centrally. If the rules set by the government do not match the school's needs or the community's preferences, the use of resources becomes inefficient. Moreover, school administrators might become accountable not to parents and students but to central authorities, and thus a centralized system will lead to low school productivity. The widespread observations of failures of centrally planned education systems, especially in developing countries, indicate

that community specific factors and conditions should be considered properly for effective provision of social sector resources [World Bank (1996a)].

With this regard, "community participation" has recently become a key concept in local-level decision making process in the arguments on the social sector reforms. The stress on the process and mechanism design of participation is a natural outgrowth of agency problems. In the context of developing countries, the policy makers and researchers began to recognize the significance of potential discrepancies between the actions taken by an agent and the interests of those that the agent is supposed to serve [Stiglitz (1999)]. Recent research provides evidence that participation is necessary for an effective development of a community. Isham, Narayan, and Printchett (1995), for example, have shown that increasing beneficiary participation directly causes better project outcomes, by using data from 121 diverse rural water projects. Participation not only brings to the project relevant information that outside development agencies are not likely to have, but also brings with it commitment. In turn, commitment brings with it greater effort of agents that is a necessary condition of a successful project [Stiglitz (1995)]. Local participation in project implementation ensures that projects and policies match with the local context. Educational quality, for example, can be improved when schools are able to implement resource allocation according to local conditions and are accountable to parents and communities through community participation [World Bank (1995)]. In the context of developing countries, three examples of empirical investigations are James, King and Suryadi (1996) for Indonesia, Jimenez and Paqueo (1996) for the Philippines, and Glewwe (1997) for the Philippines. The first two studies conclude that there are efficiency gains from community-based involvement. Glewwe (1997) examined the influence of peer group effects in education and found that the distribution of peer group characteristics across each student's peers matters. However, in spite of the powerful reasoning, there is relatively little empirical evidence except the above mentioned studies to document the merits of community-management in education, especially in the context of developing countries. The main reason of the lack in empirical studies is that these administrative arrangements have only recently begun to be implemented in developing countries [World Bank (1996a)].

This chapter investigates the role of community participation in the area of primary education reform through a new case study from El Salvador. We study a recent successful example of El Salvador's Community-Managed Schools Program (more popularly known by the acronym, EDUCO, or *Educacion con Participacion de la Comunidad*). The EDUCO program is an innovative program for both pre-primary and primary education to decentralize education by

strengthening direct involvement and participation of parents and community groups [See, for example, Jimenez and Sawada (1998)]. In terms of both theoretical and empirical analyses, we will investigate the incentive and organizational structures that make the EDUCO program overcome the inefficiency that is widely observed in the centralized education systems.

In El Salvador, community education has endogenously emerged in the 1980s during the civil war. At that time, public schools could not be extended because of warfare around the country. Some communities, therefore, took the initiative to organize their own schools, administered and financially supported by an association of households. In 1991, El Salvador's Ministry of Education (MINED) institutionalized these community schools as the EDUCO schools and also decided to use the prototype as the principal method of expanding education in rural areas. In EDUCO schools, the Community Education Association (*Asociacion Comunal para la Educacion* or ACE) elected from the parents of the students has a central role of school administration and management: ACE is responsible for allocation of school budgets and for hiring and dismissing teachers by monitoring teacher's performance. The partnership between MINED and ACEs is expected to improve school administration and management by reflecting local demand needs more appropriately. On the other hand, the parents' associations (*Sociedad de Padres de Familia* or SdPF) in traditional schools have limited roles: SdPF has no administrative capability over school personnel nor budget.

Initially, MINED imposed three purposes of the EDUCO program: first, augmentation of educational supply in the poorest rural communities; second, promotion of the participation of local community members in education; third, improvement of the quality of pre-primary and primary schooling. The initial evidence indicates that the EDUCO program has accomplished these objectives successfully [El Salvador, MINED (1995)]. MINED also expects that moving away from traditional programs that provide education centrally could improve outcomes through increased community and parent involvement. In fact, all traditional primary schools will be finally transformed into EDUCO schools by the year of 2000.

5.1.1 Outline of the Chapter

This chapter investigates the organizational structure and incentive scheme which made the EDUCO program successful. To this end, we estimate the "augmented" reduced form production function by incorporating parents and community involvement as major organizational inputs. Figure 5.1 and 5.2 represent the basic structure of the augmented production function for

traditional and EDUCO schools, respectively. First, we will construct a formal theoretical model of the EDUCO school. Utilizing a principal-agent framework, we will show that parents or parental associations (principal) can affect not only teacher (agent) effort and their performance by imposing an appropriate incentive scheme but also school-level inputs by delegated school management. Outputs of educational production, usually measured by child educational performance, are created by school level inputs as a result of school-community interactions and by household level inputs such as home teaching (Figure 5.1 and 5.2).

Secondly, this chapter examines empirically the prediction of the formal model. It estimates "augmented" reduced form production functions using two measures of educational outcomes, i.e., standardized test scores in mathematics and language, among third-grade students.[1] Then, the transmission mechanism from community participation to educational output is investigated. To this end, we estimate teacher compensation function, teacher effort function, and input demand functions, based on the theoretical implications of the principal-agent framework.

The rest of this chapter is organized as follows. Section 5.2 discusses various aspects of community participation, social capital and education. Particularly, the importance of an appropriate teacher payment scheme is reviewed. In Section 5.3 and 5.4, the formal theoretical framework is derived. In Section 5.3, we derive the optimal incentive scheme by solving an optimization problem of parental association. Then the optimal level of teacher effort is determined endogenously. Section 5.4 represents the "augmented" reduced form educational production function by taking into account endogenous teacher effort as a function of community participation. In Section 5.5, the formal econometric framework of the production function is constructed and estimated. Section 5.5 also discusses the data set and the estimation results of the student achievement equation. Section 5.6 empirically investigates the theoretical prediction of the transmission mechanisms from community participation to educational outcome. We estimate teacher compensation function, teacher effort functions, and input demand functions. Section 5.6 concludes with discussions of policy implications.

[1] Chapter 4 estimates the reduced form production function extensively. The section of the estimation of production function in this chapter basically replicates the results of Chapter 4 with an alternative set of variables.

5.2 Social Capital and Community Participation

5.2.1 Community Participation, Social Capital and Education

Community participation can itself help create a sense of community and thus generate a high level of social capital, which is defined as the institutions, relationships, mutual trust, and norms that form the quality and quantity of a group or society's social interactions.[2] Accumulation of social capital facilitates the provision of public goods, which becomes the key in social sector reform [Coleman (1988)]. Therefore, the accumulation of social capital promotes social development or sustainable and equitable development of a society, which enhances economic development. While the importance of social capital has been recognized in the areas of sociology and political science, it is seldom used as an input in the modeling of an economic production process. Social capital has only recently received attention in the economics literature. Fafchmaps and Minten (1998, 1999a, 1999b), for example, show that agricultural traders use social capital to overcome transaction costs through a reduction in information and search costs and through substitution for poor market institutions. This indicates that social capital has a large effect on efficiency in market transactions. Knack and Keefer (1997) use indicators of trust and civic norms from the World Values Survey for a sample of 29 market economies in order to test their hypothesis of whether "social capital" matters for measurable economic performance. They find that trust and civic norms are stronger in nations with higher and more equal incomes, with institutions that restrain predatory actions of chief executives, and with better-educated and ethnically homogeneous populations. Temple and Johnson (1998) show that indexes of social development constructed in the early 1960s have considerable predictive power with respect to economic growth, indicating that social arrangements, including social capital, matter.

Social capital can improve the quality of education through various forms of community participation. School productivity becomes higher when parents and local citizens are actively involved. In the US, there is an emerging empirical literature which investigates the importance

[2] The most narrow concept of social capital is defined as a set of "horizontal associations" between people [Putnam (1993)]. In this view, social capital is composed of social networks and associated norms that have an effect on the productivity of the community. A second and broader concept of social capital is defined as vertical as well as horizontal associations between people [Coleman (1988)]. Thirdly, the broadest view of social capital includes the social and political environment that enables norms to develop and shapes social structure. In addition to the informal and small scale social relationships of the first two concepts, this view also includes the more formalized institutional relationships and structures, such as the political and legal systems [North (1990) and Olson (1982)].

of community role in determining the academic performance of the students in the community [Coleman (1990)]. In their seminal work, Coleman and Hoffer (1987) argued that where parents and community members have a voice and take an active interest in children's educational well-being, teachers are more committed, students achieve higher test scores, and better use is made of school facilities in those communities. Studies of US schools showed lower dropout rates in the Catholic schools, religiously based high schools that are surrounded by a community based on the religious organization, than in other public and private schools, even after controlling religion and household financial position [Coleman and Hoffer (1987) and Coleman (1988)]. This observation is attributed to the students in religiously based schools being enveloped within a community that reinforces the norms and values of the school. This finding implies that social capital outside the school, in the whole community surrounding it, is important for formation of human capital. Henderson, Mieszkowski, and Sauvageau (1987) have found that, other things being equal, students perform at a higher level if their fellow students are high achievers, which indicates that social capital is accumulated through peer interactions.[3] The recent Charter School movement in the US also documents the importance of community participation and school autonomy.[4] Charter Schools are independent public schools designed and operated by educators, parents, community leaders, and others. By construction, the Charter Schools are more responsive to communities and free from the demands of the bureaucratic process. The autonomy of charter schools overcomes the traditional bureaucracy and regulations that prevent an efficient allocation of school resources.

5.2.2 Importance of Teacher Payment Scheme

In a conventional centralized education system, teacher payment rates are usually set by the central government. While in most developed countries, teachers' organizations negotiate levels of payments, their influence varies depending on the collective bargaining process and the form of negotiation. In developing countires, government regulations usually construct the teacher payment scheme. For example, in Paraguay, a completely fixed-wage compensation scheme is employed for teacher payments [World Bank (1996)]. There are no wage premiums for seniority and no rewards for superior performance. Such a centralized education system with

[3] Evans, Oates, and Schwab (1992), however, concluded that measures of peer group are potentially endogenous variables and thus suggest the need for careful modeling of the choice of communal peer groups through selection of residence and school.

[4] As of February 1999, 34 states and the District of Columbia had passed charter school laws and 27 states

rigid teacher payment schemes is highly likely to create deterioration of teacher effort and educational quality. The prototypical argument is that payments that are not connected to performance discourage high productivity [Cohn (1996)]. Teacher compensation, therefore, must be linked to job performance in order to retain well-qualified teachers [Gaynor (1998)]. It is reasonable to expect that linking compensation to job performance would motivate teacher and thus improve quality of education. In recent years, merit teacher payment schemes have been introduced in many states and districts in the US [Cohn (1996)].[5] A study of US schools by Jacobson (1988), for example, concluded that the implementation of an incentive plan that monetarily rewarded high rates of teacher attendance was accompanied by a significant, short-term reduction in teacher absences. During the first year of this attendance incentive plan, teacher absences declined significantly and the total number of teachers with perfect attendance increased four-fold. Cohn (1996, p.227) also shows that the South Carolina Teacher Incentive Plan Award had a significant impact on scores of student achievements. Mickler (1987) concludes that three merit pay plans conducted in Ladue School District, MO, Dalton County, GA, and Lake Forest, IL have been successful as well. Mickler (1987) argues that an important ingredient in a successful implementation of merit payment scheme is the active participation and involvement of teachers in the teaching performance evaluation process.

The empirical evidence, however, is not abundant enough to endorse the importance of merit payment in developing countries. But the following examples from South America and South Asia are the exceptions. In the first example, a locally monitored incentive scheme has been implemented in Nicaragua [Gaynor (1998)]. The Nicaraguan Ministry of Education is developing guidelines that include teacher performance incentives, personnel management, and criteria for applying salary supplements to teachers funded by local contributions. Approximately, 25% of the basic teachers' salary are paid monthly as teacher incentives and they are adjusted each term according to teacher performance. This payment is based on regular teacher attendance and low student dropout rates. The school council elects a member who monitors teachers' attendance and administers the local contributions that are received directly by the school. Teacher attendance reports are signed weekly by the chair of the school council and then sent to the municipal education council. Penalties apply when a teacher missed days of school or is late for school by 30 minutes or more on three occasions. The second example is the teacher payment reform in the Dominican Republic. With help from the World Bank, the Dominican government has fabricated a new teacher compensation system with the aim of

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and the District of Columbia are operating 1,200 charter schools, serving over 300,000 students.

developing a clearer carrier structure for teachers [Gaynor (1998)]. Under the new system, teacher salaries increase according to improvements in their classroom performance. Performance evaluation of teacher accounts for 20-25% of total salaries. The final example is a merit payment scheme, which has been successfully implemented even in one-teacher schools in Nepal. At schools in the Seti Zone Project in Nepal, teachers in one-teacher schools work under the performance-based payment scheme. Teachers in these schools receive payments directly from supervisors but only if they attained observable performance goals [Bennett (1991)].

5.2.3 Potential Pitfalls of the Merit-based Payment Scheme

Under the above mentioned merit payment systems, a significant portion of each teacher's salary is based on her/his performance evaluated by supervisors. The opponents of the merit-based system conclude that research on teacher compensation and reward preferences in US history provides only limited support for the proposition that the merit-based payment system can effectively motivate teachers to improve their performance [Cohn (1996)]. Indeed, there is a wide range of technical, organizational, and financial obstacles for merit-based payment schemes. First, performance-based payments might encourage "opportunistic" behavior, i.e., behavior that benefits the individual teacher at the expense of others [Cohn (1996)]. Among teachers, cooperation becomes rare, while competition is common. Opportunistic behavior by teachers, jealousy by those not receiving the merit bonus, and effect of merit pay on administrators may have strong negative effects on the school quality.

Second, it is difficult to establish objective and fair criteria of teacher performance. Before standardized tests were common, school administrators usually employed their own "merit ratings" to determine teacher payments, opening the door to nepotism, arbitrariness, and discrimination, causing serious morale problems. Even if test scores become available, the use of student achievement data may be problematic. Teachers who are compensated based on test scores of students would be tempted to neglect other aspects of education such as social skills and creative thinking. Teachers might also be led to teaching the most receptive students, whose test scores are easiest to improve, while neglecting students who have more trouble learning [Milgrom and Roberts (1992, p.230)].

Objective indicators of teaching performance, therefore, are difficult to generate, but they are necessary for an impartial and effective merit-pay system. As a result, the predominant

[5] The merit-based payment is defined as the payment by results [Cohn (1996, p.210)].

payment mechanism for teachers in the United States is the single salary schedule [Cohn (1996)]. A study concluded that the popularity of the US's merit teacher payment scheme in the 1920's and 1950's resulted in widespread failure in the education program [Johnson (1984)]. Failure of the plans to meet their objectives, funding shortages and overall expense of the programs, and recognition that the merit pay bonuses did not provide sufficient incentives to teachers became problematic [Johnson (1984)].

In fact, similar problems with the merit-based teacher remuneration scheme apply to developing countries [Lockheed, Verspoor and associates (1991)]. First, monitoring by supervisors incurs various monetary and non-monetary costs. Usually teacher supervisors face difficulty when monitoring a consistent set of activities, since establishing and implementing an objective teacher evaluation system that justifies the supervisor's decision is costly. Especially in small rural schools with only one or two teachers, teacher evaluation by external supervisors becomes expensive and thus proper evaluation may be inherently difficult. Nonetheless, fair and appropriate evaluation is the fundamental requirement for an effective merit-based payment scheme. Second, potential inconsistency between true and observable teacher efforts can create serious inefficiency in the system. Under the merit payment scheme with external supervisors, teachers become accountable not to parents and students but to the supervisors. The scheme might promote uncooperative teacher attitudes toward parents and students. As a result, system outcomes will become inconsistent with welfare objective of the community.

5.2.4 Community Participation as a Necessary Condition

However, teacher monitoring by communities, not by external supervisors, can overcome these inherent problems of a merit-based teacher payment scheme. Close monitoring by community groups can be less costly than teacher evaluations by external supervisors. Even in a small rural school with only one teacher, frequent and close teacher monitoring becomes possible if the supervisor is drawn from the same community. When members of the community association are elected from the parents of the students, inconsistency between the behavior of teachers and the welfare objectives of community disappear. Teachers will become accountable to the community association which monitors, supervises, and evaluates their performance. As a result, teacher will become responsible to parents and students. Community participation not only utilizes relevant information that outside government agencies are not likely to have, but also

imposes commitment on teachers, which leads them to exert greater effort.[6]

These advantages of community management and administration of schools seem to apply to the El Salvador's EDUCO program. Teachers in EDUCO schools are selected, hired, supervised and dismissed by the parent associations drawn from the parents of the students (ACEs). The quality of EDUCO teachers is judged according to their teaching performance and behavior. While an EDUCO teacher's salary is higher in many cases, they have less job stability than teachers in traditional schools, especially when teachers do not put much effort towards improving their teaching quality [World Bank (1995)]. As we will discuss in the later sections, the observed better attendance, performance and commitment of EDUCO teachers may confirm the importance of improving the incentive structure based on teacher performance evaluation under the community monitoring system.

5.3 The Theoretical Framework I: The Model of Endogenous Teacher Effort

5.3.1 Theoretical and Empirical Analysis of Principal-Agent Framework

The success of community participation depends on how it can overcome agency problems which arise from discrepancies between the agent's action and the principal's objective. In our framework, the "principal" is either MINED in traditional schools or parental association in EDUCO schools, and the "agent" is a teacher. To investigate these teacher incentive issues formally, we will construct a principal-agent model of endogenous teacher effort.

The literature on theoretical treatments of principal-agent problem is substantial. For example, the model of sharecropping, which was developed during the 1970's in order to explain the particular agrarian institution in developing countries, became one of the first fully worked out principal-agent models in economics [Otsuka, Chuma, and Hayami (1992)]. On the other hand, empirical studies of agency relationships are not widely available.[7] For example, despite the theoretical importance of moral hazard and the distinction between worker time and worker effort, there is little direct empirical evidence on worker shirking. The lack of wide empirical studies can be attributed to the difficulty for an econometrician to observe agent's performances,

[6] This advantage of community participation is pointed by Stiglitz (1999).

[7] Among the recent empirical works, Brant and Hosios (1996), for example, developed and estimated a structural principal-agent model of employment contracts in order to evaluate the roles of credit and incentive issues in the design of rural labor contracts. The empirical results indicate that shirking by workers was the dominant incentive issue and that reputation rather than

e.g., employer's estimate of worker effort [Salanie (1998)]. While there have been wide studies of the disincentive effects of input use such as fertilizer, seeds and worker time [Shaban (1985)], in the context of developing countries, there is almost no evidence on the withholding of worker effort except Foster and Rosenzweig (1994) and Laffont and Matoussi (1995). Laffont and Matoussi (1995) estimated production functions using the tenant's production as a natural measure of a worker's effort and performance. The data from Tunisia indicates that the tenant's share of output and the degree of efficiency have a positive relationship. Foster and Rosenzweig (1994) astutely used panel data on workers' health and calorie intake to measure the effort effects, rather than output effects, of different labor payment schemes. They showed the effort level under piece rates is higher than the level under fixed salaries.

These empirical studies of the basic agency model show significant effects of compensation on performance. While it is important to point out that incentives matter, these studies do not truly test predictions of the agency theory. A more precise test of agency theory is to address whether contracts are structured to reflect agency concerns [Prendergast (1999)]. Therefore, a second line of the empirical literature has focused on identifying the relationship between compensation schemes and proxies of measures of agent's performance. The most celebrated example of empirically estimating compensation schemes has been a series of papers that estimate pay-for-performance for executives and, particularly, chief executive officers [for example, Jensen and Murphy (1990)]. However, there is only limited evidence that show that the optimal slope of the compensation scheme is determined by risk aversion and the returns to effort and contracts are designed to optimally trade off risk against incentives [Prendergast (1999)].

This chapter makes two contributions to the principal-agent literature. First, there have been almost no previous applications of the agency framework to social sector management issues, especially in the context of developing countries. This chapter is the first to formulate a theory and empirical framework of decentralization of education program in a developing country, although, in the context of the United States, McMillan (1998) formulated an insightful and related general equilibrium model of the interaction of parental and school preferences in determining educational outcomes. Moreover, this chapter empirically investigates not only the relationship between compensation scheme and agent's performance but also the consistency between the contracts and the theoretical prediction. Therefore, this chapter provides an accurate test of the agency theory by investigating whether contracts are structured to reflect agency problems.

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termination was the primary worker-disciplining device.

5.3.2 The Model[8]

For the initial step of modeling our idea, a teacher's optimization problem can be represented as an expected utility maximization. A teacher determines his/her optimal effort level, e, so as to maximize the following expected utility:

$$e^* = \arg\max_{\{e\}} \int_{-\infty}^{\infty} Wg(W)dW - CS(e),$$

where W is a wage rate and g(•) is a probability distribution function of W. In other words, g(•) denotes the wage offer function in a particular school. According to empirical dicta, the cost created by effort, CS, will be a concave function of effort level, e [Lazear (1996)].

In El Salvador, specific government regulations (*Escalafon Magisterial*) insure a teacher's job stability and relatively fixed amount of real wage rate in traditional schools [World Bank (1995)]. Hence, teacher salaries are not linked directly to the teaching performance in traditional schools. In other words, teacher compensation in traditional schools can be described by a fixed wage system. On the other hand, teachers in EDUCO schools receive contingent payments depending on their teaching performance. The ACEs supervise and evaluate EDUCO teachers' quality and performance. Moreover, EDUCO teachers' job stability itself links to their performance [World Bank (1995)]. However, the true level of teacher effort is not observable to MINED or parental associations. Hence, we can plausibly represent that a teacher, particularly an EDUCO school teacher, is paid on the basis of the "observed" level of teaching effort OE, where OE represents the principal's estimate of the "true" level of teacher effort. The wage payment scheme is assumed to be a linear compensation scheme. Then we can represent the teacher payment scheme by a linear function of the observed level of effort as follows:

$$W = a_1 + a_2 OE. \tag{2}$$

Note that a case of $a_1 > 0$ and $a_2 = 0$ represents a fixed wage contract, while $a_1 \geq 0$ and $a_2 > 0$ denote a piece rate contract.

While we can simply interpret the linearity with respect to effort level as an

[8] The model constructed in this chapter follows a standard principal-agent model with a linear compensation scheme. For example, see Ross (1973), Hart and Holmstrom (1987), Milgrom and Roberts (1992), and Lazear (1996).

approximation of a general non-linear wage payment formula, theoretically, the linear compensation scheme is shown to be quite robust to the specification of the environment [Holmstrom and Milgrom (1987); Laffont and Tirole (1987); McAfee and McMillan (1987); Hart and Holmstrom (1987)]. The linear payment system is preferable in the sense that this system applies a uniform incentive pressure that makes the teacher want to make additional effort no matter what his/her performance has been. Because incremental improvements in child ability are typically equally desirable for parents after either a slow or a fast start, this uniform incentive pressure is adequate and optimal. Moreover, linear systems have the advantage of being simple to understand and administer. A complex non-linear scheme might not be able to provide the desired level of a teacher's motivation since teachers may not understand the complex scheme easily and/or a principal cannot administer it as intended.

5.3.3 The Optimal Teacher Effort

As we have mentioned, the principal will have difficulty observing the level of the true teacher effort directly. Instead, the principal can observe an imperfect indicator of the true teacher effort, OE, that is, an indicator that provides some information about the teacher effort but is contaminated by random events beyond the control of the teacher. In other words, this observed level of effort is an estimate of the true level of teacher effort e. Such an indicator may include days of teacher attendance or intensity of a teacher's meeting with parents. Formally, we can write

$$OE = e + z, \tag{3}$$

where z indicates a measurement error with E(z) = 0. Note that e and z are not separately observed by the principal. A more involved community association can observe teacher effort with fewer mistakes through close and frequent monitoring of a teacher's behavior. Therefore, the degree of community participation is naturally regarded as the determinant of precision of teacher effort estimation. Mathematically, this consideration can be represented as

$$Var(z) = V(CP),$$

where CP is the degree of community participation with $\partial V/\partial CP < 0$. Note that the precision of

effort estimation is defined as the inverse of the variance of measurement error. This function V(CP) denotes the technical relationship between teacher monitoring by community participation and precision of observing teacher's true effort.

From (2) and (3), we have the reduced form payment scheme equation:

(2') $$W = a_1 + a_2 e + a_2 z,$$

and therefore the teacher optimization problem becomes

$$e^* = argmax_{\{e\}} \; E\,[a_1 + a_2 e + a_2 z] - CS(e).$$

Then we have the first order condition of this problem as follows:

(4) $$a_2 = CS'(e^*).$$

This condition is the so-called incentive compatibility constraint. This condition must be satisfied by any feasible employment constraint. Interpretation of equation (4) is straightforward: a teacher will select their effort levels so that their marginal reward in the left hand side equals their marginal costs from additional effort in the right hand side. Hence, we have the optimal level of effort as a function of the payment scheme parameter:

(4') $$e^* = e\,(a_2),$$

where it is easily verified that $\partial e^*/\partial a_2 > 0$. Using equation (4), we can discuss the teaching performance in traditional schools. The lack of compensation mechanisms for improved teaching quality and of adequate supervision restricts the effective control of teacher effort in traditional schools. This inappropriate incentive structure for teacher payments seems to be responsible for poor teacher performance and for prevalent teacher absenteeism in traditional schools.

5.3.4 Optimal Teacher Payment Scheme given by a Parental Association

In the EDUCO schools, the ACE is responsible for hiring and replacing teachers and allocation of school budgets. In other words, the ACE has a central role in personnel and budget

management and thus can change the reward structure easily. On the other hand, the SdPF in traditional schools has only a limited role in school management. The payment scheme parameters, a_1 and a_2, in El Salvadorian schools, are likely to be related systematically with school type and/or the degree of community participation. The higher intensity of community participation, CP, will be reflected in the teacher reward and punishment structure. As a result, the optimal level of teacher effort will be higher in EDUCO schools than in traditional schools. The model in this sub-section will formalize this argument.

If a parental association has full administrative and management ability, the coefficient a_2 is determined endogenously by the parental association in order to "discipline" teachers.[9] The parental association will concern the social benefit of education, which is measured by a weighted average of student i's educational achievement, Y_i, and a teacher's benefit. Let λ_i be the weight for child i, which represents the teacher and/or parental association's preference over students. Then, assuming a risk neutral principal, we can derive the principal's certain equivalent as $E(\Sigma_i\lambda_iY_i) - E(W)$. The risk avert teacher's certain equivalent is represented by $E(W) - CS(e) - (1/2)\gamma Var(W) = E(W) - CS(e) - (1/2)\gamma(a_2)^2V(CP)$. Combining these two formulas, the sum of the certain equivalent incomes of the teacher and the parental association becomes $E(\Sigma_i\lambda_iY_i) - CS(e) - (1/2)\gamma(a_2)^2V(CP)$, where γ is the teacher's coefficient of absolute risk aversion. The optimization problem of parental association, therefore, becomes

$$\underset{\{a_1,a_2\}}{Max} \sum_{i=1}^{N} \lambda_i Y_i - CS(e) - \frac{1}{2}\gamma(a_2)^2 V(CP)$$

$$s.t.\ \ W - CS(e) \geq U_0,$$

$$a_2 = CS'(e)$$

where the first constraint $W - C(e) \geq U_0$ represents the individual rationality constraint for a teacher with a reservation utility U_0. The second constraint is the incentive compatibility constraint. The first-order condition for this problem is $[\Sigma_i\lambda_i(\partial Y/\partial e) - CS'(e) - \gamma a_2 CS''(e)V(CP)](\partial e/\partial a_2) = 0$. Hence, the optimal slope of the wage compensation scheme becomes:

$$a_2^* = \sum_{i=1}^{N} \lambda_i \frac{\partial Y_i}{\partial e} \bullet \frac{1}{1 + \gamma V(CP)CS''(e)}$$

[9] In fact, our data set (the association member questionnaire) indicates that 80% of ACEs in EDUCO schools

This condition, a.k.a., the optimal intensity of incentives condition, indicates that the parental association will choose a_2 optimally to induce the teacher to set the marginal cost of effort equal to its marginal social value of effort, i.e., weighted average of students educational attainments. We can plausibly treat the effect of teacher effort on educational output, $\partial Y/\partial e$, as an exogenously fixed technological relationship. Moreover, to simplify the argument, the curvature of the cost function is approximated so that C"(e) is constant. Then, this optimal intensity of incentives simply becomes a function of the degree of community participation and school type parameter:

$$a_2^* = g(CP), \tag{5}$$

where $g(CP) \equiv \Sigma\lambda(\partial Y/\partial e)\,[1 + \gamma V(CP)C''(e)]^{-1}$ and it is easily verified that $\partial a_2^*/\partial CP > 0$. Therefore, we have a_2 as a function of the degree of community participation.

This indicates the important role of community monitoring. The appropriate intensity of an incentive is affected by the precision with which teacher performance or effort is measured by the principal. Under the centralized system, community participation is minimal and thus precision of effort estimation is quite low. It is unfruitful to use a wage incentive scheme when effort measure is highly imprecise. As a result, the fixed teacher compensation scheme in traditional schools can be rationalized. On the other hand, in EDUCO schools, intensive community participation improves measurement of teacher effort. Strong incentives, therefore, are likely to be optimal when a teacher's performance is easy to identify. It is worth noting that the base payment a_1 does not enter as a component of the efficiency consideration of the contract. The fixed base payments, a_1, will be determined by an agreement with which both parties will obtain the sufficiently high level of welfare.

As mentioned above, specific regulations in traditional schools (*Escalafon Magisterial*) break a link of teacher salaries to the teaching performance by imposing fixed wage scheme. The typical compensation scheme in traditional schools may be described by the case of $a_1 > 0$ and $a_2 = 0$. On the other hand, teachers in EDUCO schools are selected, hired, supervised and dismissed by the parent associations (ACEs), who judge the quality of EDUCO teachers by their teaching performance. The typical compensation scheme in EDUCO schools, therefore, becomes $a_1 \geq 0$ and $a_2 > 0$.

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discussed about teacher discipline at their meetings.

Finally, combining equation (4) with equation (5), we have the optimal level of effort as a function of the level of community participation and school type:

$$e^* = e\,[g(CP)], \tag{6}$$

where $\partial e^*/\partial CP > 0$.

5.3.5 Moral Hazard

The formal model in this section indicates that the intensity of the incentives provided to teachers differs according to the degree of community involvement in teacher monitoring. In a typical case, $CP^{ED} > CP^{TR}$, where CP^{ED} and CP^{TR} represent the level of community participation for an EDUCO school and a traditional school, respectively. As a result, we have $a_2(CP^{ED}) > a_2(CP^{TR})$ and thus $e\,(CP^{ED}) > e\,(CP^{TR})$, utilizing equations (5) and (6). These results indicate that the level of teacher effort is systematically higher in EDUCO schools than in traditional schools due to difference in the intensity of community participation. The positive gap between the teacher effort level in EDUCO schools and that in traditional schools, i.e., $e\,(CP^{ED}) - e\,(CP^{TR}) > 0$, indicates the existence of moral hazard of teacher effort in traditional schools. Since teacher effort itself contributes students' achievements positively, the possible relative deficiency of student performance in traditional schools arises from the moral hazard problem of unobserved teacher effort.

5.4 The Theoretical Framework II: The Production Function Approach

As we have seen above, the production of educational outcomes is a complex interaction of the behaviors of various agents who participate in the schooling process such as students, groups of parents, teachers, and administrators at various levels, from the school up to the education ministry. Moreover, agents not directly connected to the educational system may affect these outcomes if they influence the environment in which students learn. For example, the performance of students at schools in a particular community has been attributed to community and peer group effects of social capital, i.e., stock of mutual trust [Coleman (1990)]. To investigate empirically these various aspects of the schooling process in this section, we employ a conventional reduced form model of educational production [Hanushek (1995)]. Most studies

measure output by students' achievement scores, school attendance rates, repetition rates, school continuation or dropout rates. These variables are thought to capture prospects of future earnings in the labor market. In this chapter, we focus on student scores on standardized achievement tests.

Suppose that a child i's educational achievement, Y_i, can be represented by the production function:

$$Y_i = f(X_i, C_m, D_i, Z, e_i^*), \tag{8}$$

where X represents a vector of student and household characteristics, C is a vector of community m's specific variables, D is an indicator variable of school type attended by a student, where D = 1 for an EDUCO school and D = 0 for a traditional school, and Z denotes a vector of observed school-level characteristics which varies by school rather than by student. Equation (8) really expresses achievement for the ith student in a particular school. To simplify notation, we drop the school subscript. By combining equation (6) and (8), we can derive a reduced form model as follows:

$$Y_i = f[X_i, C_m, D_i, Z, e(CP_i)]. \tag{9}$$

This formulation represents that the effect of community participation on outcomes may be mediated through teacher's effort level.

The optimization behavior of a school administration entity, either MINED in traditional schools or ACEs in EDUCO schools, leads to the resulting input demand functions:

$$Z_i = Z(C_m, D_i), \tag{10}$$

where a vector of relative prices of various school inputs is represented by community variables C. The school type indicator variable is incorporated as the argument of this demand function since this variable potentially affects productivity of school output. Substituting equation (10) into (9), we have a highly reduced form production function:

$$Y_i = f[X_i, C_m, D_i, Z(C_m, D_i), e(CP_i)]. \tag{11}$$

This reduced form model assumes that the effects on achievement of a school's observed characteristics, such as class size, teacher characteristics, etc., are fully determined by its management structure, i.e., whether it is EDUCO or not, the characteristics of the students and their parents, and the intensity of community participation in school administration and management.

5.5 The Econometric Framework

5.5.1 Empirical Specification

We estimate a linear approximated version of the reduced form educational production function of equation (11):

$$Y_i = X_i\beta + C_m\gamma + D_i\alpha + CP_i\delta + v_i, \tag{13}$$

where u represents a well-behaved measurement error term with assumptions of $E(v_i)=0$ and $Var(v_i)=\sigma_v^2$. To control for observed school inputs, we add school characteristics to correspond to the empirical versions of equation (9).

$$Y_i = X_i\beta + C_m\gamma + D_i\alpha + Z_i\mu + CP_i\delta + v_i. \tag{14}$$

5.5.2 Costly Monitoring, Optimal Participation, and Endogeneity Issues

So far, we have assumed that the degree of community participation CP and thus the measurement of teacher performance, which is represented by the variance V, are determined outside the scope of the model. However, CP will be endogenously determined as well, since any monitoring effort by a community association is costly because of participants' opportunity costs.

To derive the optimal level of teacher monitoring, suppose M[V(CP)] denotes the minimum amount that must be spent on monitoring needed to achieve an error variance of teacher effort observation as low as V. To improve precision of teacher effort prediction should require some resources. Hence, we can assume that M is a decreasing function, i.e., $M'(V) < 0$ and thus $M'(CP) > 0$. To obtain an internal solution, we also suppose that the marginal cost of variance reduction is a rising function, i.e., M'(V) is increasing. Then, we have the following sub-

optimization problem of a principal:

$$(15) \qquad \underset{\{V\}}{Max} \sum_{i=1}^{N} \lambda_i Y_i - CS(e) - \frac{1}{2}\gamma(a_2)^2 V - M(V).$$

Note that the introduction of the costly measurement does not affect the incentive constraint equation (4). We may therefore hold e and a_2 fixed and choose V to maximize the equation (15). The first-order condition of this problem then becomes:

$$(16) \qquad \frac{1}{2}\gamma(a_2)^2 + \frac{\partial M}{\partial V} = 0$$

If monetary transfer, M, is exogenously given, this condition gives the optimal level of V, which implicitly solves the optimal level of community participation, CP. We can compare two polar cases for exposition. In the first case with high level of a_2, community participation will be more intensive so that V is set lower than in the case of low level of a_2. In this case, more resources should be spent on measurement. On the other hand, if a_2 is low, the level of CP should be lower so that V is set higher. This argument is refereed as the monitoring intensity principle in the literature [Milgrom and Roberts (1992, p.226)].[10]

In our particular setting in El Salvador, the amount of participation cost M is exogenously determined and provided by government: in the case of EDUCO schools, MINED makes a direct transfer of funds to ACEs. In this case, we can write a reduced form optimal participation level as a function of government transfer, i.e.,

$$CP^* = CP(M).$$

Recalling equation (6), we have

$$e^* = e[CP(M)],$$

i.e., optimal level of effort is a positive function of the government's monetary transfer to a

[10] Formally speaking, in an optimally designed incentive system, the amount of measurement, V, and the intensity of incentives, a_2, are chosen together by selecting a level of CP. Hence neither causes the other, although setting intense incentive and measuring performance carefully are complementary activities [Milgrom and Roberts (1992)].

community association. This means that monetary transfer to the community is used a device to extract teacher effort whereas the direct payment to teachers by MINED does not enhance the level of teacher effort.

According to the argument above, it will be quite natural to treat the amount of monetary transfer from government to parental association, M, as an identifying instrumental variable for the level of community participation, CP. This selection of an instrumental variable based on the theory is one of the methodological innovations in this chapter.

5.5.3 Data

The data of 311 primary schools, which are randomly sampled from the 3634 primary schools, was collected in October 1996 by MINED of El Salvador with the assistance of the World Bank and USAID. The survey covered 162 municipalities out of 262 that share responsibility with the central government for the delivery of social services. The original data set contains information from four different school types, pure EDUCO, mixed, traditional public and private schools. Since EDUCO was introduced only in 1991, it was not possible to give achievement tests in 1996 to those students who were about to finish primary education in EDUCO schools and to compare their scores with those in traditional schools. Instead, third-grade sections were selected for each school and then five students were randomly selected in that same section.

The sampling scheme is designed so that the survey is nationally representative. Moreover, the original sample was selected in such a way as to allow for four types of schools -- pure EDUCO, pure traditional, mixed, and private schools -- to be considered. In this study, we dropped students from private schools and traditional public urban schools from the sample since their students are not comparable with the EDUCO students. Moreover, since mixed schools have their own specific school administration and management structure, we only compare students in the pure EDUCO and pure traditional schools in this chapter. This left us with 605 students in 30 pure EDUCO schools and 101 pure traditional rural schools. The actual data collection process was composed of interviews with five different types of participants in the education community: director of the sampled school, teacher of the sampled 3rd grade class, sampled student in the 3rd grade, parents of the student, and parents in parent group of the sampled school.

5.5.4 Variables and Descriptive Statistics

For dependent variables, the achievement tests for various subjects were applied by MINED on October 1996 with the assistance of the Intercultural Center for Research in Education (MINED 1997). These were applied nationally in the 3rd, 4th and 6th grades, but because EDUCO students had reached only the 3rd grade at the time of the data collection, we use only the third-grade results in the analysis. Moreover, we focus only on the results for the mathematics and language tests which are employed conventionally as measures of educational outcome.

The mathematics test is composed of 30 questions on ten key subjects, that is, three items for each subject. A student has achieved an objective if she/he got two questions right out of three questions. For the language test, there are 36 questions on nine objectives, that is, four items each. A student has achieved an objective if she/he got three questions right out of four questions. According to Table 5.1, for this sample, the average student was able to master 3.66 out of 10 subjects in math, but only 1.69 out of 9 in languages. These results are not out of line when compared to national averages (MINED 1997). Of greater interest, though, are the comparative average values for EDUCO and traditional schools. Students in EDUCO schools score marginally lower than their traditional school counterparts in both subjects, although the differences are not statistically significant (Table 5.1).

Table 5.1 also lists descriptive statistics of the other variables used in the analysis. In terms of child specific characteristics, students are divided equally by gender. A significant portion of them live without parents, with a slightly higher proportion among EDUCO students. EDUCO students also have a slightly higher number of siblings and are slightly older, although the differences are not significant.

Using the descriptive statistics in Table 5.1, we can informally evaluate the three main objectives of the EDUCO program. First, EDUCO households are poorer than traditional households and parent's socioeconomic characteristics are much better for traditional school students than for EDUCO students. Parents of traditional school students have more education than those of EDUCO students. 53% of mothers or female guardians of traditional students have basic education, compared to 50% for EDUCO students. The same is true of fathers. The education differences are reflected also in the asset indicators. Fewer EDUCO parents have access to home-ownership, electricity, sanitary services and running water. These all suggest that

EDUCO students come from poorer background than traditional school students. For the coverage issue, therefore, EDUCO program has been successful in targeting poorer segments of the population.

The socioeconomic characteristics of students and households are consistent with the pattern for school characteristics. While school level teacher-pupil ratios and the availability of sanitary facilities are similar in both types, fewer EDUCO schools have access to electricity or piped water. On the other hand, more EDUCO teachers have finished university education but are less experienced. The EDUCO teaching corps consists of relatively young recent graduates who receive a "bonus" for teaching in the program. There are no differences in access to textbooks in the two types of schools.

Second, with respect to parent participation issues, parents of EDUCO students participate more in school affairs. Parent associations in EDUCO schools visit classrooms almost 4-5 times more often than their traditional counterparts. ACEs in EDUCO schools are more involved than are parents' associations in traditional schools. At the parental association meetings, 80% and 79% of ACEs discussed teacher discipline and attendance of school personnel, respectively, while corresponding figures of PdSF are 62% and 38%, respectively. Less teacher absenteeism in EDUCO schools might reflect the effectiveness of potential teacher monitoring by parental associations in these schools. In fact, teachers are absent from EDUCO schools for 1.09 days per month on average, while 1.35 school days per month are missed by teachers in traditional schools.

Finally, with respect to the output quality, there are no significant test score differences in spite of the poorer background of EDUCO students. With a simple t-test on the equality of two means, we cannot reject the null hypothesis that both schools have the same mean test score. This implies an advantage for community participation in education. In the following sections, we will empirically evaluate whether there is an EDUCO effect, after controlling for household background and school and classroom inputs, using a formal econometric framework. By doing this, these conjectures regarding the consequence of parents' participation and possible EDUCO effects could be investigated properly.

5.5.5 Results of Production Function Estimation

As mentioned above, the observable teacher effort variable, OE, and the level of community participation, CP, are both likely to be endogenous. Therefore a simple OLS

estimation of production function (13) and (14) may not provide consistent estimation of coefficients. To eliminate the potential bias due to this endogeneity, we include the monetary transfer from government, M, as an identifying instrumental variable. However, the exogeneity assumption of the geographical allocation of government transfers may be restrictive, since the government transfers might be a function of a community's characteristics. Hence, in addition to this variable, we constructed another identifying instrumental variable, ACP_{im}, for a student i in a municipality m, which is defined as follows:

$$ACP_{im} = \frac{\sum_{i \in m} CP_i \times (\text{Number of students})_m - CP_i}{(\text{Number of students})_m - 1}.$$

This variable captures the municipality level "net" average propensity of community participation. We can easily verify that ACP is uncorrelated with the error term by construction but is likely to be correlated with the participation variable, CP.

Tables 5.2 and 5.3 represent resulting municipality fixed effects estimators of production function (13) and (14) for mathematics and language tests, respectively. Regardless of the specification, i.e., with or without controlling for household characteristics, household assets, school and classroom inputs, and teacher quality, consistently positive EDUCO participation effects are observed. Moreover, these coefficients are statistically significant for all language test specifications and most mathematics specifications. However, the loss of statistical significance when we include classroom quality variables for mathematics tests (specifications 4 and 8) indicate that positive EDUCO participation effects may be partly transmitted through better classroom environment in EDUCO schools such as the availability of classroom library (Table 5.2).

With this highly reduced form of a production function approach, however, the transmission mechanism from community participation to output improvement is not necessarily clear. To investigate community participation effects, we estimated wage compensation equations, teacher effort functions and input demand functions in the following section.

5.6 Transmission mechanism from participation to output

5.6.1 Estimating the compensation scheme

We represent the teacher payment scheme by a linear function of the observed level of effort multiplied by exponential wage adjustment term. Combining the reduced form teacher payment scheme of equation (2) with optimal wage payment scheme function (5), we have:

$$W = a_1 + g(CP)\, OE. \tag{17}$$

Note that the sensitivity of observed effort, OE, is represented by $g(CP) \equiv \Sigma\lambda(\partial Y/\partial e)\,[1 + \gamma V(CP)C''(e)]^{-1}$. For estimation purpose, we approximate this equation (17) by a linear function as follows:

$$W = a_{ik} + (a_{20} + a_{21}\, CP)\, OE + \varepsilon_m + u. \tag{18}$$

where u represents a measurement error for econometrician and we assume E(u)=0. This is an estimable optimal payment scheme function. The first term a_{ik} is a dummy variable which is specific to a teacher's grade certified by MINED. This reflects the fact that the amount of the teacher's fixed payment is based on the teacher's formal ranking. In order to control for community specific unobserved heterogeneity, department dummy variables, ε_m, are added. [11]

We can test whether the intensity of community participation is related to the optimal payment scheme parameter a_2 by testing a null hypothesis of H_0: $a_{21} = 0$. If we reject the null hypotheses and we find a statistically significant coefficient on the slope of the payment scheme parameter, i.e., $a_{21} > 0$, then we may conclude that the finding is consistent with the optimally imposed payment scheme by the principal through the community participation.

The remaining empirical issue is how to quantify the observed measure of teacher effort, which is not observed by the econometrician. According to the results of the parental member questionnaire, 80% and 79% of ACEs at EDUCO schools discussed at the group meeting teacher discipline and attendance of school personnel, respectively. On the other hand, only 62% and 38% of PdSF in traditional schools discussed these issues. These figures imply that teacher attendance

[11] We could employ municipality fixed effects estimation. However, the data unit here is classroom-level, not student-level, and basic school sampling is based on municipality. In order to guarantee sufficient

rate might be reflected in determining the teacher compensation in EDUCO schools. Moreover, according to the teacher questionnaire, when a student was absent, 75% of the EDUCO teachers visited the family, while only 41% of the traditional school teachers visited the family. Hence, observed effort level, OE, is assumed to be captured by days of teacher's attendance and hours of teacher-parents meetings. These effort measures are directly observable to both teacher and parents, and thus teachers might be interested in improving this measure.[12] We will judge the relative importance of these variables as a teacher effort measure by using various statistical criteria. We will employ two criteria of selection of regressors, i.e., the Amemiya's prediction criterion and the Akaike's information criterion [Amemiya (1980)].

Estimation results of equation (18) are represented in Table 5.4. The dependent variable is hourly base salary of teachers. The first observable effort variable is teacher's days of school attendance per month. The second effort variable is teacher's hours per month meeting with parents. The estimated coefficients on the interaction variables, a2OE and a2OE2, are all positive. Moreover, these coefficients are statistically significant except the instrumental variable estimation using teacher's hours of meeting with parents variable as the effort variable. Yet, the goodness of fit for these two instrumental variables results for the hours of meeting variable is relatively poor, according to the Amemiya's prediction criterion and the Akaike's information criterion. Hence, we may conclude that overall results in Table 5.4 indicate that the slope of wage compensation scheme is positively related with the degree of community participation, i.e., $a_{21} > 0$. This finding is consistent with the theoretical prediction of the optimal intensity of incentives condition, $a_2^* = g(CP)$ with $\partial a_2^*/\partial CP > 0$. Therefore, EDUCO schools with a relatively high degree of community participation follow a piece rate payment, which is a compensation scheme based on the level of observable effort. On the other hand, traditional schools with low level of CP might have a flatter or even a fixed wage payment scheme.

Since the Mincer wage equation is a standard empirical formula of wage determination, we also assume that the estimation model of a wage payment scheme is a combination of linear compensation scheme and standard Mincer wage equation variables. Modification of equation (17) gives:

(17') $$W = a_1 + g(CP)\, OE + QL\, \beta,$$

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degree of freedom, we used department level fixed effects.

[12] Other candidates of measurable teacher effort include number of dropouts after the initial enrollment

where the wage adjustment term *a la* Mincer, QL, represents a vector of teacher quality variables such as education level and length of teaching experience. The linear econometric model of equation (17') is:

$$W = a_{ik} + (a_{20} + a_{21} CP)\, OE + \underline{QL}\, \beta + \varepsilon_m + u. \qquad (18')$$

Estimated coefficients on the teacher quality variables QL are all statistically insignificant (Table 5.5, specification II). Moreover, the null hypothesis of all zero β coefficients cannot be rejected for both effort measures, according to the F-test results reported in Table 5.5. This indicates that Mincer wage equation does not fit well for the teacher compensation scheme in El Salvador.

5.6.2 Estimation Results of Teacher Effort Function

The above estimation results indicate that EDUCO schools teachers receive a piece rate, depending on their performance observed by parental groups. In contrast, traditional schools employ a fixed teacher wage scheme. According to equation (4), the piece rate payment scheme in EDUCO schools is thought to enhance teacher effort. On the other hand, lack of compensation scheme for improved teaching quality seems to restrict improved teacher performance in traditional schools. Moreover, choice of payment scheme should be related with the intensity of community participation according to the optimal intensity of incentives condition [equation (5)]. Hence, the observed level of teacher effort must be a function of community participation level [equation (6)].

In order to investigate this mechanism empirically, a linearized version of the teacher effort function is estimated with both teacher based and household based data sets. From equations (3) and (6), we have OE = e*(CP) + z. By linearizing this, we get an estimation model of the observed effort level:

$$OE_i = \alpha_0 + \alpha_1 D_i + \alpha_2 CP_i + z_i.$$

However, we should note that CP and z are likely to be correlated each other by construction. We therefore employ the instrumental variable method to ensure consistency of estimators too.

There are two different proxy variables of the true effort level used: teacher's days of

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(pr_el1), number of subjects taught (pr_fl1), and duration of daily teaching (pr_fl2).

school attendance and teacher's hours meeting with parents. The estimated coefficients of the effort function with department dummy variables are presented in Table 5.5.[13] The estimated coefficient, α_2, is consistently positive with a sufficient level of statistical significance. This finding indicates that EDUCO school teachers have consistently higher effort level, since parent associations are more able to extract teacher effort through participation. This implies that the incentive structure and thus the optimal effort level will be significantly different between EDUCO and traditional schools. We conclude that, with the higher degree of community participation, the teacher effort measure in EDUCO schools is consistently better than that in traditional schools. Community participation seems to affect positively the teacher effort level and thereby creates better performance. This is not a surprising result, given the different wage payment scheme employed among two types of schools.

5.6.3 Estimation of school level input demand functions

As we conjectured with production function estimation results, positive EDUCO participation effects may be partly transmitted through a better classroom environment in EDUCO schools. To investigate the difference in classroom quality, we estimate the classroom-level school input demand function. For tractability, a linear function is utilized here:

$$Z_i = \pi_0 + \pi_1 D_i + \pi_2 C_m + \eta_i,$$

where we assume that prices are captured by a department dummy variable C.[14] We estimated the input demand functions for classroom variables, since these seem to capture EDUCO effects from the results of educational production functions. School type indicator variables are incorporated as the argument of this demand function since this potentially affects productivity of school output. As a second specification, the community participation variable, CP, is also added.

The estimation results are summarized in Table 5.6. First, we should notice that the number of students in classroom is consistently and significantly lower in EDUCO schools than in traditional schools. The difference between the average number of students in a traditional school and an EDUCO school classroom is about seven students. Moreover, the result with the community participation variable indicates that the degree of community participation decreases teacher-student

[13] See footnote 11.

[14] See footnote 11. Particularly, this is a useful assumption for maximizing the conditional likelihood

ratio significantly. According to the results reported in Table 5.2 and 5.3, a smaller classroom size might improve student achievement, implying that classroom size reduction is an important transmission mechanism of community participation. The coefficients of classroom size, however, are not statistically significant in Table 5.2 and 5.3.

Second, the number of books in classroom library is consistently larger in EDUCO schools than that in traditional schools. Although the coefficients themselves are not statistically significant, on average, EDUCO schools have fifty to sixty additional books in the classroom library (Table 5.6). Together with the significantly positive coefficients of number of books in the classroom library in the student test score regressions (Table 5.2 and 5.3), positive EDUCO effect might be well captured by a promotion of the classroom library of EDUCO schools. This observation of the classroom library effects is consistent with the World Bank's past evaluation result of the EDUCO program (World Bank 1995, pp.19-20). There may be a positive impact of classroom libraries in completing teacher strategies and in stimulating student interests and reading habits which affect achievement scores significantly.

Thirdly, textbook availability seems to be better in EDUCO schools, but the coefficients are not statistically significant. The textbook availability – student achievement nexus also is not clear since the coefficients of text availability in Table 5.4 and 5.5 are not statistically significant. Finally, Table 5.6 indicates that the multigrade classroom is one of distinct characteristics in EDUCO schools. The effect of community participation on educational output through introduction of multigrade education system is positive, but not strong since, in Table 5.2 and 5.3, the coefficients of the multigrade classroom are not statistically significant.

5.7 Conclusions

The results of reduced form production functions indicate that, controlling for household characteristics, household assets, school and teacher quality, we observe consistently positive and statistically significant EDUCO participation effects. These positive EDUCO effects, however, might be partly captured by better classroom environment in EDUCO schools such as classroom size and the availability of a classroom library.

With this reduced form production function approach, however, the transmissions structure from community participation to output improvement is not necessarily clear. To investigate the structural relationship between community participation and educational outputs, we estimated

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function for logit model with fixed effects.

teacher compensation functions, teacher effort functions and input demand functions. First, teacher wage payment is relatively fixed in traditional schools, while EDUCO school teachers receive piece rate, depending on their performance. We should also note that the slope of wage equation is positively affected by the degree of community participation. This finding can be interpreted as the optimal intensity of community participation. Second, teacher effort measure in EDUCO schools with the high intensity of community participation is consistently better than that in traditional schools. Community participation seems to enhance the teacher effort level through creating an appropriate design for the teacher's wage compensation scheme. ACE visits increase academic performance indirectly. On the other hand, poorer student performance in traditional schools arises from moral hazard problem of unobservable teacher effort.

Moreover, we found that community participation increases educational productivity through improving schools inputs. First, the degree of community participation decreases teacher-student ratio or classroom sizes significantly. Together with the production function estimation results which show that a smaller classroom size improves student achievement, classroom size reduction maybe an important transmission mechanism of community participation. Second, the number of books in classroom library is consistently larger in EDUCO schools than that in traditional schools, and we found that positive and significant coefficients of the number of books in the classroom libraries reflected in the student test score regressions. Positive EDUCO effect might be well captured by the positive effects of larger classroom library size on student performance.

The most important contribution of this chapter is applications of the agency framework to social sector management issues, together with empirical estimations of theoretical implications. With respect to the estimation methodology, the chapter has three contributions. First, in order to select the observed measure of an agent's effort level, the empirical framework employed the econometric approach of the selection of regressor, combined with descriptive statistics and qualitative information of the parental association questionnaire. Second, this chapter empirically investigates the consistency between the observed contracts, and the theoretical prediction of the model, the consistency which is still missing in the literature. Third, with respect to the econometric framework, Chapter 5 has a methodological innovation in the selection of identifying instrumental variables for the community participation variable, which is endogenously determined. Based on the theoretical condition of the monitoring intensity principle, we select the amount of monetary transfer from the government to the community associations as an identifying instrumental variable.

Recalling equation (16), the community participation is likely to be enhanced by the

government's support: the optimal level of teacher effort is a positive function of the government's monetary transfer to the local community association. This means that monetary transfer to the community is used as a teacher effort extraction device, whereas the direct payment to teachers by MINED does not enhance the level of teacher effort sufficiently. Our empirical results indicate that decentralization of an education system, which involves delegation of school administration and teacher management to a community, results in substantial gains in school productivity.

Our empirical results support the view that participation is necessary for a fully effective social development. Community participation not only utilizes larger sets of relevant information in order to overcome the information problems, but also brings commitment and thus greater effort of agents. Moreover, local-level participation in project implementation ensures consistency between a policy and local demand. Community participation in school management improves educational quality since educational resources are allocated according to local conditions and thus their allocation becomes responsive to parents and communities.

Figure 5.1

The Augmented Production Function Model with Endogenous Teacher Effort (Traditional Schools)

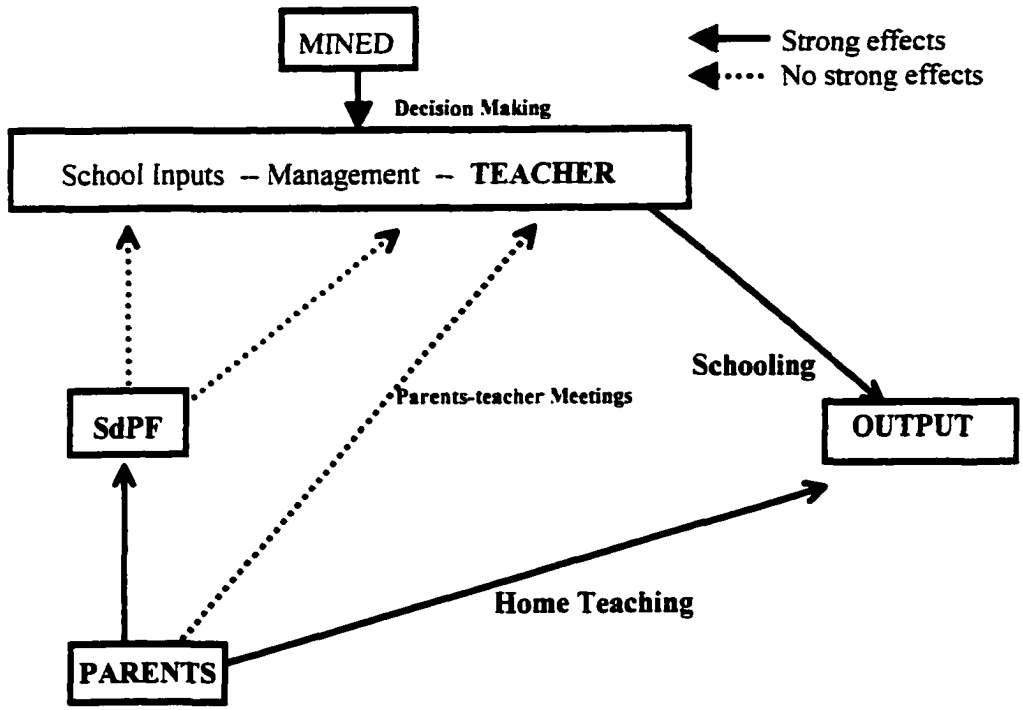

Figure 5.2

The Augmented Production Function Model with Endogenous Teacher Effort (EDUCO Schools)

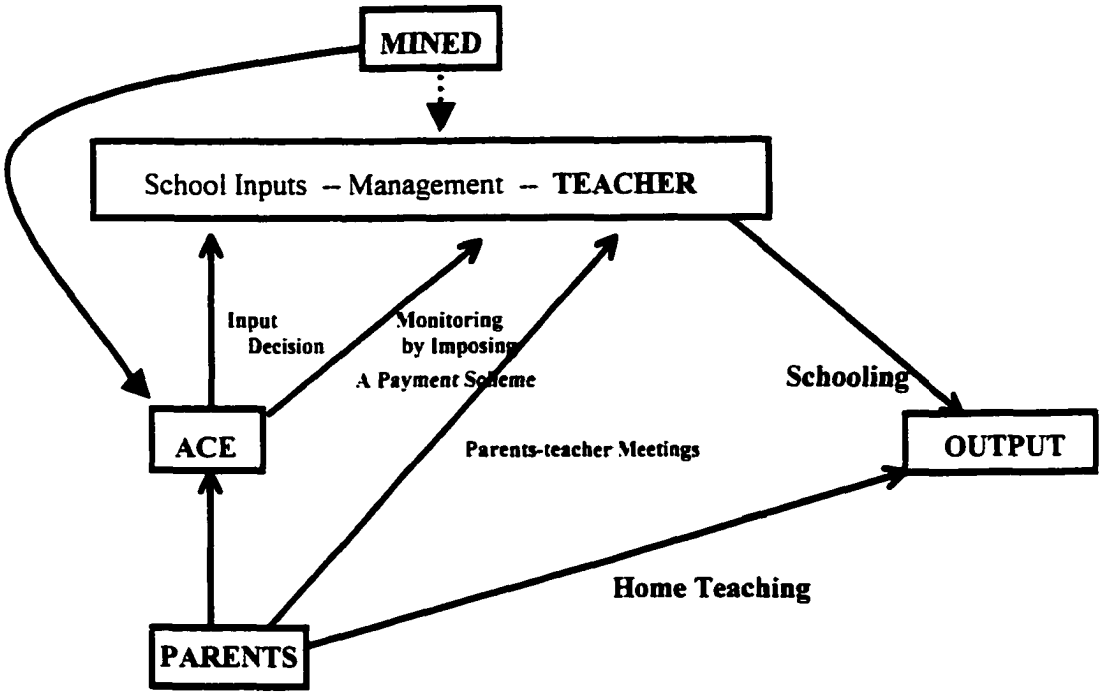

Table 5.1
Summary Statistics by School Type

Variable definitions	Code	All Schools	EDUCO	Traditional
Cognitive Outcome				
Achievement test score, math (# of subjects taken)	ma3mas	3.70 (2.55)	3.59 (2.77)	3.74 (2.48)
Achievement test score, language (# of subjects taken)	le3mas	1.74 (1.71)	1.73 (1.84)	1.75 (1.66)
Child Generic Chracteristics (CHG)				
Gender (female=1)	a_d_1d	0.51	0.51	0.51
Child's age	childage	10.59 (1.76)	11.01 (1.97)	10.45 (1.67)
Live without parent(s)=1	a_c_1d2	0.14	0.16	0.13
Household Generic Characteristics (HHG)				
Mother enter basic education=1	edl_m	0.53	0.50	0.53
Mother's education missing=1	ed_mm	0.08	0.06	0.09
Father enter basic education=1	edl_p	0.39	0.38	0.40
Father's education missing=1	ed_pm	0.04	0.03	0.04
Number of siblings (age of 4-15)	pa_b3	2.01 (1.54)	2.11 (1.50)	1.98 (1.55)
Household Assets (HHA)				
Own house=1	pa_e1d	0.72	0.68	0.73
Electricity available=1	pa_e81d	0.57	0.28	0.66
Sanitation available=1	pa_e82d	0.18	0.06	0.21
Water available=1	pa_e85d	0.06	0.01	0.08
School Quality (SQ)				
Teaher-pupil ratio (school level)	d_p_all	0.04 (0.06)	0.05 (0.09)	0.03 (0.04)
If sanitation/latrine available at school=1	d_d11d	0.93	0.89	0.94
If electricity available at school=1	d_d12d	0.68	0.30	0.80
If piped water available at school=1	d_d21d	0.31	0.12	0.37
Teacher Quality (TQ)				
=1 if teacher is female	pr_fem	0.71	0.65	0.73
=1 if teacher finish University education	predu_un	0.46	0.75	0.37
Year of teacher experience	pr_year	7.76 (6.44)	4.37 (2.70)	8.83 (6.89)
Year of teacher experience squared				
Age of the teacher	pr_age	32.53 (7.31)	27.55 (4.02)	34.10 (7.41)
Classroom Quality (CQ)				
# of students in the classroom	pr_d2	26.39 (10.75)	20.75 (6.39)	28.15 (11.23)
If all students have math and/or language textbook=1	pr_text			
If textbook data missing=1	text_m			
=1 if teacher teaches in multigrade classroom	pr_d15d	0.24	0.39	0.19
=1 if multigrade information missing	pr_d15m	0.01	0.04	0
# of books in classroom library	books	75.57 (199.37)	114.63 (272.84)	63.29 (168.41)
=1 if classroom library information missing	book_m	0.47	0.24	0.54
Community Participation Variables (CP)				
# of ACE/SpDF's visits to classroom per month	pr_d11	2.38 (4.56)	5.65 (6.59)	1.35 (3.05)
Instrumental Variables				
Transfer from Government to parental association	transf	2317.86 (4780.50)	8325.11 (6215.20)	430.63 (1743.60)
Net average intensity of participation	acp	2.09 (1.25)	2.31 (1.24)	2.02 (1.24)
Number of Observations	N	594	142	452

Note: Standard errors are in parentheses

Table 5.1 (continued)
Definition, means, and standard deviation of variables by school type
Variables used for teacher wage and effort function

Variable definitions	Code	All Schools	EDUCO	Traditional
Teacher Wage				
Monthly salary of teacher	pr_c2	3025.11	2914.90	3058.60
		(516.44)	(275.35)	(566.74)
Salary per hour	wage	32.98	30.47	33.74
		(23.40)	(17.64)	(24.92)
Teacher Effort Variables				
Teacher's school attendance per month	attend	26.92	26.92	26.62
		(1.37)	(1.16)	(1.43)
Teacher's hours per month meeting with parents	pr_f123	3.41	4.94	2.94
		(2.69)	(3.18)	(2.35)
Number of Observations	N	133	31	102

Table 5.2
Production Function Estimation with Municipality Fixed Effects
Dependent Variable: Mathematics Test Score

Sample	spec.	1	2	3	4	5	6	7	8
Method of estimation		OLS	OLS	OLS	OLS	IV	IV	IV	IV
Variable definitions	Code	Coef. t	Coef. t	Coef. t	Coef. t	Coef. t	Coef. t	Coef. t	Coef. t
Community Participation Varibale									
# of ACE/SdPF's visits to classroom per month~	pr_d11~	0.12 (1.75)*	0.12 (1.66)*	0.15 (2.04)**	0.12 (1.48)	0.10 (1.42)	0.11 (1.45)	0.15 (1.96)**	0.09 (1.08)
=1 if EDUCO schools	e_w	-0.91 (1.31)	-0.60 (0.86)	-0.60 (0.82)	-1.13 (1.37)	-0.82 (1.19)	-0.54 (0.79)	-0.61 (0.83)	-1.02 (1.26)
Child Generic Chracteristics (CHG)									
Gender (female=1)	a_d_1d	-0.66 (3.07)***	-0.65 (2.99)***	-0.61 (2.80)***	-0.52 (2.37)**	-0.67 (3.09)***	-0.65 (3.00)***	-0.61 (2.79)**	-0.53 (2.39)**
Child's age	childage	0.18 (2.86)***	0.18 (2.82)***	0.17 (2.71)**	0.17 (2.65)**	0.18 (2.88)***	0.18 (2.83)***	0.17 (2.70)**	0.17 (2.66)**
Live without parent(s)=1	a_c_1d2	0.41 (1.17)	0.39 (1.13)	0.42 (1.20)	0.47 (1.36)	0.41 (1.17)	0.40 (1.14)	0.42 (1.20)	0.48 (1.36)
Household Generic Characteristics (HHG)									
Mother enter basic education=1	edl_m	-0.05 (0.22)	-0.05 (0.19)	-0.09 (0.36)	-0.06 (0.23)	-0.06 (0.23)	-0.05 (0.19)	-0.09 (0.36)	-0.06 (0.25)
Mother's education missing=1	ed_mm	-0.14 (0.31)	-0.23 (0.52)	-0.25 (0.56)	-0.02 (0.05)	-0.14 (0.32)	-0.23 (0.53)	-0.25 (0.56)	-0.02 (0.05)
Father enter basic education=1	edl_p	-0.05 (0.19)	-0.07 (0.27)	-0.04 (0.16)	-0.07 (0.30)	-0.05 (0.20)	-0.07 (0.28)	-0.04 (0.16)	-0.08 (0.32)
Father's education missing=1	ed_pm	0.58 (0.93)	0.44 (0.69)	0.45 (0.72)	0.44 (0.70)	0.57 (0.92)	0.43 (0.68)	0.45 (0.72)	0.43 (0.69)
Number of siblings (age of 4-15)	pa_b3	-0.04 (0.52)	-0.03 (0.44)	-0.03 (0.46)	-0.02 (0.25)	-0.04 (0.54)	-0.03 (0.46)	-0.03 (0.45)	-0.02 (0.27)
Household Assets (HHA)									
Own house=1	pa_e1d	-0.16 (0.61)	-0.15 (0.57)	-0.12 (0.44)	-0.22 (0.84)	-0.16 (0.62)	-0.15 (0.57)	-0.12 (0.44)	-0.22 (0.86)
Electricity available=1	pa_e81d	0.03 (0.10)	-0.04 (0.12)	-0.03 (0.08)	0.05 (0.15)	0.03 (0.11)	-0.04 (0.11)	-0.03 (0.08)	0.06 (0.18)
Sanitation available=1	pa_e82d	0.56 (1.71)*	0.50 (1.49)	0.51 (1.52)	0.56 (1.65)*	0.57 (1.73)*	0.51 (1.50)	0.51 (1.52)	0.57 (1.68)*
Water available=1	pa_e85d	-0.30 (0.64)	-0.22 (0.46)	-0.25 (0.52)	-0.20 (0.42)	-0.31 (0.66)	-0.22 (0.47)	-0.25 (0.52)	-0.21 (0.44)

Note 1) Huber-White consistent robust standard errors are reported. The symbols *, **, and *** indicate statistical significance at 10%, 5%, and 1% levels, respectively.

Note 2) ~ indicates endogenous variable. Instrumental variables are composed of all exogenous variables, the government's monetary transfer (M), and average community participation (ACP).

Table 5.2 (continued)
Production Function Estimation with Municipality Fixed Effects
Dependent Variable: Mathematics Test Score

Sample	spec.	1	2	3	4	5	6	7	8
Method of estimation		OLS	OLS	OLS	OLS	IV	IV	IV	IV
Variable definitions	Code	Coef. t	Coef. t	Coef. t	Coef. t	Coef. t	Coef. t	Coef. t	Coef. t
School Quality (SQ)									
Teaher-pupil ratio (school level)	d_p_all		-36.70 (1.59)	-34.19 (1.47)	-28.70 (1.17)		-37.14 (1.62)*	-34.05 (1.47)	-30.17 (1.25)
If sanitation/latrine available at shool=1	d_d11d		0.51 (0.80)	0.72 (0.98)	1.39 (1.61)		0.51 (0.80)	0.71 (0.97)	1.43 (1.63)
If electricity available at school=1	d_d12d		0.36 (0.71)	0.04 (0.08)	0.55 (0.93)		0.34 (0.67)	0.05 (0.09)	0.55 (0.93)
If piped water available at school=1	d_d21d		-0.15 (0.32)	-0.28 (0.59)	0.06 (0.11)		-0.14 (0.30)	-0.28 (0.59)	0.07 (0.13)
If library available	pr_d55d								
Teacher Quality (TQ)									
=1 if teacher is female	pr_fem			-0.29 (0.56)	-0.28 (0.47)			-0.29 (0.56)	-0.26 (0.44)
=1 if teacher finish University education	predu_un			-0.92 (1.99)	-0.76 (1.40)			-0.92 (1.95)	-0.72 (1.28)
Year of teacher experience	pr_year			0.04 (0.59)	0.06 (0.86)			0.04 (0.58)	0.06 (0.90)
Age of the teacher	pr_age			-0.02 (0.51)	-0.06 (1.04)			-0.02 (0.50)	-0.06 (1.09)
Classroom Quality (CQ)									
# of students in the classroom	pr_d2				-0.05 (1.43)				-0.05 (1.48)
If all students have math and/or lanugage textbook=1	pr_text				-0.13 (0.28)				-0.13 (0.28)
If textbook data missing=1	text_m				1.50 (1.68)*				1.52 (1.70)*
# of books in classroom library (unit=100 books)	books				0.25 (2.45)**				0.26 (2.47)**
If # of books data missing=1	book_m				0.60 (0.85)				0.63 (0.89)
=1 if teacher teaches in multigrade classroom	pr_d15d				0.14 (0.19)				0.07 (0.11)
=1 if multigrade information missing	pr_d15m				0.27 (0.13)				0.47 (0.23)
Constant	_cons	2.81 (3.09)***	2.83 (2.00)**	3.44 (2.16)**	4.31 (2.17)**	2.81 (3.09)***	2.85 (2.02)**	3.43 (2.18)**	4.43 (2.24)**
R-squared	R^2	0.28	0.29	0.30	0.32	0.28	0.29	0.30	0.32
Number of Observations	N	594	594	594	594	594	594	594	594

Note 1) Huber-White consistent robust standard errors are reported. The symbols *, **, and *** indicate statistical significance at 10%, 5%, and 1% levels, respectively.
Note 2) + indicates endogenous variable. Instrumental variables are composed of all exogenous variables, the government's monetary transfer (M), and average community participation (ACP).

Table 5.3
Production Function Estimation with Municipality Fixed Effects
Dependent Variable: Language Test Score

Sample	spec.	1	2	3	4	5	6	7	8
Method of estimation		OLS	OLS	OLS	OLS	IV	IV	IV	IV
Variable definitions	Code	Coef. t	Coef. t	Coef. t	Coef. t	Coef. t	Coef. t	Coef. t	Coef. t
Community Participation Varibale									
# of ACE/SdPF's visits to classroom per month+	pr_d11+	0.10 (2.04)**	0.11 (2.15)**	0.15 (2.70)***	0.12 (2.00)**	0.11 (2.21)**	0.12 (2.26)**	0.16 (2.82)***	0.11 (1.83)*
=1 if EDUCO schools	e_w	-0.13 (0.28)	-0.17 (0.34)	-0.35 (0.70)	-0.78 (1.41)	-0.19 (0.40)	-0.20 (0.41)	-0.43 (0.85)	-0.76 (1.38)
Child Generic Chracteristics (CHG)									
Gender (female=1)	a_d_1d	0.03 (0.20)	0.04 (0.25)	0.05 (0.30)	0.08 (0.52)	0.03 (0.22)	0.04 (0.26)	0.05 (0.32)	0.08 (0.51)
Child's age	childage	0.04 (0.91)	0.04 (0.86)	0.04 (0.90)	0.03 (0.70)	0.04 (0.90)	0.04 (0.86)	0.04 (0.88)	0.03 (0.70)
Live without parent(s)=1	a_c_1d2	0.48 (1.89)*	0.47 (1.87)*	0.49 (1.95)*	0.51 (2.04)**	0.48 (1.88)*	0.47 (1.86)*	0.49 (1.94)*	0.52 (2.04)**
Household Generic Characteristics (HHG)									
Mother enter basic education=1	edl_m	0.06 (0.36)	0.06 (0.35)	0.06 (0.37)	0.07 (0.40)	0.06 (0.36)	0.06 (0.35)	0.06 (0.37)	0.07 (0.40)
Mother's education missing=1	ed_mm	0.23 (0.80)	0.26 (0.90)	0.19 (0.65)	0.31 (1.03)	0.23 (0.81)	0.26 (0.91)	0.20 (0.66)	0.31 (1.03)
Father enter basic education=1	edl_p	0.15 (0.91)	0.15 (0.87)	0.13 (0.79)	0.08 (0.51)	0.15 (0.92)	0.15 (0.87)	0.13 (0.79)	0.08 (0.50)
Father's education missing=1	ed_pm	-0.51 (1.34)	-0.52 -1.33)	-0.49 (1.26)	-0.46 (1.17)	-0.51 (1.33)	-0.52 (1.32)	-0.48 (1.24)	-0.46 (1.18)
Number of siblings (age of 4-15)	pa_b3	-0.01 (0.23)	-0.01 (0.15)	-0.02 (0.39)	-0.02 (0.32)	-0.01 (0.21)	-0.01 (0.14)	-0.02 (0.37)	-0.02 (0.33)
Household Assets (HHA)									
Own house=1	pa_e1d	0.02 (0.12)	0.01 (0.03)	0.01 (0.06)	-0.07 (0.34)	0.02 (0.13)	0.01 (0.03)	0.01 (0.06)	-0.07 (0.34)
Electricity available=1	pa_e81d	-0.02 (0.07)	-0.05 (0.24)	-0.08 (0.37)	-0.01 (0.03)	-0.02 (0.08)	-0.05 (0.25)	-0.08 (0.40)	-0.01 (0.02)
Sanitation available=1	pa_e82d	0.30 (1.27)	0.28 (1.21)	0.30 (1.25)	0.32 (1.31)	0.29 (1.25)	0.28 (1.19)	0.29 (1.22)	0.32 (1.31)
Water available=1	pa_e85d	-0.45 (1.16)	-0.47 (1.21)	-0.45 (1.18)	-0.44 (1.15)	-0.44 (1.15)	-0.46 (1.21)	-0.44 (1.16)	-0.44 (1.16)

Note 1) Huber-White consistent robust standard errors are reported. The symbols *, **, and *** indicate statistical significance at 10%, 5%, and 1% levels, respectively.
Note 2) + indicates endogenous variable. Instrumental variables are composed of all exogenous variables, government's monetary transfer (M), and average community participation (ACP).

Table 5.3 (continued)
Production Function Estimation with Municipality Fixed Effects
Dependent Variable: Language Test Score

Sample	spec.	1	2	3	4	5	6	7	8
Method of estimation		OLS	OLS	OLS	OLS	IV	IV	IV	IV
Variable definitions	Code	Coef. t	Coef. t	Coef. t	Coef. t	Coef. t	Coef. t	Coef. t	Coef. t
School Quality (SQ)									
Teaher-pupil ratio (school level)	d_p_all		5.87 (0.36)	13.32 (0.83)	13.04 (0.78)		6.14 (0.38)	14.04 (0.88)	12.77 (0.77)
If sanitation/latrine available at shool=1	d_d11d		-0.22 (0.43)	-0.59 (1.10)	0.05 (0.08)		-0.22 (0.43)	-0.59 (1.10)	0.06 (0.09)
If electricity available at school=1	d_d12d		0.24 (0.66)	0.04 (0.11)	0.39 (0.96)		0.25 (0.69)	0.06 (0.16)	0.39 (0.96)
If piped water available at school=1	d_d21d		-0.18 (0.57)	-0.30 (0.93)	-0.20 (0.57)		-0.18 (0.58)	-0.31 (0.97)	-0.20 (0.56)
Teacher Quality (TQ)									
=1 if teacher is female	pr_fem			0.01 (0.03)	-0.05 (0.14)			0.00 (0.01)	-0.05 (0.13)
=1 if teacher finish University education	predu_un			-0.72 (2.24)**	-0.62 (1.73)*			-0.74 (2.26)**	-0.61 (1.67)*
Year of teacher experience	pr_year			-0.06 (1.46)	-0.05 (1.08)			-0.06 (1.51)	-0.05 (1.06)
Age of the teacher	pr_age			0.06 (1.92)*	0.04 (1.36)			0.06 (1.96)*	0.04 (1.33)
Classroom Quality (CQ)									
# of students in the classroom	pr_d2				-0.03 (1.53)				-0.03 (1.54)
If all students have math and/or lanugage textbook=1	pr_text				-0.31 (1.10)				-0.31 (1.10)
If textbook data missing=1	text_m				0.59 (1.02)				0.59 (1.03)
# of books in classroom library (unit=100 books)	books				0.20 (2.41)**				0.20 (2.41)**
If # of books data missing=1	book_m				0.10 (0.23)				0.10 (0.24)
=1 if teacher teaches in multigrade classroom	pr_d15d				0.19 (0.41)				0.17 (0.39)
=1 if multigrade information missing	pr_d15m				1.65 0.94				1.68 0.95
constant	_cons	2.65 (4.16)*** *	2.76 (2.74)*** *	2.08 (1.86)*	2.98 (2.21)**	2.65 (4.17)*** *	2.75 (2.74)*** *	2.05 (1.84)*	3.01 (2.26)**
R-squared	R^2	0.23	0.24	0.25	0.27	0.23	0.24	0.25	0.27
Number of Observations	N	594	594	594	594	594	594	594	594

Note 1) Huber-White consistent robust standard errors are reported. The symbols *, **, and *** indicate statistical significance at 10%, 5%, and 1% levels, respectively.
Note 2) ~ indicates endogenous variable. Instrumental variables are composed of all exogenous variables, government's monetary transfer (M), and average community participation (ACP).

Table 5.4
Estimation Results of Wage Compensation Scheme
Dependent Variable: Wage Payment Per Hour

Specification		I	I	I	I	II	II	II	II
Method of estimation		OLS	IV	OLS	IV	OLS	IV	OLS	IV
		Coef.	Coef.	Coef.	Coef.	Coef.	Coef.	Coef.	Coef.
		t	t	t	t	t	t	t	t
= 1 if EDUCO	e_w	-5.50	-7.84	-7.53	-15.84	-3.18	-1.11	-5.64	-7.48
		(1.30)	(2.19)**	(1.66)*	(1.28)	(0.77)	(0.27)	(1.04)	(0.88)
Teacher's days of attendance per month~	attend~	-2.43	-2.48			-2.89	-5.66		
		(0.96)	(0.59)			(1.09)	(1.53)		
pr_d11*attend~	a2OE2~	0.04	0.04			0.04	0.04		
		(2.12)**	(2.07)**			(2.17)**	(2.21)**		
Teacher's meeting with parents ~	pr_f123~			-0.39	3.65			-0.48	1.21
				(0.53)	(0.52)			(0.58)	(0.33)
pr_d11*pr_f123 ~	a2OE~			0.19	0.06			0.17	0.10
				(1.96)**	(0.31)			(1.79)*	(0.88)
Mincer equation variables									
= 1 if female teacher	fem					-2.09	-2.31	-1.33	-0.56
						(0.37)	(0.39)	(0.24)	(0.10)
=1 if finish technical school	predu_tc					7.25	7.44	6.75	6.48
						(0.79)	(0.80)	(0.74)	(0.74)
= 1 if finish collage	predu_un					0.47	0.40	1.41	2.61
						(0.05)	(0.04)	(0.15)	(0.27)
Years of past teaching experience	pr_year					1.27	1.56	0.77	1.03
						(1.16)	(1.24)	(0.66)	(0.83)
Years of past teaching experience squared	year2					-0.04	-0.05	-0.02	-0.03
						(1.17)	(1.31)	(0.63)	(0.80)
constant	_cons	91.99	234.71	29.51	20.57	91.68	163.18	20.01	14.95
		(1.36)	(2.46)**	(4.17)***	(1.04)	(1.24)	(1.68)*	(1.55)	(0.85)
Number of observations		133	133	133	133	133	133	133	133
R-squared		0.12	0.05	0.13	0.00	0.15	0.13	0.14	0.13
RSS (in thousands)		63.43	69.00	62.85	72.30	61.23	62.68	61.66	63.15
Amemiya's Prediction Criterion (in thousands)		85.64	93.15	85.10	97.89	89.58	91.70	90.21	92.34
Akaike's Information Criterion (in thousands)		86.89	94.53	86.10	99.05	90.62	92.77	91.25	93.46
Test statistics for Mincer wage equation variables (F-value for the null hypothesis of all β's are zero)						0.69 [0.63]	0.81 [0.54]	0.30 [0.91]	0.31 [0.90]

Note 1) Huber-White consistent robust standard errors are reported. The symbols *, **, and *** indicate statistical significance at 10%, 5%, and 1% levels, respectively.
Note 2) ~ indicates endogenous variable. Instrumental variables are composed of all exogenous variables, government's monetary transfer (M), M squared, average community participation (ACP), ACP squared, and M-ACP interaction variable.

Table 5.5
Estimation of Teacher Effort Function
by Department Fixed Effects Estimation
Dependent variable:
Teacher's days of school attendance or hours meeting with parents (per month)

Dependent variable		attend		pr_fl23	
Method of Estimation		OLS	IV	OLS	IV
		Coef. t	Coef. t	Coef. t	Coef. t
constant	_cons	26.25 (57.31)**	26.25 (57.49)**	2.74 (2.41)**	1.96 (2.47)**
=1 if EDUCO	e_w	0.43 (1.35)	0.44 (1.39)	1.49 (2.81)***	1.51 (2.69)***
# of ACE/SpDF's visits to classroom per month~	pr_d11~	0.05 (2.09)**	0.05 (1.82)*	0.15 (2.28)**	0.15 (2.13)**
R-squared	R^2	0.23	0.23	0.26	0.26
Number of Observation	N	133	133	133	133

Note 1) Huber-White consistent robust standard errors are reported. The symbols *, **, and *** indicate statistical significance at 10%, 5%, and 1% levels, respectively.
Note 2) ~ indicates endogenous variable. Instrumental variables are composed of all exogenous variables, government's monetary transfer (M), and average community participation (ACP).

Table 5.6
Fixed Effects Estimation of Classroom-level Input Demand Function

Dependent Variable		# of students in classroom (pr_d2)		=1 if all students have math and/or language textbooks		# of books in classroom library		=1 if multigrade classroom	
Estimation Method		Within Department Estimator with Robust Standard Errors		Conditional logit		Within Department Estimator with Robust Standard Errors		Conditional logit	
Specfication		1	2	1	2	1	2	1	2
		Coef. t	Coef. t	Coef. z	Coef. z	Coef. t	Coef. t	Coef. z	Coef. z
constant	_cons	37.78 (8.36)***	38.16 (8.44)***			-3.17 (0.26)	-10.39 (0.73)		
=1 if EDUCO	e_w	-7.12 (4.33)***	-6.18 (3.49)***	0.64 (1.01)	0.95 (1.25)	62.69 (1.31)	44.71 (0.81)	0.80 (1.62)	0.62 (1.24)
# of ACE/SpDF's visits to classroom per month	pr_d11		-0.22 (2.30)**		-0.06 (0.83)		4.26 (1.16)		0.07 (1.39)
R-squared	R^2	0.18	0.18	0.01	0.02	0.11	0.11	0.02	0.04
Number of Observation	N	133	133	103	103	133	133	124	124

Note 1) The symbols *, **, and *** indicate statistical significance at 10%, 5%, and 1% levels, respectively

Note 2) Logit model with department fixed effects is estimated consistently by maximizing conditional likelihood function.

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