Micro Household Surveys and Development Microeconomics: With Special Emphasis on Child Health and Intrahousehold Resource Allocation in Sub-Saharan Africa and South Asia [$]

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Abstract:

This paper surveys the recent progress in modeling agricultural households and then gives an illustrative example of the achievements in child health in Sub-Saharan Africa and South Asia, paying special attention to the issue of intrahousehold resource allocation. From the empirical example using micro data sets from the Demographic and Health Surveys, a clear contrast is found in the effect of mothers' farming on child health between the two regions. We interpret that this could be due to a difference in gender roles in agricultural production and household food security. Because gender roles in agricultural production in Sub-Saharan Africa are "sex-segregated" where females are likely to grow subsistence food crops and are responsible for the production and disposal/marketing of these crops, those children with farming mothers are healthier than those with farming fathers. Because gender roles in agricultural production in South Asia are "sex-sequential" where females are assigned a specified set of operations without command over the disposal/marketing of crops and those households that send their women to agricultural labor markets are likely to be very poor, those children with farming mothers are less healthy than those with farming fathers. This interpretation is a tentative one without structural evidence. A microeconometric analysis, which directly combines households' resource allocation rules with households' achievement in production, consumption, and human capital investment is required.

Keywords: agricultural household models, risk, intrahousehold resource allocation, child health, gender roles

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1. Introduction

In recent decades, there has been rapid progress, both theoretical and empirical, in the development of analytical tools for household behavior. The progress has been simulated by newly available micro household data collected from developing countries, including those in West Africa.

With this background, this paper focuses on agricultural household models in which households' decision-making in production is simultaneously analyzed with that in consumption (Singh et al. 1986; Kurosaki 2001, Chs.1-3). Based on theoretically consistent modeling, this approach could provide useful information on the potential effects of exogenous changes in rural economies (e.g., a new technology or market reform) on farmers' supply response and on welfare status. In other words, this approach enables us to enhance our understanding of farmers' decision-making process and factors that affect their decisions.

The specific objectives and the structure of this paper are as follows. First, the recent progress in modeling agricultural households is surveyed briefly to clarify the direction for future research (Section 2). In this attempt, the impact of newly collected micro household data sets on the literature is assessed. Second, as an illustrative example in this direction, we contrast the achievement in child health in Sub-Saharan Africa with that in South Asia using micro data (Section 3). In addition to a descriptive analysis, we provide econometric results to distinguish the effects of gender roles on child health from that of resource availability at the household level. The final section summarizes the paper with suggestions for future research.

2. Recent literature on agricultural household models[1]

2.1 Micro household surveys and development microeconomics

Recently, microeconometric studies on the behavior of rural households have been

conducted for developing countries. The accumulation of detailed data sets of micro households has facilitated this development, such as the World Bank's Living Standards Measurement Study [LSMS] (Grosh and Glewwe 1998). The design and nature of these data sets and their utility for development analyses are comprehensively analyzed in Grosh and Glewwe (2000). Therefore, this section focuses on the issues that are relevant to modeling and analyzing rural households empirically with special emphasis on the poor in Sub-Saharan Africa and South Asia.

First, why is it important to analyze the household as a unit? A quick answer to this question is that it is a basic unit of data collection regarding consumption, which is one of the most important determinants of people's welfare. Another reason is the importance of self-employment enterprises in low income economies, such as peasant farming, household manufacturing, miscellaneous jobs in informal sectors, etc. In such cases, information on income that sustains household consumption is not available at the individual level but only at the household level.

In the traditional setup for collecting statistics, the two sides of the household economy were usually collected in separate surveys: information on consumption was the focus of household expenditure surveys and information on peasant farm production was collected through farm accounting surveys. However, as is well known now as the "non-separability" of production decisions from consumption preferences, a separate treatment of the two sides cannot be justified in conditions commonly found in developing countries, such as markets with significant transaction costs and incompleteness (Singh et al. 1986; Haddad et al. 1997).

It is only by simultaneously collecting information on households covering their demography, consumption patterns, saving and asset adjustments, production decisions, investment, etc. that we can analyze the real constraints faced by households in enhancing their welfare and their possible response to changes in the exogenous environment, including policy reforms. In attempts to model the microeconomics of rural households, such interactions could be conceptualized as (i) *intrahousehold* resource allocation, such as interaction between peasant farm production and household consumption

or competition for food among household members, (ii) *intertemporal* resource allocation, such as saving for uncertain events for the future or investing in children's human capital, and (iii) *interhousehold* resource allocation, such as transfers among reciprocally linked households.

The second point is that micro household data have been accumulated from developing countries, which enable us to analyze these three interactions empirically. A good example is those microeconometric studies using LSMS data sets (Grosh and Glewwe 1998; 2000). This project was initiated by the World Bank in 1979 to assess living standards, poverty, and inequality in developing countries. Through collaborative work with statistics authorities in each country, micro data covering comprehensive aspects of the household economy have been collected. A number of them are panel data in which direct information on household dynamics can be obtained. In each country, several thousand or more households have been surveyed on a sampling basis with detailed household questionnaire, supplemented by community questionnaires and price questionnaires.

Another data set that is worth mentioning is a village-level survey data set collected in the Indian Deccan Plateau by the International Crops Research Institute for the Semi-Arid Tropics [ICRISAT] (Walker and Ryan 1990). The data set includes panel information spanning a decade, collected in three villages and covering more than 100 households. Although the data set is not ideal in terms of representativeness and its cross section size, it has been utilized intensively in microeconometric studies on economic development, since this data set is especially rich in its detailed agronomic variables (e.g., soil quality) and has a relatively long time horizon. The data set has been analyzed in various studies that are theoretically consistent as a household model and empirically rigorous as an application of microeconometrics.[2]

2.2 Recent development of studies on risk and intrahousehold resource allocation

The microeconometric studies have feedback effects on the theoretical modeling of households. This paper focuses on two areas of relevance to rural economies in South Asia and Sub-

Saharan Africa: household behavior under risk and intrahousehold resource allocation models.

First, regarding the effects of risk on household behavior and household welfare, significant progress has been observed both in theoretical modeling of households' strategy in coping with risk and in empirical investigation using high-quality household data. Among them, Townsend (1994) and Udry (1994) are worth mentioning. Townsend (1994) proposed a model of Pareto-efficient risk-sharing among villagers and applied the theoretical model to the ICRISAT households in order to investigate whether they are effectively insured or not. He found that the extent of insurance was much better than previously expected but still not to the level of Pareto efficiency. Udry (1994) proposed a model in which state-contingent loans are used to share risk efficiently among villagers and applied the theoretical model to Nigerian households in order to investigate whether they are insured through such kind of loans. He found that households do use state-contingent, reciprocity-based loans but the resulting insurance is not Pareto efficient.

These and other studies have found that the existence of risk and the incompleteness of insurance markets imply a static welfare loss for the poor because they suffer more from consumption instability including food insecurity. Faced with inefficient risk sharing, households may resort to income smoothing, or, *ex ante* risk management, which decreases the production efficiency of poor farmers (Kurosaki 1998; Kurosaki and Fafchamps 2002). If income smoothing measures are not sufficient, households may use decumulation of production capital such as land, livestock, or human capital (Rosenzweig and Wolpin 1993; Fafchamps et al. 1998; Fafchamps and Pender 1997; Jacoby and Skoufias 1997). This is indeed an expensive way to cope with risk since it potentially converts transient poverty into permanent poverty.

Another area in which both theoretical and empirical modeling of household behavior have progressed substantially is a rigorous treatment of intrahousehold resource allocation.[3] In the traditional models of household behavior such as found in Singh et al. (1986), a household is treated as a single economic agent that maximizes its welfare defined over the vector of consumption

expenditures by individual household members. These models are called “unitary household models” Important implications of these models for development policies are that intrahousehold resource allocation should be efficient in the Pareto sense and that the bargaining power among household members should not affect resource allocation of the household.

Empirical studies have cast serious doubts on these two implications. For example, Udry (1996; 1999) demonstrated that marginal productivity of land is not equalized between wife-managed plots and husband-managed plots for the case of Burkina Faso, even after controlling for land quality. This is in clear violation of the Pareto efficiency in intrahousehold resource allocation. Furthermore, the effects of income transfer on consumption expenditure patterns may be different depending on who commands the transfer in the household; a number of empirical studies on developing countries found that husbands prefer to spending on luxury consumption goods like tobacco, whereas wives prefer to spend more on education and child health (Quisumbing and Maluccio 2000).

To incorporate these empirical findings into a theoretically consistent model of household behavior, “collective household models” have been proposed in the literature (Udry 1996; Apps and Rees 1996; Chiappori 1992; 1997; Haddad et al. 1997). In these models, a household is modeled as a collective of individual members with individual objective functions and they compete for resource allocation among the household members based on some specified rules of bargaining and cooperation. The collective models are more general than the unitary models. Intrahousehold resource allocation may not be Pareto efficient and improvement in production efficiency can be expected through changes in bargaining parameters among household members. These implications are important from a development perspective. Udry (1996) showed the existence of Pareto inefficiency among Burkina Faso farmers and attributed the inefficiency to the information asymmetry and the incomplete enforcement between the wife and the husband.

Recent observations on household resource allocation in developing countries have given more support to collective household models than to unitary household models (Bardhan and Udry

1999). Nevertheless, the number of rigorous empirical studies based on theoretically consistent models of intrahousehold resource allocation is not large. Extension of the models to incorporate risk coping and intertemporal dynamics of collective households is especially called for.

3. Child health and intrahousehold resource allocation in Sub-Saharan Africa and South Asia

3.1 Descriptive evidence and its interpretation

Recently, child health in developing countries has been analyzed with recognition of the fact that it is a result of long-term investment in children's human capital by their parents (Behrman 1997a; 1997b; Alderman et al. 1996; 2001). At the same time, a number of empirical studies on households' expenditure on health and education of children have been conducted for developing countries in a static framework. Some of them attempted to test the implications of collective household models versus unitary household models (Quisumbing 1996; Quisumbing and de la Bri`ere 2000; Quisumbing and Maluccio 2000). Both lines of the literature have found that a household resource constraint, which could be represented by per capita real income or consumption expenditure, is an important determinant of child health.

Table 1 contrasts the achievement of Sub-Saharan Africa and South Asia in terms of per capita economic growth and child health indicators. Information on economic growth shows that South Asia has enjoyed higher economic growth than Sub-Saharan Africa. Trends in per capita food production show a similar contrast between the two regions. Therefore, as far as the macro indicators suggest, South Asian countries have fewer resource constraints in improving child health. Nevertheless, indicators for child health in rural areas, which were calculated by one of the authors (Ueyama 2000) using micro data contained in the Demographic and Health Surveys (DHS),[4] do not support this conjecture. On the contrary, it is South Asian countries that suffer from more problems in child malnutrition than Sub-Saharan Africa.

Figure 1 summarizes our approach to explain this contrast. The curve including point A shows the average propensity to spend on child health as the household resource level goes up.

First, this curve shifts with preferences and bargaining characteristics of households. For example, faced with the same resource constraint, the unitary household with a male household head may spend less on child health (point B_1) than the collective household where its female members have a relatively strong bargaining power and they evaluate the future status of child health more highly than males (point C_1). This difference in preferences may come from social norms on gender roles or an economic calculation of future income with a differential in survival probability between males and females. Bargaining powers of females versus males might be a function of social norms on gender roles and the economic power related with household formation such as a differential in wealth levels attributable to the wife and the husband at the time of their marriage.

Second, this curve shifts with the level of consumption risk perceived by the household. For example, with the same expected income, a household faced with a high risk of insufficient food may spend less on child health (point B_1) than a household whose food consumption is secure (point C_1). This difference in food security may come from a difference in gender roles in household strategy to secure food crops.

In both cases, neglecting the possibility of shifts in Engel curves for child health expenditure yields a bias in estimating the marginal propensity to spend with respect to resource availability, as is shown in Figure 1. As an extreme case, the slope based on observations A, B_2, and C_2 would be negative while the real slope is positive.

Based on this approach, we hypothesize that the contrast in Table 1 is due to the difference in intrahousehold resource allocation rules in the two regions. Among various determinants of these rules, we focus on gender roles in agricultural production and household food security. Relatively speaking, gender roles in agricultural production in Sub-Saharan Africa are “sex-segregated” in contrast to those in South Asia which are “sex-sequential” (Boserup 1970; Whitehead 1985; 1990). In Sub-Saharan

Africa, females are likely to grow subsistence food crops whereas males grow cash crops and each sex is responsible for each group of crops from production to disposal/marketing; in South Asia, in contrast, households grow both subsistence food crops and cash crops with different operations assigned to different sexes, where the disposal and marketing are usually controlled by males. We expect that "sex-segregated" gender roles with females concentrating on food crops are more consonant with better child health because females can allocate more food and nutrition to children, at the same level of expected household income.

3.2 Econometric evidence using DHS micro data

To empirically test this hypothesis, detailed information is necessary regarding household income on the one hand and gender roles and sex-segregation/sequentialization in agricultural production on the other hand. This is left for further research. In this paper, we instead approximate the former by the usual determinants of household income and the latter by the gender-differentiated job participation in agriculture. The choice is basically due to the limitation of our micro data sets; we use various rounds of DHS for various countries in Sub-Saharan Africa and South Asia. DHS is rich in information on individual health achievement but does not give detailed information on household income or consumption.

We report estimation results for rural Nigeria and rural Pakistan in Table 2. The dependent variable is the "weight for age" of individual children, normalized as the standard deviation from the reference median. Considering that both economies are low-income countries with a serious problem in malnutrition, we can interpret those variables that have a positive effect on the dependent variable as those factors that improve child health. The explanatory variables include the following. As income factors, a dummy for durable consumption goods (electricity, television, car, and toilet facility) and education dummies for fathers and mothers are included. A twin dummy and child age are also included to control the physical characteristics of children. Our concern is on the effects of two

dummies, one for father's engagement in agricultural work and another for mother's engagement in agricultural work. If the resource allocation on child health is affected by the sex-segregation or sex-sequentialization in agriculture, we expect that mothers' agricultural engagement dummy has a more positive or less negative coefficient than fathers' agricultural engagement dummy in sex-segregated Sub-Saharan Africa.

Our results in Table 2 show a clear contrast between the two countries. In Nigeria, the coefficient on the dummy for a farming father is negative but insignificant. On the other hand, those children whose mother is engaged in agriculture are associated with a better nutrition status, which is statistically significant. This can be interpreted as evidence that women's agricultural role in Nigeria has favorable effects on child health through improved food security via the sex-segregated crop production system.

In sharp contrast, in Pakistan, the effect of mothers' engagement in agriculture on child health is not only significantly negative, but also more negative in a relative sense than that of fathers' farming engagement. The sex-sequential hypothesis can explain the fact that both dummies have similar effects, but it cannot explain the more negative effects of mothers' agriculture engagement dummies. To explain this, the social norm of *purdah* (the custom of seclusion of women) and its effects on labor force allocation in South Asia need to be explained.[5] The norm is strongly observed in Pakistan. Because of the prevalence of *purdah*, male household heads in Pakistan do not prefer female family members to work outside; when the female members work domestically in productive activities, the heads do not recognize their work as economically productive work unless they are engaged in the marketing stage also, which is very rare. Therefore, only poor households that cannot afford to observe *purdah* send their female members to agricultural wage jobs. Consequently, those households in DHS that report that mothers are engaged in agriculture are likely to belong to the poorest section. Because these mothers are not farm managers of subsistence food production as in Sub-Saharan Africa, their children in Pakistan suffer from lower health achievements.

To exploit the strength of DHS in that it covers various countries with a similar questionnaire format, we estimate a similar model for other countries in Sub-Saharan Africa and South Asia. Summary results are shown in Table 3 in terms of the coefficients on the two dummies for father's engagement in agricultural work and for mother's. Results for three other South Asian countries (Bangladesh, India, and Nepal) consistently support our hypothesis that sex-sequential gender roles in agricultural production together with a *purdah* custom result in lower health for children whose mothers are engaged in agriculture. The negative effect of a farming mother is the strongest in Pakistan where *purdah* is observed the most strictly.

Results for Sub-Saharan Africa are mixed but the majority shows a pattern similar to Nigeria (1990); those children with their mother working in agriculture have relatively better health conditions than those with their father working in agriculture. Central African Republic, Cameroon (1991), Kenya (1993), Mali, Nigeria (1999), Tanzania in both years, and Togo are those countries with a clear superiority for farming mothers. Only in Cote d'Ivoire, Ghana in both years, and Niger (1992) is the pattern significantly reversed as in South Asia.

4. Conclusions

In this paper, we surveyed the recent progress in modeling agricultural households and then analyzed the achievement in child health in Sub-Saharan Africa and South Asia, paying due attention to the issue of intrahousehold resource allocation. From empirical analyses using DHS micro data sets, we showed a clear contrast in the effect of mothers' farming on child health between the two regions. We interpreted this to be due to a difference in gender roles in agricultural production and household food security. Because gender roles in agricultural production in Sub-Saharan Africa are "sex-segregated" where females are likely to grow subsistence food crops and are responsible for the production and disposal/marketing of these crops, those children with farming mothers are healthier

than those children with farming fathers. Because gender roles in agricultural production in South Asia are "sex-sequential" where females are assigned a specified set of operations without authority over the disposal/marketing of crops and those households that send their women to agricultural labor markets are likely to be very poor, those children with farming mothers are less healthy than those children with farming fathers.

An implication of this interpretation for development policies could be as follows. The impact of the introduction of new agricultural technologies, e.g., rice farming technology for West Africa, on household resource allocation to child health is not only through a rise in expected household income but also through changes in intrahousehold resource allocation rules.[6] If the new technologies result in higher household income, their direct impact on child health should be positive. However, their net impact needs to be assessed with consideration on the latter channel through changes in bargaining positions and changes in food security, whose direction cannot be known *a priori*. We need a detailed study on the determinants of intrahousehold resource allocation for each case of concern.

Since the interpretation of our econometric results based on DHS data is tentative and without structural evidence, there may be other explanations that are consistent with the results. To strengthen our argument, the empirical analyses using DHS data could be combined with other sources of information to associate the intercountry difference with a difference in gender roles and macroeconomic environments in each country. On the other hand, replacing the dummy variables for parents' farming engagement by those variables that directly represent household resource allocation rules is urgently called for and country-specific micro data sets on agricultural households could be used for this purpose. These issues are left for further study.

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Table 1: Economic growth and child health indicators.

	Sub-Saharan Africa	South Asia
Economic Growth Indicators		
Per capita real GNP (1999, US$)	500	440
GNP growth rate (1980-90, %)	-1.2	3.5
GNP growth rate (1990-99, %)	-0.2	3.8
Growth rate of per capita private consumption (1980-98, %)	-1.2	2.6
Child Malnutrition Rate, Rural		
Height for age	32.81	46.21
Weight for age	29.21	46.43
Weight for height	9.92	14.93

Note: "Child Malnutrition Rate" is defined as the percentage of children (0-3 age) whose indicators are below the reference median by two or more standard deviations.

Data Source: World Bank (2000) for economic growth indicators, various rounds of DHS for child malnutrition. See Table 3 for reference years of DHS.

Table 2: Regression results for weight for age (standard deviations from the reference median).

	Nigeria (Rural, 1990)			Pakistan (Rural, 1991)		
Intercept	-119.24	(-15.90)	***	-152.79	(-19.40)	***
Electricity dummy	26.27	(3.00)	***	-2.36	(-0.36)	
Television ownership dummy				5.15	(0.75)	
Car ownership dummy	11.04	(1.07)				
Toilet facility dummy	-13.54	(-2.73)	***	22.91	(3.41)	***
Father's education						
Primary education dummy	18.29	(2.96)	***	-2.84	(-0.33)	
Secondary education dummy	20.68	(2.36)	**	27.19	(3.42)	***
Tertiary education dummy	49.21	(3.06)	***	19.99	(1.03)	
Mother's education						
Primary education dummy	4.89	(0.77)		1.33	(0.11)	
Secondary education dummy	-0.74	(-0.07)		61.57	(3.65)	***
Tertiary education dummy	45.35	(1.03)		-1.73	(-0.01)	
Twin dummy	-25.07	(-2.45)	**	-65.57	(-3.70)	***
Child age	-21.53	(-13.27)	***	-18.17	(-8.12)	***
Father's farming engagement dummy	-4.17	(-0.72)		-6.86	(-1.00)	
Mother's farming engagement dummy	18.67	(3.43)	***	-29.45	(-2.49)	***
R-squared	0.073			0.086		
F-statistics for zero slope	20.11	***		13.11	***	
Number of observations	3357			1820		

Source: Estimated by the OLS by the authors from DHS.
Note: t-statistics are indicated in parentheses, with *** 1% ** 5% and * 1% significance (two-sided test).

Table 3: Summary of regression results for rural areas in various countries.

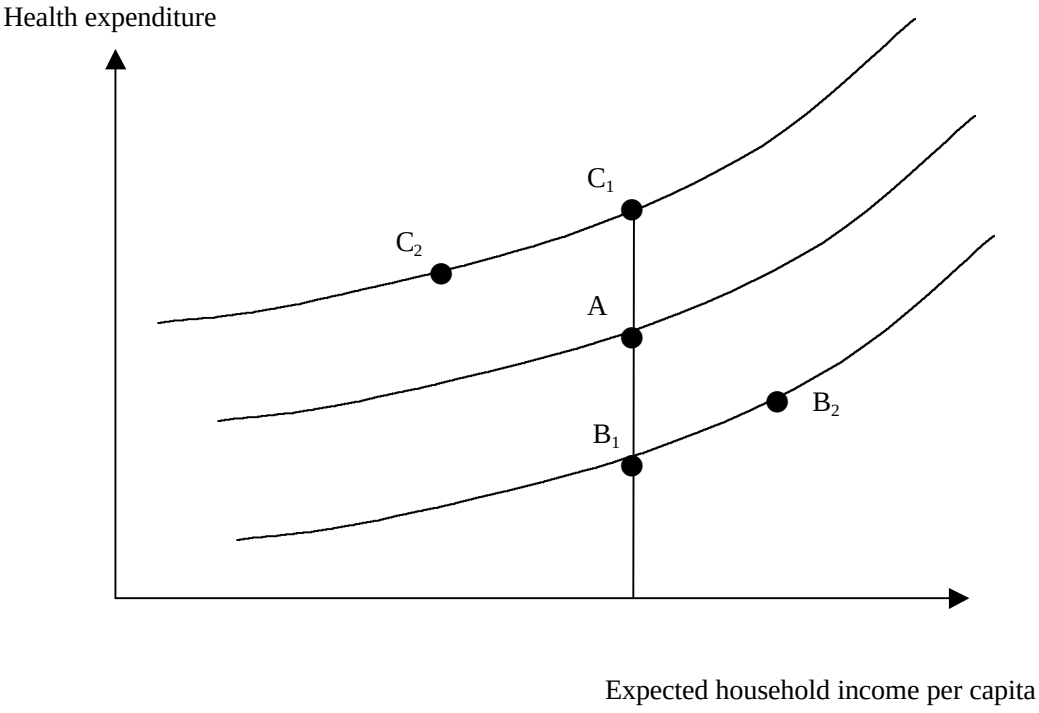
	DHS year	Father's farming engagement dummy			Mother's farming engagement dummy		
Sub-Saharan Africa							
Benin	1996	-9.13	(-1.16)		1.19	(0.19)	
Burkina Faso	1992	-17.12	(-1.93)	*	-4.37	(-0.52)	
Burkina Faso	1999	1.05	(0.14)		-1.26	(-0.26)	
Central African Republic	1994	-19.49	(-2.01)	**	10.72	(0.92)	
Cote d'Ivoire	1994	2.38	(0.28)		-20.34	(-2.94)	***
Cameroon	1991	-23.19	(-2.41)	**	7.33	(0.86)	
Cameroon	1998	-7.08	(-0.65)		15.87	(1.53)	
Ghana	1993	1.98	(0.20)		-31.19	(-3.80)	***
Ghana	1998	2.33	(0.33)		-18.75	(-3.26)	***
Kenya	1993	-8.74	(-2.10)	**	3.16	(0.74)	
Kenya	1998	-0.25	(-0.04)		-9.15	(-1.59)	
Mali	1996	-20.56	(-2.99)	***	3.01	(0.59)	
Malawi	1992	3.86	(0.65)		-0.25	(-0.02)	
Nigeria	1990	-4.17	(-0.72)		18.67	(3.43)	***
Nigeria	1999	-25.86	(-1.70)	*	47.93	(2.65)	***
Niger	1992	-2.16	(-0.26)		-27.49	(-3.61)	***
Niger	1998	0.82	(0.14)		-4.17	(-0.82)	
Rwanda	1992	-10.73	(-1.92)	*	-14.56	(-1.21)	
Tanzania	1992	-14.59	(-3.20)	***	0.44	(0.11)	
Tanzania	1996	-10.89	(-2.18)	**	-1.31	(-0.34)	
Togo	1998	-6.39	(-1.00)		8.57	(1.68)	*
Uganda	1995	-1.77	(-0.31)		-0.65	(-0.13)	
Zambia	1992	-11.26	(-2.05)	**	-9.31	(-1.82)	*
Zimbabwe	1994	-8.96	(-1.31)		5.55	(0.84)	
Zimbabwe	1999	-6.45	(-0.90)		-2.61	(-0.40)	
South Asia							
Bangladesh	1997	-0.37	(-0.10)		-7.37	(-1.66)	*
India	1993	-1.25	(-0.72)		-5.80	(-2.93)	***
Nepal	1996	-1.55	(-0.39)		-6.73	(-1.28)	
Pakistan	1991	-6.86	(-1.00)		-29.45	(-2.49)	***

Source: Estimated by the OLS by the authors from various rounds of DHS.

Notes: (1) t-statistics are indicated in parentheses, with *** 1% ** 5% and * 10% significance (two-sided test).

(2) Estimated models are the same as in Table 2, i.e., Weight for Age (standard deviations from the reference median) as the dependent variable and similar explanatory variables.

Figure 1. Child health expenditure and resource constraint



[1] This section is based on Kurosaki (2001, Chs.1-3).

[2] For example, among the studies listed in the reference of this paper, those based on the ICRISAT data include Behrman (1988a; 1988b), Fafchamps and Pender (1997), Jacoby and Skoufias (1997), Rosenzweig and Wolpin (1993), and Townsend (1994).

[3] See Haddad et al. (1997) for various approaches. Empirical investigation of intrahousehold resource allocation is one of the focus areas of the International Food Policy Research Institute, whose latest studies are available from its web site (http://www.cgiar.org/ifpri/). Behrman (1997) is also a useful and compact survey on this subject.

[4] DHS are sample surveys designed to collect information on women from age 15 to 49 in developing countries regarding their fertility, family planning practices, and health conditions. In most surveys, data on household attributes, husband information, and children characteristics are also included. See the web page at http://www.measuredhs.com/.

[5] Literally, *purdah* means a curtain; symbolically, it represents the custom of social and economic seclusion of women in South Asia. See Kurosaki (2001b) for an empirical analysis of labor force allocation and rural labor markets in rural Pakistan where *purdah* plays an important role.

[6] Sanginga et al. (1999), for example, examined the effects of soybean introduction on child health in Nigeria, not only through income but also through other routes. The authors thank Dr. V. Manyong of IITA for this reference.