Demand for children's education among small farmers in a rural area of Brazil

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In recent years economic studies have focused on the role of education as a factor leading to higher incomes in rural areas. These studies indicate that education helps to increase the productivity of resources in agriculture as well as the occupational mobility of farm people. This study is an analysis of the demand for children's education among small farmers in Brazil. The region studied was the Vale do Ribeira in the state of São Paulo, a relatively poor area located about three hours drive from the city of São Paulo. The method of analysis was to use cross-section household data to examine the demand for children's education from the perspective of human capital theory and the new household economics. Ordinary least squares regression analysis was used to examine the relationship between school enrollments of children and variables which reflect the opportunity costs of time for family members as well as other hypothesized household influences. The ages of the parents, the education of the wife, type of land tenure, number of children in the family and their ages, the frequency at which the husband listens to the radio, and family consumption expenditures are important determinants of the demand for children's education. Costs and returns to education are important considerations for school enrollment. In the sample area the opportunity cost of children's time in school is determined by the value of their time spent in off-farm work or work within the home. The wife appears to be an important decision-maker in the education process, and the tenure status of the family also effects schooling decisions significantly.
DEMAND FOR CHILDREN'S EDUCATION

AMONG SMALL FARMERS IN A

RURAL AREA OF BRAZIL

A Thesis
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of
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determined by the cost and returns to education, with the allocation of time and individual characteristics of family members entering into these cost-return calculations.

Ordinary least squares regression analysis was used to examine the relationship between school enrollments of children and variables which reflect the opportunity costs of time for family members as well as other hypothesized household influences. The statistical results indicate that the ages of the parents, the education of the wife, type of land tenure, number of children in the family, the number of children below four in the family, the frequency at which the husband listens to the radio, and family consumption expenditures are important determinants of the demand for children's education. These variables were all statistically significant at the 5 percent level or higher.

To a lesser extent, the farming characteristics of households (use of modern inputs, value of livestock), age of the children, and the distance of the school from the home are important in explaining enrollment rates. These variables were significant at the 10-percent level in at least one of the equations estimated.

The results indicate that costs and returns to education are important considerations for enrollment of children in school. In the sample area it appears that the opportunity cost of children's time in school is determined by the value of their time spent in off-farm work or in work within the home. The results show that the wife is an important decision maker in the education process. The tenure status of the family and household ownership of assets also appear to affect schooling decisions significantly.
Jabara, Cathy Lynn, M.S., Purdue University, December 1977. Demand for Children’s Education Among Small Farmers in a Rural Area of Brazil. Major Professor: Dr. G. Edward Schuh.

In recent years many economists have focused on the role of education as a factor which can lead to higher incomes in rural areas. It has been shown that education helps to increase the productivity of resources in agriculture as well as the occupational mobility of farm people. Statistics for Brazil show that education levels in rural areas are low, both in an absolute sense and as compared to education levels in urban areas. This suggests that low levels of education may be part of the poverty problem in Brazilian agriculture.

To contribute to a better understanding of education in rural Brazil, an analysis of the demand for children's education among small farmers was undertaken. The region studied was the Vale do Ribeira in the state of Sao Paulo, a relatively poor area located about three hours drive by car from the city of Sao Paulo.

The method of analysis was to use cross-section household data to examine the demand for children's education from the perspective of human capital theory and the new household economics. These two bodies of theory suggest that household demand for education is
CHAPTER I

INTRODUCTION

A major share of the poverty in the Brazilian economy is concentrated in the agricultural sector. As of 1970, per capita incomes among rural people were only about one-third of those in the nonfarm sector (43, p. 16). Moreover, during the decade of the 1960's, the disparity in incomes actually widened (43, p. 19). Hence, rural people have failed to participate in the rapid and fairly sustained development of the Brazilian economy to the same extent as their urban counterparts.1/

Resource productivity in Brazilian agriculture, with the important exception of Sao Paulo, is quite low by international standards.2/ Production tends to be carried out with traditional techniques of production. As a result, the productivity of labor and land is relatively low and, with some important exceptions, use of modern inputs such as fertilizer, improved seeds, and pesticides is quite limited.

1/ Historical perspective on the development process in Brazil can be obtained from Baer (1) and Martin (31).
2/ For an analysis of Brazilian agriculture, see Schuh (44).
These two characteristics of Brazilian agriculture, low productivity of resources and low incomes, are not independent. Fishlow (15) in particular has argued that the problem of generalized poverty in the agricultural sector is due in large part to the low productivity of human resources employed in the sector.

Recent developments in the development literature have pointed to the importance of investments in human capital as a means to both modernizing the production process in agriculture and to raising per capita incomes of rural people (46). In their path-breaking study Hayami and Ruttan (24, p. 97) show that one-third of the variation among countries in agricultural labor productivity can be explained by differences in human capital. In the case of Brazil, Thompson (54) has shown that differences in investments in rural education and in agricultural research and extension tend to account for as much of the variation in agricultural labor productivity among states as do differences in the endowments of land and labor.

Data to be presented in the next section suggest that Brazil, similar to many other countries, has a marked disparity in educational attainment between the urban and rural sectors, with the rural sector lagging far behind the nonfarm sector. The goal of this study is to add to our knowledge of why this disparity exists and why it has persisted for so long. Specifically, this study will focus on the demand for education, with the maintained hypothesis being that the educational disparity reflects in part factors affecting the demand for education.
The theory of demand for education is derived from the more general theory of human capital. In the present study human capital theory will be formulated within the context of the new household economics, which focuses on the family as a decision-making unit. In contrast to most other studies of the demand for education, hypotheses about the factors affecting the demand for education will be tested with a sample of micro data that was taken as part of a larger study of rural poverty in Brazil. The use of such micro data provides a more detailed test of factors affecting the demand for education than has been possible with aggregate data.

**Education in Brazil**

The educational system in Brazil has traditionally consisted of three levels of schooling: primary schools, secondary schools (ginasio or colegio), and university or superior schooling. Until recently primary schooling was a three to five year course of study, depending upon the state and the area within the state, in schools which operated half a day. The large cities usually maintained a five-year primary school while the smaller cities and towns usually

1/ For a comprehensive exposition of human capital theory see Becker (3).
2/ For a review of the "state of the arts" with respect to the new household economics, see Schultz (50).
3/ For a description of the study see Patricksee and Carvalho (38).
4/ For a description of the Brazilian School system prior to the most recent reforms, see Robert J. Havighurst and Aparecida J. Gouveia (23). Also, see Richard and Francine Weisskoff (57), Ch. 5.
5/ Some schools operated with three-hour sessions, while others held four-hour sessions.
had four-year schools. In the villages and open country there tended to be only three-year schools. Primary schooling was provided free by the government where schools were available.

The secondary school system differed in a number of important ways from the primary school system. In the first place, spaces in the public schools at this level were severely limited. From the ginásio level on through the higher levels, admission was based upon passing a rigid, highly competitive entrance examination.1/ Very few graduates of the four-year primary school could pass this examination. In addition, nearly all secondary schools charged tuition fees, which made it even more difficult for children from poor families to go beyond primary school.

Education was provided basically through a publicly financed school system, although private and parochial schools existed at every level. Four years of primary school attendance was required by law starting at age 7. However, schooling was not universal. Many children started school at a later age, and of those who did enroll, many did not complete the required course of study. The mean age for beginning and terminating schooling has varied widely among Brazilian families and communities.

1/ Through measures adopted in 1970, the Brazilian government set out to reform the curricula of the secondary schools. In place of the academic ginásios the plan is to set up a system of vocational schools (ginásio orientado para o trabalho) in which a reformed academic curriculum would be combined with courses in industrial arts, agriculture, home economics, and commercial arts. These measures are designed to reduce drop-out rates and to encourage students to continue their education. See Weisskoff and Weisskoff (57).
The entire lower-level educational system was reformed in 1974. Primary school (primeiro grau) was expanded to eight years by the combination of the old primary and ginásio schools. Eight years of schooling are now obligatory and tuition is free for this full period. Secondary school (segundo grau) corresponds to the old colegio, and is for three years. This level of schooling is also provided by the state at no tuition cost to the student, but the lack of schools and qualified teachers requires that a competitive entrance exam still must be passed. Private schools still exist at this level for students not passing the entrance exam, or for those who prefer private schools for other reasons.

Another modification of the 1974 reform was to adjust the vacation period so that those going to school only three hours a day ultimately receive the same amount of schooling as those going four hours a day. Variations in the quality of schooling are still quite high, however, and many of the other problems noted above still exist.

An important characteristic of education in Brazil is the wide disparity in educational attainment between the rural and urban sectors. Data in Table 1, based on the 1970 Demographic Census, provide a breakdown of the enrollment of school-age children by sector, region, and sex. For the nation as a whole less than 40 percent of the children 6-14 years of age living in rural areas were attending school as of this date. Even in the more well-developed South and Southeast of the country the percentage was only slightly above 50 percent - in sharp contrast to the high frequency rates of the urban sector.
Table 1. Children Aged 6-14 Attending School in Brazil, 1970, by Sex, Region and Sector.

<table>
<thead>
<tr>
<th>Category</th>
<th>Nation</th>
<th>North</th>
<th>North-west</th>
<th>South-east</th>
<th>South</th>
<th>Central-west</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>67.2</td>
<td>60.3</td>
<td>52.0</td>
<td>78.3</td>
<td>72.2</td>
<td>63.1</td>
</tr>
<tr>
<td>Sector</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Urban</td>
<td>95.9</td>
<td>93.9</td>
<td>79.5</td>
<td>91.9</td>
<td>97.5</td>
<td>97.6</td>
</tr>
<tr>
<td>Rural</td>
<td>38.8</td>
<td>33.0</td>
<td>33.1</td>
<td>53.2</td>
<td>52.0</td>
<td>31.8</td>
</tr>
<tr>
<td>Sex</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>68.1</td>
<td>59.3</td>
<td>50.3</td>
<td>80.5</td>
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</tr>
<tr>
<td>Female</td>
<td>66.3</td>
<td>48.5</td>
<td>53.6</td>
<td>76.5</td>
<td>68.6</td>
<td>63.3</td>
</tr>
</tbody>
</table>

Source: R.D. Singh and G.E. Schuh (52), Table 2.

\(^a/\) Includes children attending primary school only.
Using somewhat different data from the same census, Langoni showed that over 53 percent of the labor force in agriculture was illiterate, with 99 percent being either illiterate or having had only primary schooling.\textsuperscript{1} In contrast, only 14 percent of the labor force in the urban sector was classified as illiterate, with some 60 percent having had primary schooling and 13 percent secondary schooling.

The data in Table 1 also show that there was a wide difference among regions in school attendance as of 1970, with the disparity being especially great among the rural population. Attendance among this group was lowest in the sparsely populated Central West, and highest in the more well-developed Southeast. Attendance in the poverty-stricken Northeast, with approximately 30 million people, was only slightly above that of the Central West.

Interestingly enough, there is less of a disparity in attendance between males and females. Attendance rates tend to be somewhat higher for males, although the reverse is true for the Northeast.

\textbf{The Potential Contribution of Increased Education}

Since the pioneering work of Schultz (48) and Becker (3) most economic analyses of education have concentrated on the role of education as an investment good.\textsuperscript{2} The central idea behind the theory of human capital that has resulted from this approach is that individuals and families make decisions to invest in education,

\textsuperscript{1} The Langoni study is cited by Schuh and Singh (45, p. 50-52).
\textsuperscript{2} For a survey of research on the economics of education, see Psacharopoulos (42).
either in themselves or in their children, based upon its expected profitability or rate of return. Decisions with respect to education are regarded as rational investment responses to certain monetary and psychic returns. Thus, according to this theory it should be possible to analyze these decisions just as one does decisions pertaining to the formation of physical capital.

The return to investments in education accrues to the individual undertaking the investment as well as to society. Education is assumed to influence the future real income and productivity of individuals through increasing the stock of knowledge at an individual's command. Moreover, it includes not only formal schooling, but also on-the-job training and any other type of informal training which imbeds productive knowledge in individuals and increases their productivity.

In recent years various economists have pointed specifically to the importance of education among farm people and its role in contributing to increased productivity and earnings. Education or formal schooling is generally viewed as contributing positively to the incomes of individuals and families through its effect in improving the quality of the human resources owned by the individual or family. Studies by Welch (58) and Gisser (17) have indicated that increased educational opportunities in rural areas can contribute not only to increasing the productivity of labor resources, but also

1/ For an analysis of the relationship between education and income, see Becker (3), as well as earlier studies by Houthakker (25), and Miller (34).
to increasing the mobility of rural people from low productivity farm employment to more productive employment in the nonfarm sector. Schultz (47) on the other hand, has stressed the importance of education in dealing with the various disequilibria individuals face in a market economy.

Welch was one of the first to develop a systematic analysis of the contribution of education to production. His objective was to explain how education increases the productivity of farm labor. He attributed the gains in productivity from education to a "worker effect" in which output is increased due to the higher quality of labor resources employed, and to an "allocative" effect in which managerial ability to acquire and decode information about costs and inputs is enhanced. According to Welch, allocative ability plays a key role in determining the productivity of education in agriculture, and is most relevant in a dynamic setting in which considerable change is taking place.

Gisser showed that education not only increases the productivity of labor resources in agriculture, but also increases earnings of the rural labor force by increasing the mobility of rural workers. Generally, those individuals with a higher level of education are better informed of alternative job opportunities and possess job skills which make it easier to obtain nonfarm employment. Gisser's study showed that the effect of education in reducing the supply of labor in agriculture is an important contribution of education to increased rural income since it helps to reduce the surplus of human agents employed in agriculture.
Schultz expanded on the seminal ideas of Welch and Gisser and developed a more general discussion of the role of education in enhancing the ability to deal with disequilibria. Such disequilibria are generalized in the economy, and occur in household production, in firm production, and in labor and capital markets. For Schultz, an important component of the return to education is the return to exploiting these disequilibria which cognitive skills provide. The prevalence of imperfect product and factor markets in rural areas would thus make education especially valuable to rural people.

The Demand for Education

Most of the economic analyses of education to date consist of attempts to estimate the rate of return to education as an investment good. These estimates involve analyses of the costs and benefits associated with incremental units of education. Empirical evidence on rates of return are presumed to be important to individuals and to society as decision variables, and aid in obtaining an optimal social as well as private allocation of resources to investments in human capital.

The private return to the individual from the acquisition of additional education includes the direct financial return realized through higher earnings in market work, in addition to certain nonmonetary returns which occurs through broadened opportunity

1/ Becker (3) estimated the rate of return to college and to high school education. Mincer (36) estimated rates or return to on-the-job training. Martin Carnoy (9) estimated social rates of return to education in Mexico. For a more complete summary of rate of return analyses of education, see Psacharopoulous (42). For a defense of the rate of return approach, see Mark Blaug (7).
choices for employment and the opportunity to obtain further education as desired.\(^1\) Also, to the extent that production takes place within the household and home earnings are substituted for market earnings, education increases the real income of individuals through increased productivity within the home.\(^2\)

The costs of education include the direct costs for tuition and fees which the individual pays as well as the indirect or opportunity cost of the individual's time. The latter includes the income foregone by the student from spending his time in investment opportunities as opposed to earning his full opportunity wage.

Most of the rate-of-return studies recognize that there are two rates of return applicable to the decision process in regard to education: a private and a social rate of return. It is generally believed that there are certain external benefits from education that are not completely captured by the individual. Such spill-over effects are the basis of public subsidies to education.

The private rate of return to education is an estimate of the net benefits from education which accrue to the individual. Individuals are assumed to make their decisions as to whether to invest in education on the basis of the private rate of return. The social rate of return reflects the net benefits which accrue to society, including the

\(^1\) For a more complete analysis of the returns associated with education, see Weisbrod (56), and Blaug (7). For a more detailed account of the costs of education, see Hansen (22).

\(^2\) For an analysis of education in nonmarket activities, see Michael (33).
spill-over effects and any additional social costs of increased education. To the extent that education is publicly financed, the supply of education is presumably based upon its social rate of return.

The economic approach to education assumes that the demand for education, either from the individual or social perspective, is a function of its profitability or rate of return. This relationship is shown in Figure 1. The demand curve shows the marginal benefits of an incremental unit of education, with this benefit measured by the rate of return on each individual dollar of investment in education. The marginal rate of return depends upon the time series of marginal returns and the marginal production cost of the investment. The usual method to calculate the marginal rate of return is to calculate the internal rate which equates the present value of returns to additional units of education to the direct and indirect costs of education.

The supply curve shows the effective marginal financing cost of additional units of education, which is measured, for simplicity,

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1/ For a clear exposition of the relationship between the demand for education and its rate of return, see Becker (4). This section is largely based upon Becker's analysis.

2/ The demand curve is downward sloping due to the diminishing returns which are expected to set in from production of additional units of human capital.
Figure 1. Supply and Demand for Human Capital.
by the rate of interest pertinent to each additional dollar invested. This curve essentially represents the supply curve of capital for financing education.\footnote{Becker draws the supply curve as a step function. The supply curve is sloped upwards to illustrate the fact that investment funds are scarce and that a person accumulating capital must eventually shift from low-priced sources of funds to more expensive sources of funds. For example, an individual may have access to gifts from parents, relatives, and the government. When these are exhausted he may have access to subsidized but positive-cost loan funds. And when these are exhausted he may have to turn to regular commercial loans. The cost, of course, is measured by the foregone alternatives.}

According to theory, if the marginal rate of return to further investments in education exceeds the supply price of funds, income for individuals and/or society would be increased by additional investment. The opposite is true when the marginal rate of return is less than the supply price of funds for education. Income is maximized by investing up to $X_0$ dollars in education, or where marginal returns equals marginal supply price.

**Previous Studies of the Economics of Education in Brazil**

Studies of the returns to education in Brazil have been made for two cities in Minas Gerais by Castro (10), for the state of Sao Paulo by Levy (30), and for all of Brazil by Langoni (29). The estimated rates of return were high in all cases, indicating that investment in education has a relatively high payoff in Brazil. Moreover, in all three studies the rate of return was highest for primary education (a range of 20-40 percent) and lowest...
for university education (range 10-15 percent). The return to secondary education tended to lie in an intermediate range between these two.

Langoni also used census data to make an analysis of various factors explaining the differences in individual incomes. He found that between 1960 and 1970 education was the single most important factor in explaining differences in per capita incomes.

There have been two studies of the economics of education for rural people. In terms of rates of return, they present rather divergent results. Thompson (54) introduced formal schooling as a variable in the aggregate production function and found that it had a statistically significant coefficient. Since this approach gave him a marginal product for education, he was able to estimate a marginal internal rate of return to additional investments in rural education. The result was 25 percent for the agricultural sector as a whole, which compares quite favorable with the rates encountered for population groups undifferentiated by sector.

Patrick and Kehrberg (19), on the other hand, used micro data to fit the parameters of firm-level production functions with education also included as an independent variable. Their results were rather disappointing in that they found very low and in some cases negative returns to education for farm people. In only one of the five areas studied were the returns positive throughout the range of education studied, with the internal rates of return being
on the order of 14-16 percent. In a second study area the rate of return was negative to the first year of schooling, but ranged between 5.3 to 12.5 percent thereafter.

Overall, these results suggest that the rate of return to investments in education in Brazil may be reasonably high. The puzzle, then, is why the level of educational attainment in rural areas is so low, and lags so far behind that in the urban sector.

Patrick and Kehrberg provide data which suggest a possible reason for this disparity. Even though primary schooling is tuition-free, their analysis of costs indicated that approximately 75 percent of the average primary-school cost was borne by the individual, and that it represented about one-third of rural per capita incomes. At the 
\textit{ginasio} and 
\textit{colegio} levels about 90 percent of the costs were borne by the individuals, and the private costs at this level exceeded per capita incomes in the areas studied.

Hence, even with public schooling, a major share of the costs are still borne by the individual. This is a reflection in part of the opportunity costs of going to school, and in rural areas of Brazil these can be quite important. Equally as important, however, is their finding that although the costs of schooling may be low in an absolute sense, they are quite high relative to per capita incomes. Patrick and Kehrberg cite data which show that in the United States, costs of primary and secondary schools were about 10 and 40 percent of per capita incomes in 1956 - a sharp contrast to the findings for their study areas in Brazil.
Objectives and Procedures

The above discussion points to higher levels of schooling as a factor that can lead to higher incomes for rural people in Brazil. At the same time the level of schooling in rural areas is quite low, and lags substantially behind that of the urban population.

The general objective of this study is to analyze the factors affecting the demand for schooling of children among poor rural households in Brazil. The ultimate goal is to isolate those factors which act as constraints on the demand for schooling, thereby adding to our knowledge of factors affecting this important form of investment and potentially providing a basis for improved policy with respect to education questions.

The specific objectives of the study are:

(1) To develop an analytical model which suggests factors which influence the demand for education of children in low income rural households;

(2) To test for the influence of these factors with data drawn from a sample of poor rural households in Brazil; and

(3) To draw the implications from the empirical results obtained.

The demand for education can be approached from a number of different perspectives. The approach of this study is to give particular emphasis to the opportunity cost or income foregone of children from increased attendance in school, with the individual household as the unit of observation. In Brazil, where the tuition
cost of primary schooling is zero, it is expected that the key cost constraint affecting poor rural families is the sacrificed output and income of children which they incur in going to school.

In addition, the research approaches the problem from the perspective of the individual household. Since most decisions to invest in education are made at an age when the immediate beneficiary of the schooling is not making his own decisions, it is the parents who hold the key decision-making role as to whether or not their children will attend school. Thus the demand for education of children will emphasize the alternative activities of children as well as the activities and characteristics of other members of the family which may influence the parental demand for schooling of their children.

A review of theory and the elaboration of a conceptual model will suggest factors which influence the participation rate of children in schooling. The effect of these factors will be tested by the use of multiple regression, drawing on household data collected from a sample of poor rural households. The results of this statistical analysis will then be used to draw implications.

Organization of the Remainder of the Thesis

The next chapter presents the conceptual framework for the study. Chapter III contains a brief description of the study region,
a discussion of the sample data to be used, and a discussion of the specific variables to be included in the model. The statistical results will be discussed in Chapter IV, and a discussion of the economic and policy implications will be presented in Chapter V. The final chapter contains a summary, conclusion and suggestions for future research.
CHAPTER II

THE CONCEPTUAL FRAMEWORK

The basic theory for the study draws heavily on the new household economics as developed by Becker (2) and extended by Evenson and Rosenzweig (14). The new household economics provides a framework within which the decisions of the family to invest in the education of its members can be analyzed. This approach stresses the interrelationships between human capital, the allocation of time, and nonmarket activities which take place within the household. For rural families in which a large proportion of economic activity takes place within the household, as opposed to the market, this theory has much relevance in explaining decisions taken by individuals.

The chapter is divided into three parts. The first part presents a brief review of the new household economics. This is followed by a discussion of the assumptions of the new household economics and their relevance to low-income countries. The third part applies this conceptual framework to the analysis of the demand for education.
The heart of the new household economics is an assumption that
the household is an economic unit which shares consumption and allo-
cates production resources under the daily constraint of time.
The house is viewed essentially as a small firm which produces
"commodities" by combining inputs of market goods and time
according to the cost minimization rules of the traditional
theory of the firm. Thus the contribution of the theory is
the systematic incorporation of nonmarket time as a cost in
the consumption of commodities on the same footing as direct
expenditures on market goods.

According to Becker, the family derives utility from the
commodities produced in this production process, not directly
from the market goods, as is assumed in the conventional theory.
These basic commodities are nonmarketable, home produced "attrib-
utes" such as good health, entertainment, and nutrition,
which the family desires for its members.\textsuperscript{1}

Households are assumed to maximize a utility function of
the form
\begin{equation}
U = U (Z_1, Z_2 \ldots Z_n)
\end{equation}
which reflects the tastes and preferences of the household for the
basic commodities.\textsuperscript{2} The basic commodities, $Z_1$, are each produced

\textsuperscript{1} The theory postulates that what the family actually desires are
the characteristics which the commodities possess. See Lancaster
(28).

\textsuperscript{2} The question of a "family utility function" is controversial.
The new household economics presupposes that a single household
manager knows this utility function and will seek to maximize
it. T. W. Schultz has argued that a household manager will
internalize the utility function of family members through a
high degree of caring. Hence, he acts as if he were maximizing
the function. For a discussion see Nerlove (37).
according to a separable household production function

\[ Z_i = F_i (X_i, T_i) \]

where \( X_i \) = a vector of market goods used in the production of the \( i \)th commodity, and \( T_i \) = a vector of time inputs used in the production of the \( i \)th commodity.

The amount of commodity \( Z_i \) produced and consumed by the household depends upon the quantities of time and market goods the household allocates to the production of \( Z_i \), as well as the state of household technology \( (F_i) \) and the efficiency with which production takes place. Efficiency, in this sense, depends upon the environment in which production takes place, and is assumed to depend primarily on the husband's and wife's education or other environmental variables.

In Becker's revised theory of choice, households choose a preferred combination of \( Z_i \) by maximizing

\[ U = U (Z_i) = U (F_i) = U (X_i, T_i) \quad i = 1 \ldots n \]

subject to a set of resource constraints. The first constraint limits the amount of market goods purchased by the household to the money income of the family:

\[ \sum p_i X_i = I = V + T_w \bar{w} \]

where:

- \( p_i \) = a vector of goods prices
- \( I \) = total money income of the household
- \( V \) = nonwage income
- \( T_w \) = a vector of time spent at work earning wage \( \bar{w} \).
The second constraint limits the amount of time which can be used in the production of all of the basic commodities.\(^1\)

\(5\) \( T_i = T_c = T - T_w \)

where:

\( T_c \) = a vector of time spent in home production, and

\( T \) = a vector of total time inputs.

Due to the assumed separability of the production functions, \(2\) can be written as

\(6\) \( T_i = t_i Z_i \)

\( x_i = b_i Z_i \)

where:

\( t_i \) = a vector of time inputs per unit of \( Z_i \), and

\( b_i \) = a vector of goods inputs per unit of \( Z_i \).

The problem of the household would appear to be to maximize \(3\) subject to the resource constraints \(4\) and \(5\). However, by recognizing that time can be converted into market goods through money income, \(4\) and \(5\) can be combined into a single constraint:

\(7\) \( \sum p_i x_i + \sum T_i \overline{w} = V + T \overline{w} \).

Substituting \(6\) into \(7\) yields the total resource constraint:

\(8\) \( \sum (p_i x_i + t_i \overline{w}) Z_i = V + T \overline{w} \).

That is, the full price of consumption of \( Z_i \) is the sum of direct costs and indirect costs of income foregone by spending time in production of \( Z_i \).

\(^1\) Note that Becker makes no distinction between time spent in household production and time spent in consumption. \( T_c \) denotes time not spent at work in the market.
Maximizing (3) subject to (8) yields the equilibrium condition

(9) $U_i = \partial U_i / \partial Z_i = \lambda \Pi_i$ where $\Pi_i = p_i b_i + t_i \bar{w}$, $i = 1...n$,

and $\lambda$ = marginal utility of money income. $\Pi_i$ represents the shadow price per unit of consumption of $Z_i$ in terms of the prices of goods and the time used per unit of $Z_i$.

If $\bar{w}$ were a constant and independent of $Z_i$, then the right hand side of the total resource constraint (8) would give the money income achievable if all of the time available were devoted to market work. However, a more meaningful resource constraint on the resources of the family is provided by the maximum money income achievable or "full income" of the family. $^1$ This income would be obtained by allocating all of the time and resources of the family to earning income with no regard for consumption activities. $^2$

The full income constraint is a more meaningful resource constraint for the household because it is firmly based on the fact that time can be converted into money income through market work. Thus the total resources of the family include not only the income generated through the market, but also the earnings foregone or "lost" through the interest in utility. The full income approach

$^1$ Full income is achieved by maximizing the earnings function $W = W(Z_1,..Z_n)$ subject to

$\sum T_i \leq T $, $i = 1...n$

$\sum p_i x_i = I = V + T \bar{w}$

$T_i = t_i Z_i$

$Z_i = b_i Z_i$

$^2$ Any time spent in sleeping, eating, or leisure activities would be spent on these activities in order to maximize money income, not to satisfy utility preferences.
also incorporates a more unified treatment of the substitution of nonpecuniary for pecuniary income, whether it occurs on the job or in the household.

If full income is denoted by $S$, then the identity

$$L(Z_1, \ldots, Z_n) = S - I(Z_1, \ldots, Z_n)$$

holds, where $L$ denotes the total earnings foregone and $I$ denotes total money income of the household. $I$ and $L$ are functions of $Z_i$ because how much income is earned or foregone is determined by the consumption set chosen.

Substituting (4) and (6), equation (10) can be written as

$$\pi_i b_i Z_i + L(Z_1, \ldots, Z_n) = S$$

which states that the household's full income is spent either directly on market goods or indirectly through the foregoing of money income. Maxmizing (3) subject to (11) yields the equilibrium condition

$$U_i = T(p_i b_i + L_i) = S$$

where the marginal price of $Z_i$ is divided into direct ($p_i b_i$) and indirect components ($L_i$).

Rewriting $L_i = \partial L/\partial Z_i = L_i T_i$

where

$$L_i = \partial L/\partial T_i$$

then (12) can be written as

$$\partial L/\partial T_i = L_i$$

1/ $\partial L/\partial T_i = L_i$ denotes the foregone earnings per hour of time used in $Z_i$. Write $L_i = \partial L/\partial Z_i = \partial L/\partial T_i \cdot \partial T_i/\partial Z_i + \partial L/\partial X_i \cdot \partial X_i/\partial Z_i$

$= \partial T_i + c_i b_i$ where $c_i = \partial L/\partial X_i$ and $L_i$ are the marginal foregone earnings of using more goods and time in $Z_i$. In this analysis $c_i = 0.$
\( U_i = T(b_i p_i + t_i l_i) \), which states that the marginal cost of \( Z_i \) is the sum of the marginal costs of using goods and time in producing \( Z_i \). Assuming an \( n \)-commodity world, the equilibrium condition for household consumption is

\[
\frac{U_i}{U_j} = \frac{\frac{\partial U_i}{\partial Z_i}}{\frac{\partial U_j}{\partial Z_j}} = \frac{b_i p_i + t_i l_i}{b_j p_j + t_j l_j} \quad i, j = 1\ldots n.
\]

To examine some of the implications of this model for household consumption behavior, the effects of changes in nonlabor income \((V)\) and wage rate \((\overline{w})\) will be considered. The principle tool of analysis for examining differences in consumption of commodities is the importance of foregone earnings.

The relative marginal importance of foregone earnings is defined as

\[
\alpha_i = \frac{l_i t_i}{p_i b_i + l_i t_i}.
\]

The importance of foregone earnings in the marginal price of commodity \( Z_i \) is thus greater the larger is \( l_i \) and \( t_i \), the foregone earnings per hour of time and the number of hours used per unit of \( Z_i \). Commodity prices for \( Z_i \) differ not only in the absolute amounts of time and goods used per unit of \( Z_i \), but also in the relative importance of foregone earnings or market goods as components of the price. Similarly, the relative marginal importance of time is defined as

\[
\gamma_i = \frac{t_i}{p_i b_i + l_i t_i}.
\]
The consumption of basic commodities in the household responds to changes in income and relative prices in the same manner as consumption of goods in the market. For instance, an increase in nonwage income \( V \) would increase consumption of most commodities with no change in relative commodity prices. However, if consumption time is increased, from (5) it can be seen that hours worked in the market must decrease unless the time-intensive commodities are sufficiently inferior.

Similarly, a rise in the cost of time \( \bar{w} \) relative to goods would induce a reduction in the amount of time and an increase in the amount of goods used per unit of each commodity. A uniform increase in \( \bar{w} \) would increase the cost per hour for all commodities, but the relative prices of commodities would change to the extent that foregone earnings differ in importance in the prices of commodities. The prices of commodities with a large foregone earnings component would rise relatively more. Thus, a compensated uniform rise in earnings would lead to a shift away from earnings-intensive commodities and towards goods-intensive commodities.

Figure (2) shows the equilibrium given by (14) for a two commodity world. In equilibrium the slope of the full income opportunity curve, which is equal to the ratio of marginal prices of \( z_1 \) and \( z_2 \) at any point, is equal to the ratio of marginal utilities given by the slope of the indifference curve \( u_1 \). With a rise in
earnings, fully compensated by a decline in other income, the opportunity curve $S$ would shift to $S'$ if $Z_1$ were the more earnings-intensive commodity. In the new equilibrium less $Z_1$ and more $Z_2$ would be consumed.

$$S = p_1 b_1 Z_1 + p_2 b_2 Z_2 + L(Z_1, Z_2)$$

Figure 2. Household Equilibrium for a Two-Commodity World.

Another important aspect of the new household economics is the production (consumption) technology employed by the household. From this perspective the household is viewed as a small firm which produces commodities for household consumption by combining market goods and the time of household members. According to the theory
of variable proportions, households will minimize costs by setting the ratio of the marginal products of goods to time equal to the ratio of marginal costs:

\[
\frac{\partial f_i}{\partial x_i} / \frac{\partial f_i}{\partial t_i} = \frac{p_i}{\partial L / \partial t_i} \tag{17}
\]

Thus a rise in the cost of time relative to goods would induce a substitution of market goods for time in the production of \(Z_i\).

If utility is considered an indirect function of goods and time rather than simply a direct function of commodities, the following conditions hold for utility maximization:

\[
\frac{\partial U}{\partial x_i} = \frac{\partial U}{\partial t_i} = \frac{p_i}{\partial L / \partial t_i} \tag{18}
\]

The above condition states that households maximize utility through allocation of goods and time to production of \(Z_i\) based upon the marginal costs of goods and time in \(Z_i\). Note that the ratio of marginal utilities depends only upon \(f_i, x_i,\) and \(t_i\) and is thus independent of other production functions, goods, and time.

\(1/\) Assuming \(b_i\) and \(t_i\) are not used in fixed proportions.
The Assumptions of Household Economics and Their Relevance to Low-Income Countries

The new household economics provides a framework within which decisions in the household can be analyzed systematically. As indicated above, there are basically four main elements to the theoretical structure of the theory: 1) a utility function whose arguments are home-produced bundles of attributes, 2) a household production technology, 3) an external labor market, and 4) a set of household resource constraints. With the additional assumptions of utility maximization and perfect knowledge, a behavioral pattern for the family can be derived in which the family allocates its total resources of goods and time to home production of basic commodities in the most rational or least-cost way.

Most of the empirical applications of the new household economics have been to households in countries with relatively high per capita incomes. However, recently more attention has been focused on using this framework as a tool of analysis for households in low income countries. However, it can be applied to households in such countries only to the extent that the basic elements and assumptions of the theory are presumed to apply.1/ For instance, it is necessary that the assumption of maximizing behavior within the household is also relevant for low-income rural households in poor countries. In this regard, previous studies have found the small farmer in such countries to be an efficient

1/ The discussion this section is drawn from Robert E. Evenson (13).
and rational allocator of resources whose responses to price signals do not differ substantially from those of large commercial farmers. Although households in low income countries may place different values on commodities and face different resource constraints, there is no obvious reason to reject the assumption of utility maximization for the low-income household.\(^1\)

Another assumption of household economics concerns the ability of the family to recognize the value of the time of family members. This question reduces essentially to the problem of whether labor markets exist and whether households have a perception of the marginal productivity of labor. In most low income countries labor markets do function, even in rural areas, with wages varying by sex, age, and task. Thus there is no reason to assume rural households are not aware of the opportunity cost of the time of family members.

A final assumption of the new household economics concerns the household's knowledge of its household production technology. In the same manner that small farmers (many of whom do not produce for the market) have knowledge of production technology, it is also reasonable to assume that low income rural households have some knowledge of household production technology.

It is true, of course, that households are likely to differ in the extent of this knowledge due to differences in education levels.

\(^1\) The assumption of utility maximization enables one to consider not only monetary productivities (which would only be considered if the individual were a wealth maximizer), but also nonmonetary productivities such as consumer goods, friendship, and so forth.
among households and their exposure to sources of information. With low investments in human capital the role of education as an environmental variable may provide a key difference among households as to utilization of available production technology. However, since no household, whether rich or poor, can have perfect knowledge of production opportunities, this difference is not expected to negate the analytical implications of the new household economics for household behavior as applied to low income families.

Application to Education

Within the context of the new household economics, a major function of the family is to provide for the education of family members. Education is viewed in the theory as a financial investment in the children which is expected to augment the future flow of child services by increasing the quality or resource intensity of the children. The decision of the family to invest in the education of children depends upon the total resources of the family and the opportunity cost of time for the children as well as other family members.

According to DeTray (12), it is assumed that the family maximizes a utility function of the following sort when making decisions about human capital:

\[ U = U(C, Z) \]

\[ C = C(N, Q) \]
where:

\[ C = \text{stock of child services} \]
\[ N = \text{numbers of children} \]
\[ Q = \text{quality of children} \]
\[ Z = \text{other commodities}. \]

Here, children are viewed as home-produced durable assets from which parents consume a flow of services. The flow of services from children is assumed to vary with both the biological units of children (numbers) as well as the resource intensity (quality) with which they are raised. Investments in child quality usually take two forms: 1) nutrition and health care, and 2) education or skills. These investments are expected to increase the future flow of child services to the household.

The utility function described in (1) assumes that quantity and quality of children are more closely related than any two commodities chosen at random. However, this assumption is not necessary to understand these relationships within the household. Accordingly, the family utility function can be written as

\[ (2) \quad U = U (Q, N, Z) \]

where no special relationships are assumed to exist among these commodities in the household utility function.

Using a form of the utility function as (2) above, the Becker model can be extended to the n-person household to more fully analyze the opportunity cost of the time of children in low income
rural households. The household consists of a husband, wife and a number of children. Parents are assumed to desire children due to the satisfactions which children provide as consumption goods and due to the indirect satisfaction they provide from working in the household doing chores and/or from working on the farm or in the labor market.

Becker's theory of the new household economics is applicable to the household as a consuming and/or producing unit. In the model presented here, the production aspect of household behavior is stressed in which the household produces basic commodities which enter into the utility function. The model is thus concerned with the family's total production time.

By incorporating production aspects into the theory of consumption, the household model implies that families respond to changes in the prices and productivities of factors, to changes in relative shadow prices of commodities, and to changes in real income as they attempt to minimize the cost of production within the household and maximize utility. Thus, a reduction in the price of some factor of production will shift the production processes toward techniques which use relatively more of that factor and consumption towards commodities which use that factor more intensively.

1/ The model presented here is taken primarily from one developed by Evenson and Rosenzweig in (14).

2/ For further discussion on the role of production in consumption see Becker and Michael (6).
Assume household preferences are represented by a utility function of the sort:

\[(3) \quad U = U (Z_e, Z_n, Z_s)\]

where:

- \(Z_e\) = education of children
- \(Z_n\) = numbers of children
- \(Z_s\) = other commodities produced by the household.

Each commodity is assumed to be produced by the household through combinations of goods and time of household members via a separate, constant-returns-to-scale production function:

\[(4) \quad Z_e = f (X_e, T_{ec}; E)^{1/} \]
\[Z_n = f (X_n, T_{nw}; E)\]
\[Z_s = f (X_s, T_{sc}, T_{sw}; E)\]

where:

- \(X_e\) = a vector of market goods used in the production of \(Z_e\) per child;
- \(T_{ec}\) = a vector of child time per child used in production of \(Z_e\);
- \(X_n\) = a vector of market goods used in production of \(Z_n\);
- \(T_{nw}\) = a vector of time inputs of the wife used in production of \(Z_n\);
- \(Z_s\) = a vector of market goods used in the production of \(Z_s\);
- \(T_{sc}\) = a vector of child time inputs per child used in production of \(Z_s\);

\(^{1/}\) It is assumed that parents spend an equal amount of education on each child. Alternatively, the production function for \(Z_e\) can be written as \(Z_e = f (X_e/Z_n, T_{ec}/Z_n; E)\).
\( T_{sw} = \) a vector of time inputs of the wife used in the production of \( Z_s \); and

\( E = \) a vector of environmental variables.

It is assumed that children are intensive of the wife's time and so only the time of the wife is involved in production of \( Z_n \). It is further assumed that only the time of the children is involved in the production of \( Z_e \) and that both the wife and children work in the household complex to produce \( Z_s \).

The environmental variable, \( E \), represents such variables as health, age, and education of the parents which are assumed to affect the efficiency of the production process. The environmental variable is distinguished from the direct inputs by the fact that the production process uses up some of the household's available time and goods but does not, in general, affect the quantity of the environmental variable.

The time of the husband is assumed to be allocated entirely to market work and to earn a wage \( W_o \). The market for this model involves work on the farm (earning an implicit wage) or in the labor market. As long as markets are competitive and the family has access to a labor market, it makes no difference whether the money income to purchase market goods is provided from the labor market in the form of a money wage, \( W_o \), or from work on the farm in the form of an implicit wage, \( W_o \).\(^{1/}\) Competition implies that the husband's

\(^{1/}\) See the Ph.D. Thesis by Teotonio Teixeira (53) for further elaboration. This conclusion holds only if markets are efficient.
implicit wage from farming must be equal to his alternative earnings or opportunity cost in equilibrium. For the husband, the wage rate \( W_0 \) reflects the relative price of income (market goods) vs. leisure. Similarly, the wife and children can also work in the market earning wage rates \( W_1 \) and \( W_2 \), respectively. For the wife and children, the relevant wage rates represent two sets of relative prices, the relative price of income vs. leisure, as well as the relative price of wage goods vs. home goods (including education). This latter relative price recognizes that children and the wife have nonmarket productive activities within the home and at school through production of \( Z_n \), \( Z_s \), and \( Z_e \) for family consumption. Education, however, is assumed to give zero returns in the present, but to add to increased productivity of children's service in the future.

In the one-period static model thus far presented, the household is assumed to maximize (3) subject to a set of resource constraints on productive opportunities. The budget constraint limits the amount of goods purchased for production of \( Z_1 \) and is determined by the total money income of the family:

\[
W_0 T_{wm} + W_1 T_{ww} + W_2 T_{wc} Z_n^{1/} + V = I = p_e X_e Z_n + p_s X_s + p_n X_n
\]

where:

\[
T_{wm} = \text{a vector of time inputs of the husband spent at work;}
T_{ww} = \text{a vector of time inputs of the wife spent at work;}
T_{wc} = \text{a vector of time inputs of the children spent at work per child; and the other variables are defined as above.}
\]

\(1/\) An equal wage for each child is assumed.
The time constraints are:

\[(6-8) \quad T_c = T_{ec} + T_{wc} + T_{sc}\]
\[T_w = T_{nw} + T_{sw} + T_{ww}\]
\[T_m = T_{mw}\]

where:

- \(T_c\) = Total time per child
- \(T_w\) = Total time of the wife
- \(T_m\) = Total time of the husband.

The time constraints limit the total activities of each member of the family to the time available per member.

Recognizing that time can be converted into goods through market work, and redefining the inputs of goods and time used in production of each \(Z_i\) to equal the marginal (= average) inputs per unit of \(Z_i\), (6-8) can be substituted into (5) to obtain the total resource constraint:

\[(9) \quad Z_n W_2 T_c + W_1 T_w + V T_m + V = Z_n Z_e (p_{eX_e} + W_2 T_{ec}) + Z_n (p_{nX_n} + W_1 T_{nw}) + Z_s (p_{sX_s} + W_2 T_{sc} Z_n + W_1 T_{sw}).\]

Maximizing (3) subject to (9) yields the following first-order conditions for an interior solution:

\[(10) \quad \frac{\partial U}{\partial X_n} = \lambda (Z_e p_{eX_e} + p_{nX_n} + W_1 T_{nw} - W_2 T_{wc})\]
\[(11) \quad \frac{\partial U}{\partial Z_e} = \lambda (p_{eX_e} + W_2 T_{ec}) Z_n\]
\[(12) \quad \frac{\partial U}{\partial Z_s} = \lambda (p_{sX_s} + W_2 T_{sc} Z_n + W_1 T_{sw})\]
\[(13) \quad Z_n Z_e (p_{eX_e} + W_2 T_{ec}) + Z_n (p_{nX_n} + W_1 T_{nw}) + Z_s (p_{sX_s} + W_2 T_{sc} Z_n + W_1 T_{sw}) - V - Z_n W_2 T_c - W_1 T_w - W_0 T_m = 0\]
where $\lambda$ = marginal utility of money income. The shadow prices, $\Pi_i$, are given by

\begin{align*}
(14) \quad \Pi_n &= Z_n p_e x_e + p_n x_n + W_1 T_{nw} - W_2 T_{wc} \\
(15) \quad \Pi_e &= Z_n (p_e x_e + W_2 T_{ec}) \\
(16) \quad \Pi_s &= p_s x_s + W_2 T_{sc} Z_n + W_1 T_{sw}.
\end{align*}

The shadow prices are thus explicit functions of goods prices, opportunity costs of time (wage rates), and the household's production technology ($t_i Z_i$ and $b_i Z_i$).

Equation (14) states that the cost of a unit of $Z_n$ (children) is positively related to the education per child, the cost of market goods used in the production of children, and the opportunity cost of the wife's time used in production of $Z_n$, and inversely related to the time per child spent in market work. Equation (15) states that the cost of a unit of $Z_e$ (education) is positively related to the cost of market goods used in the production of education and the opportunity cost of the time of children used in $Z_e$, as well as the number of children. Equation (16) states that the cost per unit of $Z_s$ (other commodities) is positively related to the cost of market goods used for the production of those commodities and the opportunity cost of the time of the wife and the children used in production of $Z_s$.

What is important to note is that the shadow prices, $\Pi_i$, are not independent of the commodity bundle consumed by the household; i.e., $Z_e$ or $Z_n$ is present in one or the other of the shadow prices.
This is the same condition which would hold if joint production in the production functions were postulated. The shadow prices illustrate the interaction between numbers of children and education as well as the interaction between other commodities produced and the number of children. For instance, an increase in the education of children raises the cost of an additional child since higher educated children are more expensive. But this increase in the shadow price of children will decrease the number of children, thus lowering the cost of education through \( \Pi_e \), which would increase the demand for children, and so on.

The dependence of the shadow prices of commodities on the commodity bundle consumed, \( Z_i \), causes difficulties in using the commodity prices, \( \Pi_i \), for analyzing commodity demand. Without the presence of the \( Z_i \) in the shadow prices, the commodity prices reflect input prices and the technology of the household as well as income. However, with the presence of the \( Z_i \) in the commodity prices, the feasible consumption set of the household is nonlinear and commodity prices vary with the commodity bundle consumed. Households with different tastes will select different commodity bundles and the commodity bundle chosen will imply different commodity prices for each household. Thus commodity prices can differ among households not only due to the difference in technology and production opportunities, but also due to differences in tastes.

1/ See Pollak and Wachter (41), for a discussion of joint production and its implications for this model. See, also Becker and Lewis (5).
The system (10-12) can be written in terms of commodity shadow prices (14-16) as

\[
\frac{\partial U}{\partial z_n} = \lambda \Pi_n \\
\frac{\partial U}{\partial z_e} = \lambda \Pi_e \\
\frac{\partial U}{\partial z_s} = \lambda \Pi_s \\
\Pi_s z_s + \Pi_n z_n + \Pi_e z_e = U \quad \text{where } U \text{ is defined to be the full income of the family.}^{1/}
\]

The quantities of \( z_n, z_e, \) and \( z_s \) demanded as a function of the parameters \( \Pi_i \) and \( \mu \) can be obtained by solving the system (19-20) simultaneously. These solutions, expressed in implicit form, are the demand functions

\[
Z_i^* = Z_i (\Pi_n, \Pi_s, \Pi_e, \mu) \quad i = n, e, s.
\]

The demand functions given in (21) exhibit all of the properties of the traditional demand functions. They are homogeneous of degree zero in \( \Pi_i \) and \( \mu \) and satisfy the Slutsky sign and symmetry conditions.\(^2/\)

In equilibrium, the consumption pattern for the family is given by

\[
\frac{\partial U}{\partial z_i} = \frac{\pi_i}{\pi_j} \quad i, j = n, e, s.
\]

Thus a change in the relative price of one of the \( z_i \) commodities will alter the consumption of the basic commodities, \textit{ceteris paribus}.

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1/ \( U \) is defined to be full income as in the Becker analysis outlined previously. (17-20) is obtained by maximizing the utility function (3) subject to the family's full income, \( U \).

2/ Due to the interdependence of \( \Pi_i \) with \( z_i \), Becker and Lewis have shown that the observed income elasticities will be less than the true income elasticities. See Becker and Lewis (5).
In the cross section it is expected that the $\Pi_i$ will vary across households due to differences in production technology and in the opportunity cost of time (foregone earnings) of individual family members, which differ across families.\(^1\) If the region considered is small, goods prices are not expected to vary across households. Within the same family, the $\Pi_i$ will differ due to differences in the opportunity costs of time (marginal productivities in alternative pursuits) among individual family members. Thus the basic commodities have different prices due to the relative importance of the foregone earnings component of the price and, across families, due to differences in production technologies. The difference in production technology across families can be due to differences in production conditions and/or to differences in environmental variables which affect the efficiency with which production takes place and the relative ease of adoption of new production technology.

The properties of the demand function $Z_i^*$ can be examined by differentiating equation (21) with respect to the various components of the shadow prices, $\Pi_i$, and transforming the component parts into elasticities. The compensated elasticity of demand for $Z_i$ with respect to the child wage rate, $W_2$, thus becomes

\(^1\) For a discussion of the role of opportunity costs in demand functions, see Mincer (35).
(23) \[
\eta_{i} \frac{1}{W_{2}} = \eta_{1} \cdot \frac{W_{2} \beta_{ec} Z_{i}}{\Pi_{e}} + \eta_{1} \cdot \frac{W_{2} \gamma_{sc} Z_{i}}{\Pi_{s}} - \\
\eta_{1} \cdot \frac{W_{2} \gamma_{wc}}{\Pi_{n}} + \eta_{1} \cdot \frac{W_{2} \gamma_{wc} Z_{i}}{\mu}
\]

where:

\[\eta_{1} \cdot \frac{1}{W_{2}} = \text{elasticity of demand for } Z_{i} \text{ with respect to the child wage;}\]

\[\eta_{1} \cdot \frac{1}{\Pi_{e}} = \text{compensated price effect of education;}\]

\[\eta_{1} \cdot \frac{1}{\Pi_{n}} = \text{compensated price effect of numbers of children;}\]

\[\eta_{1} \cdot \frac{1}{\Pi_{s}} = \text{compensated price effect of other commodities;} \text{ and}\]

\[\eta_{1} \cdot \frac{1}{\mu} = \text{full income elasticity of child services in the market.}\]

Equation (23) states that the elasticity of demand with respect to a change in the child wage rate depends upon the relative share of children's foregone earnings in the production of each commodity as well as the income elasticity of demand for commodity \( i \) and the own price and cross price elasticity of substitution in consumption. Since production technologies can change with an increase in the child wage, the foregone earnings components can get larger or smaller for a change in \( W_{2} \). The total effect of a change in \( W_{2} \) on the demand for commodity \( i \) is indeterminate. The Slutsky sign conditions

\[\text{1/} \text{ The partial derivative of } Z_{i} \text{ with respect to the child wage is}
\]

\[\frac{\partial Z_{i}}{\partial W_{2}} = \frac{\partial Z_{i}}{\partial \Pi_{e}} \cdot \beta_{ec} Z_{i} + \frac{\partial Z_{i}}{\partial \Pi_{s}} \cdot \gamma_{sc} Z_{i} - \frac{\partial Z_{i}}{\partial \Pi_{n}} \cdot \gamma_{wc} + \frac{\partial Z_{i}}{\partial \mu} \cdot \gamma_{wc} Z_{i}
\]

where * denotes compensated price effects. If elasticities are derived, the term in (23) is the result.
require the own price elasticities to be negative and, assuming a superior good, the income effect should be positive. However, the other component signs cannot be determined in advance.  \\

Similarly, the effect of a change in the wage of the wife can be illustrated:

\[
\eta_{nW} = \eta_{1} \frac{T_{nwW}}{n} + \eta_{s} \frac{T_{swW}}{s} + \eta_{\mu} \frac{T_{\mu wW}}{\mu}
\]

where the components are defined as above. On the other hand, the effect of a change in the wage rate of the husband is solely an income effect, with

\[
\eta_{nW} = \eta_{1} \frac{T_{mwW}}{n} \quad \eta_{s} = 0.
\]

The effect of a change in an environmental variable can be shown as follows:

\[
\eta_{E} = \eta_{1} E \left( \frac{\Sigma S_i MP_i - MP}{P} \right) + \eta_{2} E \left( \frac{\Sigma S_i MP_i - MP}{P} \right)
\]

\[
+ \eta_{3} \frac{\partial \Pi_i}{\partial E/X_i,T_i} = X_i \cdot \frac{\partial MPX_i}{\partial E} + T_i \frac{\partial T_i}{\partial E} 
\]

\[
\Sigma S_i MP_i = \text{percentage change in income due to a change in the output}
\]

\[
i = n,e,s \quad \text{of commodities, holding the levels of the factors of production constant. This income effect is a weighted average of the productivity effects of } E \text{ on the various production functions.}
\]

---

1/ Similarly, suppose } E \text{ is a vector of farm inputs which increase the child's productivity on the farm. If } \Phi \text{ can be estimated such that } \dot{\Phi} = g(E), \text{ then the elasticity effects should be the same as in (23).}

2/ See Robert T. Michael(33).
The last term in (26) is the income effect, which will be positive for any normal good if E's nonmarket effect on real income is positive. The other terms on the right hand side of (26) are the compensated substitution elasticities and the substitution effects of a change in E. If E is biased towards Z_i, then |MP_i| > |E S_{iMP_i}| and its relative price will fall. Since \( \eta_{i}^{*} \) is < 0 for own price effects but indeterminate for cross price effects, the total effect of a change in E on consumption of Z_i is indeterminant.

Estimation of the demand functions in (21) does involve some methodological problems. To construct commodity prices, \( \Pi_i \), which can be utilized as arguments in the demand functions, the parameters of the production technology must be known. However, the parameters of a household's technology are difficult to know a priori because the technological constraints must be inferred from household behavior. A second problem in estimation of the \( \Pi_i \) is that, once estimated, family tastes are built into the \( \Pi_i \) due to the dependence of price and the commodity bundle consumed.

To get around these problems, a demand function for the basic commodities can be estimated which is a function of goods prices, wage rates, and nonlabor income. However, this has the effect of making the household's technology a parameter of the demand functions. Accordingly, demand functions for the basic commodities can be estimated, such as

\[
Z_i^* = Z_i (p, w_0, w_1, w_2, v, \beta, b, E) \quad i = n, e, s
\]
where consumption of commodity $i$ is a function of the prices of market goods, $p_i$; wage rates, $w_0$, $w_1$, and $w_2$; nonlabor income, $V$; parameters of the household's technology, \( \beta \); parameters of the production technology, \( B \); and household environmental variables, \( E \).

The demand function in (27) has advantages over the one specified in (21) because it represents the constraints facing the household without building tastes into the prices. This is more consistent with the traditional role of prices in demand theory which assumes that households are price takers and that prices are independent of tastes. With the demand function in (27), technical progress as well as change in tastes can be reflected by shifters in the demand function.

Because there is no natural correspondence between goods prices and wage rates and the quantities of the commodities consumed, the Slutsky sign and symmetry conditions do not hold for these demand functions. For example, if the price of factor $X$ in the production of $Z_i$ increases, the impact on relative prices, $\frac{p_i}{p_j}$, depends not only upon the increase in price but also upon $X_i$'s share in the total cost of $Z_i$. The demand function in (27) does not take this second effect, the relative share in production cost of $Z_i$, into account. Only the effect of the increase in the price of $X_i$ is incorporated into the demand function. However, economic theory can be used to derive implications for the demand functions of the effects of changes in the arguments of the demand function in (27).
CHAPTER III

THE SAMPLE, DISCUSSION OF VARIABLES, AND EMPIRICAL MODEL

The Study Region

Data for testing the theoretical model are drawn from a sample of poor rural households located in the Vale do Ribeira in the state of Sao Paulo. This region consists of a multi-county (municipio) area having similar agricultural characteristics, as defined by the Brazilian Institute of Geography and Statistics. The Vale is located relatively near the largest urban industrial center of Brazil, which in principle could provide alternative economic opportunities for the residents of the region. However, the region has not participated to any great extent in the rapid growth and development of Sao Paulo, and thus remains an area of poverty in the midst of plenty.

The majority of the residents of the Vale make their living from farming activities. In 1970 about 66 percent of the population lived in rural areas and 65 percent of the labor force was employed in agriculture. The main food crops grown in the area include rice, 

1/ The descriptive analysis of the area of study is based on Patrick and Carvalho (38).

2/ This particular characteristic of the region was one motivation for its inclusion in the larger study of rural poverty of which this is a part.
corn, and beans. Other crops grown include tea and bananas as well as some horticultural crops. Livestock production is relatively unimportant and is limited to small-scale poultry and swine production.

The National Colonization and Agrarian Reform Institute (INCRA) in Brazil has defined an average farm unit (modulo) for each area of the country which is assumed to provide "full employment" and "reasonable income" for a family of four. In the Vale do Ribeira, these family units are approximately 40 hectares. All of the rural properties in the sample are smaller than the INCRA units, which suggests that they may be subject to employment and income problems.

It is presumed in this study that the Vale do Ribeira, while not statistically representative of Brazilian Agriculture, will be useful for studying the conditions of the low income farmer in Brazil. It is assumed that this area is somewhat typical of other low income areas in the country, and that the analysis of data from this region will suggest some of the relevant constraints which affect the decisions of low income households.

The Sample

The specific groups to be studied in this analysis are small landowners, sharecroppers, and renters. The small landowners are those farmers who have title to the land outright, although operationally those without legal titles to the land are also included in the sample. All of the landowners included in this sample own land which is less in amount than the family unit defined by INCRA.
Renters and sharecroppers are individuals who temporary and limited tenure rights to the land. The renters pay a fixed monetary sum to the landlord for the use of the land. Payments by sharecroppers, however, take various forms. The most common arrangement is for the sharecropper to pay a fixed percentage of total production or of a cash crop. There are also instances of individuals who receive land as a return for "keeping an eye" on the landlord's property.

The sampling distribution used in this study consists of a random sample of small landowners selected from the INCRA cadastral survey. Information which would permit random sampling of sharecroppers and renters did not exist, so samples from these categories were obtained by interviewing the sharecropper (renter) located nearest to the randomly selected small owner. In the Vale do Rebeira, a total of 95 farmer family units were interviewed, including 55 owners, 21 sharecroppers, and 19 renters.

The data collection effort was designed to emphasize the economics of the household-farm complex as opposed to simply the farm unit. In this context, the focus of the research is the household unit in which the allocation of time and nonmarket behavior of individual household members is analyzed as well as the traditional farm and off-farm production opportunities. The surveys were specifically designed to obtain information about the socio-economic characteristics of farm households in order to analyze the importance of these factors on the activities of individual family members as well as the activities of the household as a whole.
Each of the household units was interviewed three times to obtain information covering two agricultural years. The first questionnaire collected information for the 1972–73 agricultural year and emphasized the total resources of the family, including agricultural production, education, income, and the allocation of time. The second questionnaire was applied six months later in January 1974, and stressed the type of technology used as well as attitudes toward such basic decisions as participation in off-farm labor markets, use of credit, and migration. The third questionnaire was applied in July, 1974, and examined changes in family resources, income, and expenses during the 1973–74 agricultural year.

The Variables

The basic model presented in Chapter II implies that household consumption of commodities will respond to changes in the relative shadow prices of commodities which come about through changes in the prices and productivities of inputs as well as to changes in real income. Specifically, the model hypothesizes that the demand for schooling of children among farm households is a function of the wage or earning potential of the husband, the wage or opportunity cost of time of the wife and children, the direct costs of schooling (prices of market goods), and other household environmental and technological variables which influence household production.
Based upon this theory, an empirical model is specified in the following section which relates the demand for schooling to variables hypothesized to affect the relative productivities (opportunity costs) in market and home production of the various members of the family as well as the total income and other costs of education. The empirical model, as specified, relates the current demand for education of children to the income of the household, characteristics of the father which affect his attitudes and productivity in the market, characteristics of the mother which affect her productivity in home production, variables which affect the demand for labor of children, and other characteristics of the household complex which act as environmental influences or costs for education of children. A more detailed discussion of the variables and their rational follows.

**Demand for Education**

The demand for education for children, the dependent variable, is represented by the current percentage enrollments of children of school age for each household. This specification is in accordance with the theory which predicts that the parents (representing the household) decide the number of children that will go to school and that these decisions will vary with the socio-economic characteristics of the households and the market conditions they face.
Enrollments is considered to be a good proxy variable for the demand for schooling because it is expected that if households desire education for their children, these children will be attending school.\textsuperscript{1/}

The variable used to measure the demand for education is the percentage enrollments for the 1972-73 agricultural year for children who are of school age. Ideally, the measure which is desired is the percentage enrollments for a particular school year and for a particular age distribution. However, since this information was not available in a complete form, the former measure was used. Since the duration of the school year in Brazil is from March to December, enrollments during the agricultural year (July - July) may tend to overstate enrollments somewhat, since some children may have quit attending school and others started to school during the two school years encompassed. However, examination of the data suggested that the possibility of double counting was present for only a few of the families and hence the upward bias should be small.

Characteristics of the Husband

Two characteristics of the husband are hypothesized to influence the demand for children's education: his age and his level of education. These variables are included on a number of different grounds. In the first place, they may represent taste variables. For example, more well educated husbands may demand more education for their children. Similarly, older husbands may demand less

\textsuperscript{1/} This is subject, of course, to the availability of schools. If schools are unavailable, this implies that the costs of attending school are infinitely high.
education for their children since their lifetime experience was in an age when education was less important as a key to productive employment in market activities.

The age variable may play an alternative role in the model. It is generally recognized that there is a life-cycle pattern to productivity, with productivity increasing up to a certain point in the life cycle and then declining thereafter. If the opportunity costs of the child are an important determinant of the demand for schooling, then this life-cycle pattern in productivity could cause the age of the husband to influence the demand for children's education. Thus, as productivity of the husband increased, other things being equal, there would be less demand for children labor on the farm and the demand for schooling would increase. Alternatively, as productivity of the husband declined with age there would be a stronger demand for children labor, other things being equal, and the demand for education would decline. The expected effect of age would therefore depend on where the husband was in the life cycle.

The age and education variables may play still a third role in the model. Both variables represent aspects of human capital and thus may influence the overall efficiency in the household, both in household production activities and in farm production activities. The age of the husband reflects his experience in

---

1/ A recent study of the allocation of time in rural households found that the hours of time allocated to work activities declined with age. See Boulier (8).
production and can be expected to influence productivity through its effect on both managerial and labor skills. Education, of course, represents more directly the husband's stock of human capital.

If age serves as a proxy for experience or on-the-job training, then both it and education should have a positive effect on overall efficiency in the household. In a sense they may serve as a proxy for the level of technology of the household. Other things being equal, then, they should have a positive effect on the demand for children's schooling, for they will increase positively the efficiency with which resources are used within the household, thereby freeing up children's time for schooling.

The age variable may play still a different role. Suppose parents demand schooling for their children on the basis of the increased income flows which such education will provide to them over their lifetime. Older parents will have a smaller time period over which to receive the benefits of such income flows, and therefore would be expected to have a lower demand for the education of their children. In this case there would be an expected negative effect of husband's age on the demand for education, other things being equal.

Based on these considerations, the effect of husband's education on the demand for children's education would be positive. In the case of age of husband, however, it is not possible to place an a priori constraint on the coefficient. The sign will depend on which of these effects are operating or dominating and the particular stage in the life cycle in which the sample is concentrated.
Two measures of the educational attainment of the husbands are available for use in the study. The first is a continuous variable which represents the years of formal schooling actually completed. The second measure is an index of functional literacy. This latter measure was considered in recognition of the importance of informal schooling among low income households where opportunities for formal education have been limited in the past.

For the functional literacy test, the husband was asked to read a simple sentence. His reading capacity was classified as

a) rapid and without difficulty,

b) slow and without difficulty,

c) slow with difficulty, or

d) illiterate.

Both measures of education were used in testing the model since it could not be determined in advance which was the preferred measure. When the index of functional literacy is used to measure the education of the husband, the expected sign is negative due to the way it is indexed.

Type of Farm

Individual farms included in the sample differed in their tenure status. The sample included small owners, sharecroppers, and renters. A binary variable was included in the model to test for whether land-tenure status affected the demand for children's education. The basis for including such a variable is that land and capital markets are rather imperfect in rural Brazil, with the result that low-income
people have difficulty in gaining access to land. It is hypothe­sized, therefore, that sharecroppers and renters would have a stronger demand for the education of their children than would land owners, other things being equal, since education would be a more viable investment opportunity for them.

Sharecroppers and renters were grouped together and assigned a zero when the observations referred to them. Landowners were assigned a one when the observations referred to them. Therefore, the a priori restriction on the coefficient of this variable is negative.

Characteristics of the Wife

The theory of household economics suggests that the opportunity costs of the wife's time is an important determinant of the demand for children's education. Children are assumed to be time-intensive goods. Therefore, with higher opportunity costs of the wife's time, the theory predicts that the family will demand fewer children and educate them to a higher level. Hence, there is a substitution of quality for quantity of children.

Previous studies of the demand for education (59) and of allocation of time of the wife (20) have used the education of the wife as a proxy for the opportunity cost of her time. In principle, with micro data we could use the observed market value of the wife's time, or her value in on-the-farm production, as estimated, say, by her marginal value product. However, two factors argue against the use of such data. First, the data refer to only one year and
hence could be subject to rather large transitory influences. Second, only one of the women worked off the farm, and not all of them participated in on-farm work. Hence, we stayed with the tradition of previous studies and use a measure of human capital invested in the wife.

Two such variables were available from the questionnaire. The first was the number of years of formal schooling attained by the wife. The second was the response to a functional literacy question in which the wife was asked whether she could write. The answer to this question was coded with a one if she could write, and a zero if she could not. A test of the model was made with both variables, with the sign of the coefficient expected to be positive in both cases.  

Three other characteristics of the wife were also introduced into the model: her age, the number of days she was sick during the six months prior to the survey, and the hours she worked on the farm. These variables are suggested by both the new household economics and the theory of human capital.

The theory postulates that wife's time and children's time are substitutes in household production. Hence, if the wife has poor health, as indicated by a large number of days sick, it is hypothesized that there will be a stronger demand for children labor.

---

1/ The education of the wife may also reflect an efficiency or technology variable for her skill in household production. See DeTray (12). On this ground also the sign of the coefficient would be expected to be positive, since with increased efficiency in household production, other things being equal, the demand for education would be expected to be greater.
within the household, other things being equal, and in turn a reduction in the demand for children's schooling. Similarly, the more days the wife works on the farm, the stronger will be the demand for children's time in the household, and the smaller the demand for children's schooling. Both of these variables should therefore ultimately be reflecting the opportunity costs of children going to school.

Health is also a human capital variable. People with poor health tend to be less productive, other things being equal. Therefore, if the number of days sick is a proxy for the health of the wife, a large number of days sick on her part should suggest lower productivity in the household and a stronger demand for children labor within the household. This would raise the opportunity cost of schooling for the children, and reduce the quantity of schooling demanded. On these grounds the sign of the coefficient is therefore also expected to be negative.

The age of the wife is included on the same grounds as for the husband. In the first place, it may represent experience or on-the-job training. In the second place, it may represent productivity, in accord with the life-cycle hypothesis mentioned earlier. And finally, it may represent life expectancy and the influence this has on the demand for children's education.

As in the case of husband's age, it is not possible to place an a priori restriction on the coefficient of this variable. It should be noted, however, that on-the-job experience may be more important to wives in their household activities than is formal
schooling. Similarly, physical work tends to be less demanding in household activities. Hence, there may be less of a decline in productivity in wife's activities as she ages.

Unfortunately, it is not clear whether it is the wife's age or the husband's age that is important from the standpoint of life expectancy and its effect on the demand for education. Hence, it is not possible to say which age variable should play a greater role from this standpoint.

The Opportunity Cost of Children's Time

The theory of human capital, as well as the theory of household economics, places strong emphasis on the indirect costs of schooling, or the opportunity cost of the child's time in going to school. For the particular sample of data used for this study, an important aspect of these opportunity costs is the demand for children's work on the farm, off the farm, or in the household. That is, the output and/or income that would be sacrificed were they going to school rather than working on the farm.

The problem in testing this hypothesis with income data is in obtaining a variable or variables that represent these opportunity costs of children's time. The marginal value product of children's labor in the production process and/or their market wages would be likely candidates. However, not all families had children working off the farm, nor did they all have children working on the farm. Even if neither of these caveats applied, the detail required to obtain an accurate measure of such opportunity costs is great. Moreover, in the cross-section they might be subject to substantial transitory components.
An alternative approach is to include the amount of other production inputs available on the farm, on the ground that the amount of these inputs would affect the demand for children's labor and indirectly the demand for children's education. The three input categories chosen were amount of land cultivated by the household, the value of livestock owned by the family, and the amount of purchased or modern inputs used per hectare of cultivated land. These variables capitalize on the micro data we have at hand and thus may provide more detail than is possible with aggregate data. Since the interpretation of each input category is somewhat different, the following paragraphs provide a brief discussion of each.

The land variable has been treated in alternative ways in previous studies. Evenson and Rosenzweig, (14) for example, viewed land as a factor affecting the demand for labor, and hence hypothesized a negative relationship between the amount of land and the demand for schooling. Shortlidge (51), on the other hand, used land to represent the permanent income of the household. Interestingly enough, both authors obtained statistically significant coefficients for their land variable, and each with the hypothesized sign.

The variable will be interpreted in this study as a factor affecting the demand for labor. Hence, a negative coefficient is expected. The reason for stressing this interpretation is that an alternative measure of the permanent income of the family will
be included in the model (see below). 1/ With this variable included, the land variable should represent the demand for labor.

In keeping with this interpretation, land cultivated was used as a measure of the land variable rather than the total land in the farm. Land cultivated is expected to be a more direct reflection of the demand for labor on the farm, whereas total land would more closely approximate a wealth effect.

The value of livestock (cattle, hogs, and poultry) owned by the family is also hypothesized to affect the demand for children's labor and in turn the demand for education. Children often are given the task of herding or taking general care of the livestock for the family. Hence, it is expected that the coefficient of this variable will have a negative sign. 2/

The third variable introduced to reflect the demand for children's labor is the amount of purchased inputs per hectare of cultivated land. This variable includes expenditures on insecticides, fertilizer, herbicides, improved seeds, and fungicides, as well as on some other more traditional inputs. The interpretation of the coefficient of this variable is somewhat different than the coefficient of the other two input categories, in part because it is introduced on a per hectare basis rather than in terms of the total amount used on the farm.

1/ The type of farm variable may reflect a wealth effect as well, although our hypothesis is that it reflects portfolio considerations instead, especially if an independent measure of permanent income is included in the model.

2/ The wealth effect is again assumed to be negative or captured by other variables in the model.
The use of such modern inputs is usually a good measure of the level of technology used on the farm. If the variable should reflect this characteristic of the production process, a positive sign would be expected on this coefficient, since a higher level of overall production efficiency would mean a smaller demand for labor, other things being equal, and therefore a stronger demand for children's education.

Alternatively, the use of such inputs does raise the productivity of the primary resources, land and labor. To the extent that they raise the productivity of land, other things being equal, they could increase the demand for labor. Hence, the sign of the coefficient of this variable would depend on whether this input category is land-augmenting or labor-augmenting. On these grounds it is not possible to place an a priori constraint on the sign of the coefficient.

Finally, the use of modern inputs may reflect the willingness of the household to modernize by using higher quality inputs. This willingness or desire to modernize may carry over to a desire to improve the quality of the human agent and therefore be reflected in a stronger demand for children's education. On these grounds the coefficient of the variable would be expected to have a positive sign.

Another variable hypothesized to affect the demand for children's labor is the average age of children who are of school age. As a child ages, he becomes more productive in doing physical labor on the farm, acquires more skills through experience and on-the-job training, and may become more mobile relative to off-farm
activities. Thus it is expected that the opportunity cost of a child will increase as his age increases. To capture this effect the average age of children who are of school age was introduced into the model. The expected sign of the coefficient is negative.

A final variable assumed to affect the demand for children's labor within the household is the number of children less than four years of age. In many low income households older children care for the younger children while the mother and father work. Young children are highly time-intensive and the larger their number the greater will be the opportunity cost of children for attending school, other things being equal. The expected sign of the coefficient is therefore negative.

**Household Characteristics**

The variables discussed in this section represent certain characteristics of the household which are hypothesized to affect the demand for education. Some of these variables are assumed to reflect environmental influences, while others are factors which may influence the cost of schooling.

One such variable is the number of living children in the family, independently of whether they are present or not in the household. The conceptual model developed in the previous chapter suggested that this variable increased the shadow price of schooling relative to other commodities. On these grounds the coefficient of the variable would be expected to have a negative sign.
However, the sign of the coefficient may reflect another phenomenon, especially for agricultural families in which self-employment is important. If the supply of land and other inputs is relatively fixed and off-farm employment alternatives are limited, the marginal value product of children's labor may decline as the number of children increases, other things being equal. Thus, the opportunity cost of schooling would tend to decline as the number of children in the family increased. On this ground the coefficient of this variable would be expected to have a positive coefficient, with the enrollment rate increasing as the number of children increased.\(^1\)

These conflicting predictions of the theory suggest that it is not possible to place an a priori restriction on the coefficient of this variable. Whether this sign is positive or negative is therefore an empirical question, depending on the relative weights of the above two factors.

Another household variable hypothesized to influence the demand for children's education is the number of persons in the household. Such a variable was deemed pertinent in light of the importance of the extended family unit in Brazil. Family units often contain relatives who live there because of access to schooling or work opportunities, or because they simply have no place else to live.

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\(^1\) As the number of children in the family gets larger the older ones are increasingly likely to have left the household. If they are employed and remitting money back to the family, there could be an income effect as well. Such an income effect would be captured by the income variable which will be discussed below, however.
It is not possible to place an a priori restriction on the coefficient of this variable. It depends a great deal on the age and composition of the other members. If the individual provides a source of income or can work on the farm, his presence may increase the demand for children's education. On the other hand, if they are elderly or ill, they may place an additional demand on the income earning potential of the family and make it more important that children of school age work. In this case the coefficient would have a negative coefficient.

A third household variable introduced into the model was an information variable. The objective was to have a measure of the contact of the family with the outside world. Such a variable could serve as a proxy for knowledge about alternative job opportunities, and more general awareness of the alternatives and opportunities available to the family.

The survey instrument used in collecting this sample data included a question which inquired how many times a week the head of the household listened to the radio. This variable was introduced into the model, and it was expected that its coefficient would have a positive sign.

The final household variable considered was the distance of the household from the school. This variable is assumed to reflect the cost of going to school both in terms of time and direct transportation costs. Hence, the coefficient of the variable was expected to have a negative sign.
Unfortunately, data were not available from the questionnaire on other direct costs of schooling, such as costs of clothing and materials. Since these costs are not expected to vary greatly among families in a family restricted geographic area, it is not expected that the omission of this variable will bias the coefficients of the other variables.

**Income**

The demand for education is in part a demand for child services as a consumption good, since education is assumed to be a qualitative dimension to the number of children. Hence, the demand for education should be a positive function of the income of the family so long as child services are viewed as a superior good.

Two alternative variables were used as measures of income. The first was total income of the family, defined to include net farm earnings of the household as well as income from other sources such as off-farm earnings of the husband, wife, and other adults in the household, transfer payments, and income from other assets. Transfer payments included primarily pensions, but there was also a limited amount of remittances from children living away from home.

The problem with an income variable of this kind is that it probably has a large transitory component, especially for farm families. The income is primarily from farm sources, and farm income varies a great deal from year to year due to fluctuations.

1/ The off-farm earnings of children below twenty were omitted from the income variable to avoid simultaneity problems. Income from this source was fairly limited, however.
In weather and prices. Hence, there may not be a close relationship between observed family income and the demand for education.

As an alternative, consumption expenditures per household was used. Friedman (16) suggests that consumption expenditures may be the preferred proxy for permanent income since family consumption is relatively constant from year to year despite temporary changes in income. Of course, it is permanent income that should influence the demand for education.

The Empirical Model and the Data

The effect of the variables discussed above on the demand for children's education was tested by means of regression analysis. The full model whose parameters were estimated by ordinary least squares is:

\[
Y = a + b_1 X_1 + b_2 X_2 + b_3 X_3 + b_4 X_4 + b_5 X_5 + b_6 X_6 + b_7 X_7 + b_8 X_8 + b_9 X_9 + b_{10} X_{10} + b_{11} X_{11} + b_{12} X_{12} + b_{13} X_{13} + b_{14} X_{14} + b_{15} X_{15} + b_{16} X_{16} + b_{17} X_{17}
\]

where: 1/

- \( Y \) = percent enrollment of children of school age per household
- \( a \) = regression constant
- \( X_1 \) = age in years of the farm operator (HAGE)
- \( X_2 \) = type of tenure (TYPE), where, 0 = sharecropper or renter, and 1 = small owner

1/ Terms in parenthesis are abbreviations for the variable which will appear in subsequent analysis.
$X_3$ = education of the husband, measured as actual years of formal schooling (HED) or functional literacy of the husband (HREAD)

$X_4$ = age of the wife in years (WAGE)

$X_5$ = education of the wife, measured as actual years of formal schooling (WED) or functional literacy of the wife (WREAD)

$X_6$ = number of days sick for the wife in the last six months (DSICK)

$X_7$ = land cultivated by the family (CLAND)

$X_8$ = value of cattle, hogs, and poultry (measured in cruzeiros$^{1/}$) owned by the household (V LIVE)

$X_9$ = value of purchased inputs per hectare of cultivated land (INPTL)

$X_{10}$ = number of hours per day the wife worked on the farm (HWMK)

$X_{11}$ = number of children in the household below the age of four (#B 4)

$X_{12}$ = average age of school-aged children (CAGE)

$X_{13}$ = distance (in kilometers) the local school is from the house (HFSFH)

$X_{14}$ = number of living children per household (#KIDS)

$X_{15}$ = number of persons living in the household (#HOME)

---

1/ The cruzeiro is the Brazilian monetary unit. All values mentioned hereafter are measured in terms of this unit. During the 1972-73 agricultural year, the average exchange was about Cr$6.00 per U. S. $1.00.
\(X_{16}\) = informational variable measuring the number of times the husband listens to the radio per week (RADIO)

\(X_{17}\) = family income, measured as net income earned by the family during the agricultural year (NINC), or consumption expenditures of the family which includes implicit expenditures through home consumption of farm output (CONS).

All the independent variables were introduced in linear form. Experiments were made with a quadratic specification for the age variables, however.

Before turning to a discussion of the data, it should be noted that the use of an estimating procedure such as ordinary least squares when the dependent variable is expressed as a percentage may give rise to statistical problems.\(^1\) The dependent variable in the model, the percentage of children enrolled in school per family, is in fact a limited variable with an upper limit at one and a lower limit at zero. In the sample data the dependent variable takes on the limiting values for a substantial number of respondents.

Strictly speaking, account should be taken of the concentration of observations at the limiting values in estimating the parameters of the equation. When the dependent variable is limited, the assumption of homoskedasticity, which is basic to OLS analysis, is not very plausible a priori since it is expected that there will be less variation in the dependent variable over certain ranges in the

\(^1\) For a discussion of this problem see Tobin (55), Kementa (27, pp. 249-269), and Pindyck and Rubinfield (40, pp. 238-255).
values of the independent variables. Ordinary least squares estimation of the parameters in this case will be unbiased and consistent, but they may not be efficient.

Several statistical procedures have been developed for use when the dependent variable is limited. Two methods, LOGIT and PROBIT analysis, involve a transformation of the structural model into probability models which predict the likelihood that a certain relationship will exist between the dependent and the independent variables. Both of these methods involve the use of maximum likelihood estimation techniques and are costly to use. A third method, the linear probability model, can be estimated with the use of weighted least squares. However, this procedure is highly sensitive to specification errors and may not be efficient.

Because of the costs involved with LOGIT or PROBIT analysis and the weakness of the linear probability model, it was decided to proceed with ordinary least squares as a first approximation. A test for bias and inconsistency in the estimated parameters can be made by means of an F test. This test will be applied to determine whether the use of ordinary least squares was acceptable.

The sample of observations used in the analysis consists of a subsample of owners, sharecroppers, and renters originally interviewed in July 1973. The sample used for the study is smaller than the total number of observations available because it includes only those families with school age children. In total, about 40

---

1/ See Chow (11).
households were excluded because these households have no school age children or because information on the children was not available.\textsuperscript{1} The remaining sample consisted of 55 observations.

The dependent variable was measured as the percentage of children 7-15 enrolled in school for each household. In Brazil the average age at which children start to school is around 7 or 8 years. The ages 7-15 are the most common ages at which children attend school in rural areas. Although this age range is greater than what would be required for elementary schooling if the children were all to start at seven years of age, and the supply conditions are quite different from secondary schooling, the range does recognize that many children start school after seven years of age or start and then drop out for several years only to start again. Moreover, very few children in the sample went on to secondary school.

Data which show how few children in the study area go on to secondary schooling are presented in Table 2. As can be seen, the average years of schooling in the sample is rather low. Those children in the 7-11 age bracket have completed on the average about 1.6 years of schooling. This average is also indicative of the late age at which most children start to school in rural Brazil. For those children in the higher age bracket, the average years of

\footnote{The large proportion of the sample with no school-age children was due to the advanced age of the sample. According to Patrick, the average age of the small owners in the Vale was 53.6 years, and for sharecroppers and renters, 40.6 years. See Patrick and Carvalho (38, p. 12).}
schooling is greater. The completed years of schooling of the children in the older age bracket is indicative of the average years of schooling the children will receive in total.

Table 2. Average Years of Schooling of Children 7-15 in the Vale do Ribeira, 1972/73, by Age Group.$^{a/}$

<table>
<thead>
<tr>
<th>Age Group (years)</th>
<th>Average School Completed (years)</th>
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<tr>
<td>7-11</td>
<td>1.60 ($^{b/}$)</td>
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<td>(1.40)</td>
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<td>12-15</td>
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<td>(1.70)</td>
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<td>Total 7-15</td>
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<tr>
<td></td>
<td>(1.90)</td>
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</tbody>
</table>

Source: Sample data.

$^{a/}$Children who have never been to school are entered as 0; children who are in the first year of school or have completed 1 year of school are entered as 1; children who have completed 2 years of school are entered as 2, etc.

$^{b/}$Standard deviations in parentheses.
Within the sample the enrollment rates do not appear to be significantly related to whether the children are male or female (Table 3). The percentage of male children aged 7-15 enrolled in school is 70.6 percent while the percentage of female children enrolled is 69.4 percent. A Chi-square test at the one-percent level of significance indicated that the difference in the percentages is not statistically significant. Hence, there appears to be no basis for assuming that the factors hypothesized to influence the demand for children act differently for male than for female children. Therefore, no differentiation by sex was made in estimating the parameters of the model.

Table 3. Children 7-15 Enrolled in School in the Vale do Ribeira, 1972/73, by Age Group and Sex.

<table>
<thead>
<tr>
<th>Category</th>
<th>Total Number of Children</th>
<th>Percent Enrolled</th>
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</thead>
<tbody>
<tr>
<td>Age Group (years)</td>
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</tr>
<tr>
<td>7-11</td>
<td>79</td>
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<tr>
<td>12-15</td>
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<td>57.7</td>
</tr>
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<td>Total 7-15</td>
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<td>Sex</td>
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<tr>
<td>Female</td>
<td>62</td>
<td>69.4</td>
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</table>

Source: Sample data.

a/ The male and female enrollments do not total because it was impossible to determine the sex of one child in the sample.
CHAPTER IV

STATISTICAL RESULTS

A number of experiments were performed with the model in the course of the research. The objectives of these experiments were to examine the consequences of alternative specifications of the model, to examine the consequences of alternative measurements of certain variables, and to examine the consequences of omitting certain variables that did not have statistically significant coefficients. Such experiments are believed to be justified on the grounds that theory has little to say about the specific form of the model, and because it is not a priori which measurement of a variable is appropriate when the available sample data imposes constraints on how the variables can be measured. Moreover, the omission of variables that have coefficients with a low level of statistical significance provides a test of the stability of the empirical results to changes in the specification of the model. Such experiments can be particularly insightful when there is interdependence among the independent variables.

The Basic Model

The results for the first set of experiments with the model are presented in Table 4. The regression coefficients, standard errors, and partial correlation coefficients are presented, together with the adjusted $R^2$ and the value of $F$ for an $F$-test of overall regression.
Table 4. Estimated Regression Coefficients, Standard Errors, and Partial Correlation Coefficients for Independent Variables of the Demand-for-Education Model, Vale do Ribeira, 1972/73.

<table>
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<tr>
<th>Equation No.</th>
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b = regression coefficient  
c = standard errors in first parentheses  
d = partial correlation coefficients in second parentheses  

Note: Asterisks indicate level of significance. A one tailed test is used in the analysis when the regression coefficient signs have been predicted in advance.

* = .10 for one tailed test  
** = .05 for one tailed test  
*** = .025 for one tailed test  
**** = .001 for one tailed test  
* = .10 for two tailed test  
** = .05 for two tailed test  
*** = .025 for two tailed test  
**** = .001 for two tailed test
The statistical results will be analyzed on a variable-by-variable basis. The discussion of the statistical results will give particular attention to the sign of the regression coefficients and the statistical significance of the individual coefficients. To a lesser extent, the adjusted coefficient of multiple correlation ($R^2$) and the coefficients of partial correlation will be considered.1/

Five regression equations are reported in Table 4. In the first and second equations the indexes of functional literacy were used as measures of parents' educational attainment, whereas in the third and fourth equations the parents' formal schooling was used. Comparison of these two sets of equations provides a basis for comparing the relative performance of the alternative measures. The first and fourth equations include net household earnings (NINC) as a measure of household income, while the second and third equations include consumption expenditures as a proxy for the household's income.

Equation 5 is a semi-quadratic form of Equation 1 which postulates a nonlinear relationship of the parents' age variables with the dependent variable. A nonlinear relationship could exist since it is generally accepted that an individual's productivity

---

1/ The coefficients of partial correlation indicate the fraction of variation in the dependent variable explained by a given independent variable, holding constant the other variables in the equation. In this sense they provide an indication of the relative importance of the variable in the equation. When there is intercorrelation among the independent variables these coefficients must be interpreted with care, however, for their sum can be greater than the total explanatory power of the model.
and earnings will increase with age up to a certain point and then decrease. Although not statistically significant at usually accepted levels, the coefficients of the age variables in Equation 5 indicate that the demand for children's schooling will decrease with the age of the husband up to a certain point and then increase. Similarly, the results indicate that the demand for children's schooling will increase with the age of the wife and then decline after a certain age, although the coefficients of the variables are again not statistically significant at usually accepted levels.

To test for the true form of the model, an F test at the one-percent level of significance was conducted between Equation 1 and Equation 5. The results indicated that the addition of the age-squared variables to the model was of no statistical significance to the model. Based upon this result, the linear form was adopted as the true form of the model. Further analysis of the statistical results will therefore refer to the first four equations.

In these four equations, the coefficient of the husband's age (HAGE) variable consistently has a negative sign, while the coefficient of the wife's age variable (WAGE) has a positive sign. The signs of these coefficients were not predicted in advance.

In Equations 1 and 3 the HAGE variable is statistically different from zero at the 10-percent level and in Equation 2 it is significant at the 5-percent level. The coefficient of the WAGE variable is statistically significant at the 5-percent level in Equations 2 and 3 and significant at the 10-percent level in Equations 1 and 4.
The coefficients of the age variables are somewhat smaller in the equations which include the measures of formal schooling (HED, WED) as opposed to the indices of functional literacy. In Equations 3 and 4 it appears that the HED and WED variables may be picking up part of the influence of the age variables on the dependent variable.

The coefficient of the WAGE variable is relatively stable between Equations 1 and 4 (which include the NINC variable) and between Equations 2 and 3 (which include CONS). The coefficient of the HAGE variable changes slightly more between the same group of equations.

On the basis of the partial correlation coefficients, the WAGE variable appears to be slightly more important in the model than HAGE. The HAGE variable explains about 27 percent of the variation in the dependent variable holding the effects of other variables constant, while the WAGE variable explains about 32 percent.

As compared to the HED and WED variables in Equations 3 and 4, the indices of functional literacy (HREAD, WREAD) perform much better in the model. The coefficients of the HREAD and HED variables are not statistically significant at usually accepted levels, although the HREAD has the expected negative sign\(^1\) whereas the HED variables have the wrong sign. The coefficients of the WREAD and WED variables have a higher level of statistical significance than the coefficients for the husband's education variables, with

\(^1\) Due to coding, the coefficient of HREAD is expected to be negative.
WREAD statistically more significant than WED. The coefficient of WREAD is significantly different from zero at the 5-percent level in both Equations 1 and 2.

The inclusion of the CONS variable in Equation 2 lowers slightly the coefficient of the WREAD variable. This suggests that there is some interdependence between this education variable and the permanent income of the family, although it does not appear to be great. The WREAD variable explains about 28 percent of the variation in the dependent variable, holding the effects of other variables constant.

The coefficient of the WED variable is statistically significant at the 10-percent level in Equation 3, but it is not statistically significant in the other equation. The differences in the performance of the respective education variables suggests that informal schooling may be relatively important among low income households. The simple correlation coefficient between WED and HREAD is .76 while that between WREAD and WED is .70. This suggests that these alternative measures are in fact measuring different effects.

The coefficient of the TYPE variable (type of tenure) is consistently negative in all the equations. This negative sign indicates that, as hypothesized, sharecroppers and renters have a greater tendency to enroll their children in school than do small landowners. The coefficient of the TYPE variable is statistically significant in all of the equations at the 5-percent level.
The coefficient of this variable is relatively stable between Equations 1 and 2 and between Equations 3 and 4, but it is somewhat larger in the equations which include the formal schooling variables. The TYPE variable explains about 29 percent of the variation in the dependent variable, holding the effects of the other variables constant.

The coefficient of the DSICK variable (days sick for the wife) is not statistically significant at usually accepted levels in any of the equations, although it has the hypothesized negative sign. The lack of statistical significance for the coefficient of this variable may be due to a measurement problem, since this variable measures only the number of days the wife was sick in the 60 days prior to the date the questionnaire was applied. This variable may not accurately reflect the overall state of the wife's health, thereby causing the statistical relationship to be weak.

The coefficient of the cultivated land variable is also not statistically different from zero at usually accepted levels, although it does have the expected negative sign. The coefficient of this variable is unstable in the presence of alternative specifications of the model, but that is to be expected when the level of statistical significance is so low.

The coefficients of the VLIVE variable (value of livestock) have a somewhat higher level of statistical significance than the CLAND variable, and have the expected negative sign. However, the coefficients are not statistically significant at usually acceptable
levels except in Equation 4, where it is statistically significant at the 10-percent level. The coefficient of this variable is relatively stable among alternative specifications of the model.

The coefficient of the modern input variable, INPTL, has a positive sign. It is statistically significant at the 10-percent level in Equation 1, but is not statistically significant at relevant levels in the other equations. The coefficient of this variable is relatively stable between Equations 1 and 4, but undergoes a relatively large change when the CONS variable is used in place of NINC. The INPTL variable is more highly correlated with CONS than with NINC and this tends to lower its significance in Equations 2 and 3. In Equations 1 and 4, therefore, where the coefficient is statistically stronger, the variable may be serving as a proxy for permanent income.

The coefficient of the HWMK variable (hours worked on the farm by the wife) has the hypothesized negative sign. The coefficient of this variable is statistically significant at the 10-percent level in Equation 4, but it is not significant at usually accepted levels in any of the other equations. The coefficient of this variable is relatively stable in the presence of alternative specifications of the model, although it does increase somewhat in Equation 4. This variable explains about 19 percent of the variation in the dependent variable when the effects of the other variables are held constant.
The #B4 variable (number of children less than four years of age) also has the hypothesized negative sign in all of the equations. The coefficient of the variable is statistically significant at the 5-percent level in Equations 1, 2, and 4, and is significant at the 2.5-percent level in Equation 3. The coefficients of this variable are slightly larger in the equations which include the formal schooling variables. The #B4 variable explains about 28 percent of the variation in the dependent variable when the effects of other variables are held constant.

The distance variable (HFSFD) has the expected negative sign. The coefficient of this variable is relatively stable among Equations 1, 2, and 4, but it declines in Equations 3. The distance variable is statistically significant at the 10-percent level in Equation 1, but it is not statistically significant at usually accepted levels in the other equations.

The CAVE variable measures the average age of children who are 7-15 years old in the household. The coefficient of this variable has the expected negative sign, and is statistically significant at the 5-percent level in Equation 3 and at the 10-percent level in Equations 2 and 4. The coefficient tends to be larger in those equations which include formal years of schooling as measures of the parents' education.

The coefficients of the number of children per household (#KIDS) is highly significant in the estimated equations. Holding constant the effects of the other variables, this variable explains
about 30-percent of the variation in the dependent variable. The sign of the coefficient of this variable was not predicted in advance, but it is positive in all of the equations. The coefficient of this variable is statistically significant at the 5-percent level in Equations 1 and 4, and significant at the 10-percent level in Equations 2 and 3. The coefficient declines somewhat when family consumption expenditures (CONS) is entered into the model.

The coefficient of the $\$HOME$ variable (number in the household) consistently has a negative sign, but it is not statistically significant at usually accepted levels in any of the equations. The coefficient of the RADIO variable has the hypothesized positive sign and is statistically significant at the 5-percent level in Equations 1, 2, and 4, and significant at the 10-percent level in Equation 3. The coefficient of this variable decreases when the CONS variable is introduced in Equations 2 and 3. When the effects of other variables are held constant, the variable explains about 27 percent of the variation in the dependent variable.

The coefficient of the NINC variable (net family income) has the expected positive sign, but it is not statistically different from zero at usually accepted levels. In contrast, the CONS variable, the alternative measure of household income, has a larger coefficient as well as having the expected positive sign. Moreover, the coefficient of this variable is significant at the 10-percent level in Equation 2 and significant at the 2.5-percent level in Equation 3. The coefficient of the CONS variable is larger in the equation which contains formal schooling as the measure of the parent's education.
In comparing the equations, the "best" equation is Equation 2 which includes both the literacy indices of the parents and CONS as the measure of household income. The literacy indices and CONS are considered to be the better measures of education and income based upon their performance in the equations. The $R^2$ of Equation 2 is .41 and the F value is 3.1711. According to the F test, the equation is statistically significant at the 2-percent level.

Overall, the statistical results were reasonably good, especially in light of the fact that the underlying economic model was tested with micro data. Most previous tests of demand-for-education models have used highly aggregated data. The "averaging" which occurs with the aggregate data reduces the randomness in the observed behavior and tends to result in a higher $R^2$ than when micro data is used. However, the $R^2$'s obtained herein compare favorably with those obtained in studies using aggregate data.

The number of variables with coefficients that are statistically different from zero at usually accepted levels are not as large as would have been desired. However, more detail was built into the model than is usually the case in an attempt to capitalize on the detail in the micro data. It is encouraging that the $R^2$ is as large as it is, and that all of the coefficients have the expected sign in those cases in which it is possible to place restrictions on the coefficient. Moreover, the coefficients that are statistically significant tend to be those that have been important in previous studies.
A test for possible bias and inconsistency in the estimated parameters due to the use of a limited dependent variable was made by using a test suggested by Chow (11). Equations 1 and 2 were used for this purpose. The test involves re-estimating these equations with the observations whose predicted values were greater than one omitted. An F-test is then used to determine whether the parameters of this equation are different from the original equation. The tests showed that the coefficients of the respective equations were not significantly different. This suggests that the use of ordinary least squares has not distorted the results.

Other Experiments With the Model

Several of the independent variables whose coefficients were not statistically significant in the regressions reported in Table 4 were dropped from the model. The results from these experiments are reported in Table 5. These results are included in order to show the consequences of dropping variables whose coefficients were not statistically significant as well as to point out certain relationships among the independent variables. The results in Table 5 should be compared to Equation 2 in Table 4, which is considered to be the best specification of the basic model.

Three variables were dropped from the model in all of the equations reported in Table 4: DSICK, NOHOME, and HREAD. With the exception of the CLAND variable, these were the variables whose coefficients were smaller than their standard errors in Equation 2 of Table 4. The coefficient of CLAND was also smaller
Table 5. Estimated Regression Coefficients, Standard Errors, and Partial Correlation Coefficients for Selected Independent Variables of the Demand-for-Education Model, Model 2, Vale do Ribeira, 1972/73.

<table>
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<tr>
<th>Equation No.</th>
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Table 5. (Continued)

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</table>

b = regression coefficient

c = standard errors in first parentheses

d = partial correlation coefficients in second parentheses

Note: Asterisks indicate level of significance.

* .10 for one tailed test
** .05 for one tailed test
*** .025 for one tailed test
**** .001 for one tailed test

* * * * .10 for two tailed test
** ** .05 for two tailed test
*** *** .025 for two tailed test
**** **** .001 for two tailed test
than its standard error in that equation, but it was decided to omit it from the model only in conjunction with the other input variables.

In Equation 1 of Table 5, CAGE was dropped from the model in addition to the above three variables. The reason for doing this was to determine how strong the interrelationship was between the number of children less than 4 years of age, #B4, and this variable, the average age of the children. The coefficient of #B4 does decline somewhat with this change in the specification of the model, and its coefficient becomes somewhat less significant. This suggests that there is more interrelation between these two variables. Moreover, the results suggest that a stronger relationship for the number of children less than four years of age is obtained when the average age of children is controlled for with a separate independent variable.

Another change that takes place in Equation 1 of Table 5 is that the coefficient of the modern input variable (INPTL) becomes somewhat more significant. This appears to be related to the dropping of the husband's education (HREAD). It is plausible that these variables would be related, and hence the modern input variable appears to be picking up at least some of the effect of husband's education.

The final change of note is a decline in both the coefficient and the level of statistical significance of the information variable (RADIO). This result was unexpected. The most likely explanation
is that it is related to the omission of the husband's education variable. (The simple correlation between these two variables is .18).

In Equation 2 of Table 5, the farm input variables were omitted from Equation 2 of Table 4, plus DSICK, NOHOME, HREAD and HMK. The main purpose of this experiment was to determine whether the set of farm inputs might be compounding the effect of the consumption variable, which is presumed to represent a measure of the permanent income of the family.

The statistical results suggest that there may be an interrelationship, for the level of statistical significance of the consumption variable (CONS) increases markedly when these variables are omitted. It should be noted, however, that the size of the coefficient itself does not change all that much.

There are some other changes of interest, however. First, the coefficient of the type of tenure variable (TYPE) increases in size, as does its level of statistical significance. This is to be expected, since type of tenure is very likely associated with the resource endowment.

Second, the coefficient for number of children (#KIDS) in the family declines, and its coefficient is no longer significant at usually accepted levels. It was hypothesized that this latter variable represented an important aspect of the opportunity costs of children's labor in going to school. What these results suggest is that unless there is some "control" in the model for the resource endowment
of the farm as represented by the land cultivated and the stock of livestock, the effect of the number of children in the family cannot be isolated.

A third change was a decline in the coefficient for the average age of the children (CAGE) compared to its coefficient in Equation 2 of Table 4, with a decline in its level of statistical significance as well. The reasons for this are probably the same as for the changes in coefficient of the number of children.

The coefficient for wife's reading ability (WREAD) increases when these variables are omitted, as does its level of statistical significance. A perusal of the other equations in Table 5 suggests no obvious reasons for this. Clearly there are some inter-correlation problems, however.

The coefficient of the information variable (RADIO) declines even further than in Equation 1, with the coefficient now smaller than its standard error. These results suggest that unless the resource endowment of the farm is controlled by the introduction of the input variables, the information variable has a weaker effect in the model.

Finally, it should be noted that the $R^2$ of equation 2 declines to .37 compared to .41 of Equation 2 in Table 4. This is in contrast to the slight increase to .42 in Equation 1. Overall, the farm input variables appear to play a useful role in the model, although their coefficients are not statistically different from zero at usually accepted levels.
The main purpose of estimating Equation 3 in Table 5 was to omit the consumption variable (CONS) while retaining the farm input variables, although some other variables were omitted as well. In a sense this is a counterpart to Equation 2 of Table 5.

The results show a number of things. First, as with other results not reported herein, when the consumption variable is omitted the coefficient of land has a positive coefficient. Hence, it tends to show a wealth effect rather than a substitution effect, and thus serves as a proxy for permanent income.

In addition, the coefficient of the modern input variables increases somewhat and has a higher level of statistical significance. This suggests that there is some interdependence between the use of modern inputs and the permanent income of the family.

Finally, the coefficient for the number of children in the family (#KIDS) is statistically significant at a much higher level when the consumption variable is omitted. The coefficient is not greatly different from what it was in Table 4, but its standard error is substantially lower. These results suggest that the sign and direction of the effect estimated in Equation 2 of Table 4 is not greatly affected by the intercorrelation between consumption and the number of children in the family.

Equations 4 and 5 were estimated primarily to discover what would happen when all variables which tended not to have significant coefficients were omitted from the model. It is encouraging that the coefficients of the remaining variables remain reasonably stable, as
their levels of statistical significance. The two exceptions are the type of tenure (TYPE) and the number of children in the family. The coefficient of type of farm becomes somewhat larger and more highly significant. The results for the number of children, on the other hand, are very similar to those of Equation 2 in Table 5. The omission of the farm input variables affect the statistical results for the number of children in the family.

Equations presented in Table 6 are the results of a final experiment with the modal. A question might be raised about the two age variables. The coefficients of these variables have been reasonably stable with a high level of statistical significance in all specifications of the model. However, they have been of opposite signs. It is possible that these results are a statistical artifact, attributable to a high level of intercorrelation between the variables. Although the intercorrelation is not as high as might be expected (.75), it was decided to omit the variables in order to verify what would happen. The basis of comparison is Equation 4 of Table 5 so as to keep the inter-correlation with other variables to a minimum. In Equation 1 of Table 6, the wife's age is omitted, in Equation 2 the husband's age, and in Equation 3 both variables.

The omission of either of the age variables results in the other age variables no longer being significantly different from zero at usually accepted levels. Both coefficients retain the same sign...

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<td>(.2096)</td>
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<td>HAGE</td>
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<td>$F$</td>
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b = regression coefficient

c = standard errors in first parentheses

d = partial correlation coefficients in second parentheses

Note: Asterisks indicate level of significance. See Table 5, p.89, for explanation.
as they have in other specifications of the model, but the size of the coefficient declines rather substantially in both cases.

When wife's age is omitted (Equation 1), the coefficient of the number of children less than four (#B4) increases substantially and is statistically significant at a higher level. The coefficient of wife's reading ability declines somewhat, as does its level of statistical significance. The other results are about the same, although the $R^2$ is lower than in Equation 4 of Table 5.

When husband's age is omitted (Equation 2), the coefficients of both the number of children less than four years of age (#B4) and the total number of children (#KIDS) decline markedly, and neither are statistically significant at usually accepted levels. The coefficient for wife's reading ability has a still lower level of statistical significance.

When both age variables are omitted (Equation 3) the coefficient of the number of children less than four years of age increases again, and is significantly different from zero at the five percent level. The coefficient for the number of children in the family increases, compared to Equation 2, but it is still not significantly different from zero at usually accepted levels.

These results leave one in somewhat of a quandary. Clearly, the statistical significance of the age variables in each case depends on the presence of the other age variable in the equation. Moreover, there are no a priori criteria by means of which one can determine whether intercorrelation is creating a problem.
Our view is that a proper specification of the model should include these variables. There are good theoretical reasons for including the variables, and the simple correlation between the two (.75) is not sufficiently great to give one much confidence than one of the variables can serve as a proxy for the two. Moreover, both variables have reasonably stable coefficients and are significantly different from zero at usually accepted levels in almost all specifications of the model. The variables at a minimum appear to serve as a control so that the coefficients of other variables are not biased.

Despite these caveats, the statistical results for these variables should be interpreted with caution.

Concluding Comments

The various experiments with the model indicate that there are some problems of intercorrelation among the independent variables. However, these do not appear to be sufficiently serious to distort the statistical results. The statistical analysis provides reasonably strong support for some variables in the model. In other cases, the level of statistical significance is not as great as would be desired, but the coefficients have signs that are consistent with a priori expectations, and in many cases the coefficient is larger than the standard error. For a relatively small sample of micro data, and given the detail provided in the specification of the model, the results are encouraging.
CHAPTER V

ECONOMIC AND POLICY IMPLICATIONS

The major part of this chapter consists of a discussion of the economic implications of the statistical results obtained, organized largely on a variable-by-variable basis. At the end of the chapter, however, an attempt is made to draw the major policy implications from these results.

The discussion is based in large part on Equation 2 of Table 4. However, the results when various experiments were made with the model is also taken into account.

Enrollments

The percentage of children enrolled in school for the area of study, 70.2 percent, is rather high when compared with statistics of enrollments for other rural areas of Brazil. One possible explanation for this high level of enrollment is that the study region is quite near the city of Sao Paulo, which provides alternative employment opportunities for the residents of the area. This closeness to the city should increase the expected returns to education through the greater demand for skilled labor in alternative off farm employments.
Another possible explanation is that by Brazilian standards Sao Paulo in general has invested at a relatively high rate in education. Hence, there just may be more schools available.

In addition, factor markets should be working more perfectly closer to the city with transportation and information less costly to obtain. New modern inputs which increase the returns to education on the farm can be provided to farmers at lower cost. Moreover, the state of Sao Paulo has invested more heavily in agricultural research. According to Welch, these factors should increase the returns to education and therefore increase the demand for it.

The relatively high enrollment rate in the area of the study is most likely due to a combination of all of these factors. The higher returns to education increase the value of the children's time which is spent in attending school relative to the value of time spent in other activities. At the same time, the supply of schooling may be greater.

However, despite the rather high percentage of enrollments, the actual average years of schooling completed by the children in the region is rather low. The sample average for years of schooling completed was 2.35 years, with children 7-11 years old having completed 1.60 years of school and children 12-15 years old having completed 3.46 years of schooling (cf. Table 2). The low years of school completed for children 7-11 indicates the late starting age of these children. Although the required starting age is 7, many children do not start school until much later.
Husband's Characteristics

The age of the husband has a statistically significant coefficient in the model, and exhibits a negative linear relationship with the dependent variable. Hence, the older the husband, the less education is demanded for the children in the family.

This result has at least three possible explanations. First, as the husband ages his vitality and productivity is expected to decline. Under this condition, the demand for children's labor on the farm may increase as children's labor is substituted for the husband's labor in tasks the husband could have performed at a younger age. Other things being equal, this would imply that the demand for education should decrease as the husband ages. This interpretation seems especially plausible in light of the fact that the average age of the husbands in the sample is rather high. This suggests that a large proportion of the observations are on the down side of the life-cycle earnings profile.

A second explanation for the negative sign on the coefficient of this variable is that it is serving as a taste variable. It could be that older husbands have a different view about education and its value, and believe that since it was not important in their time it is not important today. Hence, older husbands would demand less education for their children, other things being equal.

The third possible interpretation is that age is measuring a life-expectancy effect. Older husbands will have a shorter period
over which they can reap the benefits from investing in the education of their children. Hence they may demand less education for their children, other things being equal.

It is not possible to infer from the data or the statistical results which of these factors are at work. The most that can be said at this point is that families with older husbands tend to demand less education for their children.

The second characteristic of the husband considered was his education. The coefficient of the variable was not statistically significant from zero in any specification of the model. This suggests that the education of the father has no detectable influence on the schooling decisions for the children. A previous study by DeTray (12) in which demand for education of children was analyzed also found the education of the husband to have little influence on the schooling decision.

The education of the father was entered into the model to capture two possible effects: 1) its possible effect on overall resource productivity within the farm-household complex, and 2) a taste effect in which it was expected that husbands with more education might desire a higher level of education for their children. Based on the statistical results, it appears either that neither of these factors are important to the model, or that the variables used to measure these effects did not capture them. In the latter regard it is important to note that the level of

\[1/\] To be precise, the variable actually used was a measure of his functional literacy.
education of husbands in the sample was in general quite low, and that the variance of the variable was also quite low. Hence, the lack of statistical significance for this variable may reflect the fact that there was not sufficient variation in the variable to pick up an effect by the procedures used. The test of functional literacy was also a rather simple test.

**Type of Tenure**

The coefficient of the type of tenure variable had a negative sign in the model, indicating that sharecroppers and renters tend to demand more education for their children than do small landowners. The coefficient of this variable tended to have a high level of statistical significance, and consistently was one of the strongest variables in the model.

The sign of the coefficient was also consistent with a priori expectations. The interpretation of this result is that families which are not able to purchase land, or which do not have access to land ownership, invest more heavily in the education of their children.

It is apparent from examination of the sample averages (Appendix C, Table C.2) that what sharply differentiates the small owners from the sharecroppers is the ownership of land, capital, and livestock. Since sharecroppers do not have permanent ownership of the land they operate, it appears that they have less incentive to invest in physical assets and more incentive to invest in nonphysical forms of capital such as education.
One possible explanation for this result is that those who do not now own land are pessimistic that their children will be able to continue in agriculture. Hence, they invest more in the schooling of their children, with the expectation that this will expand their employment alternatives in the future.

**Characteristics of the Wife**

The age and education of the wife had statistically significant coefficients in the model, illustrating the extent to which the wife influences the decisions for education of the children. Moreover, these results were reasonably stable and consistent for alternative specifications of the model.

The coefficient for the age of the wife indicates that there is a positive linear relationship between this variable and the enrollment rates of the children. This suggests that the older the wife the greater the demand for schooling of the children, other things being equal.

The interesting point here, of course, is that this result is just the opposite of that obtained for husband's age. Although we noted above that these results should be interpreted with a certain degree of caution, there is a possible explanation for the disparity in results. The conceptual model developed in Chapter II postulated that within the household children's time was substitutable for wife's time. Moreover, in Chapter III it was argued that the age variable might reflect experience or on-the-job training, with the implication that productivity would rise with age, at least within a range.
The positive coefficient for the wife's age variable is consistent with the hypothesis that within the range of data in the sample an increase in age of the wife is associated with a rise in productivity that releases children's time from household activities for schooling. As noted earlier, since household activities are less demanding of physical labor, aging may not have a deleterious effect on productivity of the wife until much later in life. This could explain the divergence results between the husband's and wife's age. Another possible explanation is that age of the husband captures a life-expectancy effect, as discussed above, while age of the wife captures a productivity effect.

Education of the wife (in this case her level of functional literacy) is also positively related to the demand for schooling for the children. This result is consistent with the implications of the household economics, and also agrees with previous studies of the demand for schooling (12). More human capital invested in the wife is expected to increase the opportunity cost of her time. Since children are time-intensive commodities, a higher opportunity cost for the wife's time is expected to lead to a reduction in the demand for number of children and an increase in the demand for quality. An implication of the latter is an increase in the demand for schooling for the children.

Education (or the functional literacy) of the wife may measure a productivity effect as well. Wives with more human capital invested in them would be expected to be more productive, thereby releasing children's time for schooling.
A third characteristic of the wife considered was the hours of work she supplied to farm activities. It was expected that more work on the farm would increase the demand for children labor in the household, thereby reducing the demand for children's education.

The coefficient of this variable consistently had a negative sign in the alternative specifications of the model. However, its level of statistical significance was not high. Hence, the statistical results provide some evidence for the hours worked by the wife or children's schooling, but not a great deal. The evidence for substitution of children's and wife's labor within the household is therefore rather weak.

A fourth characteristic of the wife considered was the days she was sick during the previous six months. The coefficient of this variable consistently had a negative sign, but was not statistically significant at usually accepted levels. The negative relationship suggests that as the wife has health problems, enrollment rates of the children declines. Even though the relationship is not statistically significant, the results are suggestive of an apparent relationship between the wife and the schooling of the children.

**Opportunity Cost of Children's Time**

Neither of the coefficients for the variables representing the direct demand for children's labor on the farm, land cultivated or value of livestock, were statistically significant at usually
accepted levels, although they both tended to have the expected negative signs. The coefficient for the livestock variable was reasonably stable from one specification of the model to another, but the coefficient of the land variable was somewhat unstable.

These results suggest that within the range of the sample data the demand for children's labor on the farm does not represent a significant constraint on the enrollments of children in school. This result is in contrast with the results obtained by Evenson and Rosenzweig (14) with data from India, since they found the land owned by the family to be a significant constraint to school attendance by the children of rural families. The difference in results suggests that the constraints facing households in rural areas may differ among geographic areas.

The lack of statistical significance for the coefficient of the livestock variable is probably due to the fact that livestock production was not an important enterprise among the sample farms. The amount of livestock on the farms was not sufficiently large that this variable should constitute an important constraint to school enrollments.

It should also be noted that all of the households in the sample are small farmers with 30 or less hectares of land. This may explain why the land variable also does not have a statistically significant coefficient. With such small holdings, the available

\[1/\] The coefficient for land did become positive when the consumption variable was omitted from the equation, however.
family labor may be more than enough to farm the family's holdings. In this case, the opportunity cost of time in schooling will be determined by the value of children's time spent in household production, or in off-farm work should it be available.

Data presented in Table 7 indicate that a large proportion of the children in the sample aged 7-15 engaged in some form of work activity. This suggests that the opportunity costs of going to school might be relatively important. Moreover, as expected, the children in the older age bracket work considerably more than the children in the younger age bracket, which illustrates the extent to which the opportunity cost of time of children increases with age.

Despite this rather high level of work activity among school age children, however, the statistical results suggest that the demand for labor on the farm does not constitute a significant constraint to enrollments in school. One reason why enrollments and the number of children who work on the farm are both high could be that primary schooling is part time for half a day. The children could still have time to do farm work after school.

These results may also reflect the fact that the demand for the labor of children on the farm tends to be seasonal. The on-farm demand for child labor may be reflected more in absences of children from school in certain periods of the year than in actual withdrawal within a given school year. Moreover, long absences from school due to seasonal variations in the demand for labor would make it difficult for children to complete grade levels and to advance to

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<th>Age Group</th>
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<th>Children in Sample</th>
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<td>Off-Farm</td>
</tr>
<tr>
<td>7-11</td>
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</tr>
<tr>
<td>12-15</td>
<td>69.2</td>
<td>25.0</td>
</tr>
<tr>
<td>Total 7-15</td>
<td>38.2</td>
<td>19.1</td>
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</table>

Source: Sample data.

/a/ The total is less than the sum of farm and off-farm work percentages because some children reported work in both categories.
further levels of education. Thus, the value of time spent in farm work may still be a constraint on schooling decisions, although it does not show up in this model. Absences from school may be one reason for the low average years of schooling completed per child in the sample.

Another aspect of the opportunity costs of children's time that was considered was the average age of the children. This variable was somewhat stronger in the model, but not greatly so. The negative sign on the coefficient suggests that as children grow older the opportunity cost of their time in schooling increases and enrollment rates decline, other things being equal. Within limits the age of children is a good proxy for their opportunity cost in terms of both farm labor and off-farm labor.

The number of children below four years of age was another aspect of the opportunity costs of children's time considered in the model. This turned out to be the most statistically significant of the opportunity cost variables. The negative sign on the coefficient of this variable suggests that the demand for children's time within the household may be important. Young children are expected to be time-intensive of either the mother's or children's time. The statistical results suggest that young children do effect the demand for schooling of older children.

The importance of this variable in the model could be one explanation for the low starting age of children in school. Since the older children may be needed to mind the younger children, it is possible that many must wait to attend school until the younger children are older and can take care of themselves.
The final variable considered to represent the opportunity cost of children's time was the value of modern inputs used per hectare. The coefficient of this variable was reasonably stable from one specification of the model to another, and had a positive sign. It did not have a high level of statistical significance, however.

This variable may serve as a measure of overall resource productivity in the farm activities. To the extent it does, it suggests that an increase in productivity releases children's labor for schooling, and thereby increases the demand for education.

Alternatively, of course, it may be that those households which purchase such inputs from the nonfarm sector are more aware of the value of education in farm and off-farm work. Hence, this variable may be representing an awareness factor on the part of the family.

**Household Characteristics**

The most important of the household characteristics which influences the demand for education of children was the number of children per family (#KIDS). Based on the theory it was not possible to place an a priori constraint on this coefficient. Based on the formal model presented in Chapter II, it was hypothesized that this variable would have a negative effect on the demand for schooling, since total costs of schooling are expected to increase as the number of children in the family increases. Alternatively, it was pointed out in Chapter III that an increase
in the number of children in the family may lower the marginal product of labor on the farm and thereby lower the opportunity cost of schooling.

Given that direct costs are not the most important cost of primary schooling in Brazil, the theoretical model as derived in Chapter II may be somewhat misleading for Brazilian conditions. If indirect or opportunity costs are the most important costs of schooling, then the positive relationship obtained with the statistical procedures may be a true relation.

Assume that the marginal product of children's time on the farm is as illustrated in Figure 3. Assuming further that children are a homogeneous input which yield a fixed flow of labor services per child, Figure 3 shows that the marginal productivity of children's labor services should decrease with each additional increase in the number of children. Labor services of children would then be provided until the marginal productivity of children's labor services is equal to the value of children's time spent in education. Thus from Figure 3, $X_0$ units of child labor services should be demanded by the family. If more than $X_0$ of child services are available, these services are redundant and can be used more profitably by sending children to school. Thus, it is obvious that the more children per family, the lower is the marginal product of additional labor services per child and the lower the cost of sending children to school. Hence, the larger the family, other things being equal, the higher the proportion of children that should be in school.
Figure 3. Opportunity Cost of Children in School.
The positive relationship between the number of children and the quantity of schooling demanded also provides another explanation for the low starting age of children in school in rural Brazil. Since the opportunity cost of children in work activities is higher for those families with a few children, many children may have to wait to go to school until there are many brothers and sisters of sufficient age to participate in work activities in the family.

The distance of the home from the local school was another cost variable included in the model. The coefficient of this variable had the expected negative sign, but its level of significance was not particularly high. The negative coefficient indicates that distance from the school is a positive cost of schooling which varies among households, and that the greater the distance from the school the lower the demand for schooling.

In order to gain some insight into the effect of the distance variable on the demand for education, Table 8 presents predictions from the estimated equation of the percentage enrollments for various distances from the school, holding all other independent variables constant at their means. The results are based on Equation 2, which is considered the best equation estimated.

The results indicate that the availability of schools has a sizeable impact on the percentage of students enrolled even though the low level of statistical significance for the coefficient suggests that within the sample, distance from schools was not a major determinant of school enrollments. As predicted, by the equation, an increase in the average distance from the local school
Table 8. Estimated Percentage Enrollments at Given Levels of Distance from the Local School, Other Variables Held at Their Means, Vale do Ribeira, 1972/73.

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<th>Distance (Km.)</th>
<th>Percent Enrollments</th>
<th>Percent Change</th>
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<tr>
<td>5.00</td>
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<tr>
<td>3.00</td>
<td>68.58</td>
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<tr>
<td>1.50</td>
<td>71.95</td>
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</tr>
<tr>
<td>.50</td>
<td>74.20</td>
<td>3.1</td>
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</table>
of 2 km. would reduce average enrollments by about 7.0 percentage points, while an increase in the average distance from the local school of 1.5 km. will decrease average enrollments about 5.0 percent. These changes are rather sizeable, illustrating the extent to which increased availability of schools can be an important means of encouraging increased school attendance.

The number of persons in the home did not have a highly significant coefficient. The sign of this variable was not predicted in advance. The negative coefficient indicates that the more people there are in the home, other things being equal, the less will be the demand for education. The negative sign suggests that the larger the family, the larger the number of dependent or unproductive individuals. This would tend to raise the opportunity costs of the children of school age, thereby reducing the demand for education.

The coefficient of the radio variable tended to have the expected sign, but varied in its level of statistical significance. It tended to be a stronger variable when the farm input variables were included in the model.

These results suggest that information from the outside may influence the demand for education, although the relationship is rather weak. Information from outside sources may increase individual knowledge about the returns to education, thus increasing the perceived returns from sending children to school. Thus it is to be expected that this relationship is positive.
**Income Variables**

The consumption variable outperformed the income variable as a factor affecting the demand for children's education. Moreover, the coefficient of this variable was reasonably stable in the presence of alternative specifications of the model, and was consistently one of the strongest variables in the equation. Moreover, the coefficient had the expected positive sign.

There are good reasons for believing that family consumption is a proxy for permanent income of the family. The income variable may play two roles. In the first place, it may play the role of an ordinary budget constraint. Although tuition costs are free for primary schooling in rural Brazil, families must still pay for uniforms, lunches, and school supplies. These costs may be important for some of the families in the area. In addition, it is to be expected that children from higher income families will have a lower opportunity cost of time since those families can hire labor to perform many of the tasks that children would do on the farm or in the household. Thus it is to be expected that families with higher incomes will be more able to send their children to school than the lower income families.

The income variable may be capturing a somewhat different demand effect as well. Some aspects of education are viewed as a consumption good. Hence, an increase in income should be expected to lead to an increase in the quantity demanded of this good.
Policy Implications from the Model

Perhaps the most important implication of the model for policy purposes is that children's labor services, either in work, in the home, or in the market, are demanded by farm households. This suggests that simply making primary schooling tuition-free will not enable all students to attend school. As the statistical results indicate, there are other important constraints on enrollment such as the opportunity cost of the time of children in school.

The statistical results suggest that the opportunity cost of school is not determined to a large extent by the demand for children's labor on the farm, although information on absences might substantiate the assertion that demand for children's labor is seasonal. However, because of the proximity of the area studied to the city of Sao Paulo, the opportunity cost of time of the children appears to be determined by the value of children's time spent in off-farm work, as indicated by the statistical significance of the age variable, and in work within the household. The significance of the variables denoting the substitution of children's time for the time of the wife in household production points out the importance of children's work within the home.

Based upon the statistical evidence and an analysis of the enrollment data, it is evident that families in rural areas do send their children to school based upon some expectation of future returns and costs. The high enrollments in the study area indicate
that the families have responded to the higher returns to education in the area which should accrue due to the proximity to a major city. However, the negative signs on the coefficients of the opportunity cost variables also indicate that certain indirect costs of schooling are taken into account as well in decisions regarding education.

The results of the model indicate that if increased enrollments in school is a policy goal for rural areas in Brazil, there are several policies which can be pursued by policy makers. In general, any policies which increase the expected returns from education or which make known to rural people the importance of education should increase enrollments of children in school. The importance of the informational (RADIO) variable indicate that if rural people have contacts with the outside world such that they are aware of the value of education, they will respond to the higher returns to education as they would to any other economic opportunity. Any policy which increases the expected returns from education in effect increases the value of the time of children spent in education relative to time spent in other activities. These policies should increase enrollments in school.

The other approach to increased enrollments suggested by the results is to decrease the cost of schooling in terms of the time children must spend in school attendance. As the coefficient of the distance variable indicates, increased availability of schools will increase enrollments since the cost of schooling in terms of
transportation time will be decreased. In some cases, where the distance is too far for children to attend, costs of schooling may be perceived as quite high. In addition to increased availability of schools, improved roads and improved transportation methods in rural areas should also increase enrollments in school, since this will reduce the time of children spent in traveling to school.

The results also suggest that the introduction of new modern inputs into production processes will help enrollment rates for children. The importance of this variable in the equations suggests that those households which do use modern purchased inputs tend to send their children to school more than those households which use less of them. This may suggest that the use of such inputs is labor-saving, thereby releasing the children's time for schooling.

An important finding of the model is the value of large numbers of children per household in increasing school enrollments. The more children there are in a family, other things being equal, the lower is the marginal productivity of additional children in work activities and thus enrollment rates are increased. These results provide indirect evidence for the importance of opportunity costs for schooling. They also suggest that policies which increase the productivity of labor may have a short-run deleterious effect on schooling, and thus may require some offsetting measure if school enrollments are to be sustained.

The model also indicates the importance of the wife in the decision process for education of the children. The more well educated the wife and the more time she devotes to work at home,
other things being equal, the more the children are expected to attend school. Thus policy measures could focus on getting information to the wives of low income families on the importance of education. Since the wife evidently is the central figure in the decisions regarding education, enrollments should increase if she is more aware of the importance of schooling.

Finally, an perhaps most importantly, to the extent the opportunity costs of children's time is a constraint to educational attainment, a subsidy for schooling may be an appropriate policy response. In other words, children might be paid for going to school, or a subsidy might be paid to offset the direct costs of schooling.

At first glance, such a policy might appear to be quite expensive. However, though the amount of income transfer required might be relatively large in terms of the family's income, in absolute terms it might be quite small. Moreover, the form in which the payment is made might serve other social goals. For example, a school lunch program for low income groups in effect constitutes an income transfer. Although the amount of subsidy involved in such a policy would be quite small, it could be a critical factor in the decision-making process, especially if implemented through an important item such as food.

From a policy standpoint, it is important to note that previous studies of the economics of education in Brazil have demonstrated that the social rate of return to lower level education is quite
high. Hence, the cost of attaining high enrollment rates is not the only consideration. In making a final decision, policymakers have to weigh the costs against the expected benefits.
CHAPTER VI

SUMMARY, CONCLUSIONS AND SUGGESTIONS FOR FUTURE RESEARCH

This study has attempted to isolate the major factors influencing the demand for children's education among poor farm households in a rural area of Brazil. The approach of this study was to use OLS regression analysis as a statistical means of testing the importance of factors hypothesized by economic theory to affect the demand for education. An analysis and interpretation of the statistical results was then made, including a discussion of the more important factors influencing the demand for education. Policy implications were also drawn.

This chapter presents a summary of the study and a synthesis of the more important conclusions. To provide perspective the results obtained will be compared with those obtained from other studies. The final section will provide suggestions for further research.

Summary and Main Conclusions

The major goal of the study was to attempt to understand the demand for education of children from the viewpoint of the opportunity cost of time. Since primary schooling is tuition-free and
children in rural areas do have alternative economic opportunities both on the farm or off the farm, it was hypothesized that the important costs of schooling are indirect, as opposed to direct financial costs.

In general, the model of the demand for schooling hypothesized by the theory performed reasonably well in explaining variations in schooling enrollments among the rural families in the sample. The statistical results indicate that opportunity costs of children as well as those of the wife are important factors influencing the educational activities of rural families. An important finding of the study, as opposed to other studies which attempted to evaluate the demand for education among rural families, is the apparent significance of work within the home as a determinant of the opportunity cost of the time of children.

Due to the lack of specific data on wages of the husband, wife, and children, the empirical model analyzed the demand for schooling as a function of variables expected to determine the earnings capacity and opportunity cost of time of individual members of the household. The statistical results indicated that the age and education characteristics of the wife are highly important in determining the demand for education, as is the age of the husband. The average age of the children was also somewhat significant in explaining the demand for education. These variables point out the importance of opportunity costs of children as determinants of school attendance either from work in the home, farm, or off the farm.
Other variables which emphasize the opportunity cost of time are the number of children per household and the number of children less than four years of age. The significance of these variables again point to the importance of children as a source of labor to the household and suggest possible explanations for the late age at which many children start to school in rural areas.

The results for a variable which measured the distance from schools also brought out the importance of the availability of schools as a determinant of enrollment rates. The results of the statistical analysis showed that increased availability of schools either through a wider dispersion of schools or through better roads and transportation facilities would increase enrollments substantially by decreasing transportation costs.

The statistical results also suggested that the opportunity cost of time of children in the area studied apparently is influenced more by the value of the children's time spent in work within the home or in off-farm work than by work on the farm. This result is most likely due to the proximity of the area studied to the highly urbanized and developed city of Sao Paulo. However, these results may also indicate that the demand for children's labor on the farm is more seasonal than other work activities and would thus have an effect on absences rather than to influence enrollments from school.

This finding may also be due to the small size of the farm units in the sample and the rather extensive way in which they are exploited.
It may be that the husband, supplemented by the wife, provide all
the labor that can be effectively used on the farm.

Perhaps the most important finding of the study, however, is
the support it provides for the hypothesis that the demand for
schooling among rural households is determined by the specific
costs and rewards of education in relation to the costs and rewards
of other activities. The statistical results indicate that rural
households do respond to the economic rewards and costs of education
through a process of maximizing behavior as postulated by economic
theory. The relatively high enrollments in the area, as well as
the significance of such variables as the information variable
and the inputs per cultivated hectare, indicate that if rural families
are aware of the economic opportunities for their children which
increased educational attainment provides, they will respond to
the higher anticipated returns from education, subject to the cost
constraints, as they would in any other investment calculation.

The specific variables examined in the model suggest some
policy alternatives to policy makers if increased educational attain­
ment is a desired goal. In general, the implications of the model
suggest that measures which increase the expected returns from
education to the individual should increase enrollments. Policies
which increase the returns to education could include up-grading
the quality of rural schools as well as emphasizing the importance
of education to rural families. Other policies could decrease the
costs of education while taking into account that the most important
costs of schooling are the indirect or opportunity costs.
Relation of this Study to Other Studies

There have been only a limited number of studies which attempted to analyze the demand for schooling of children from the perspective of the new household economics, and even fewer that used micro-level household data for this purpose. An early study by DeTray (12) analyzed the demand for education of children in relation to fertility decisions. His model, however, did not take into account the opportunity cost of children in the decisions process and was not applied to rural areas.

Two studies have analyzed the demand for education of children in rural areas while taking into account the opportunity cost of time constraints. Shortlidge (51) examined the demand for education of children in rural India through the household economics approach, but used the individual rather than the household as the unit of observation. He included in his model individual characteristics of children such as age, sex, and first born in order to test the hypothesis that the schooling decision may be one in which it is decided to send a particular child to school. Shortlidge used a binary variable as the dependent variable and estimated the parameters of the model using a maximum likelihood procedure for a LOGIT equation.

Evenson and Rosenzweig (14) use a method of analysis closer to that employed in this study, with the individual household used as the unit of observation. They used two-stage least squares to estimate the parameters of a model in which schooling decisions
were viewed as simultaneously determined with decisions regarding the labor force participation of children. They also estimated separate equations of school enrollment for males and females to test for structural differences in the equations that might arise due to interactions between sex and the independent variables. Since analysis of our sample data indicated that there were no significant differences in enrollment rates between male and female children, no analysis of the sex variable was included in this study.

The model employed in this study was very similar to the model developed by Evenson and Rosenzweig. However, Evenson and Rosenzweig applied their model to aggregate county data for rural India. The approach of the present study was to test the model with cross-sectional household data from a single region of Brazil. The use of micro data, as opposed to aggregate data, made it possible to analyze more specifically the time allocation as well as other characteristics of individual family members which vary across households.

In addition, the basic model of Evenson and Rosenzweig was expanded in this study to include the value of the opportunity cost of time of children spent in household work. Indeed, a key contribution of this study is the recognition that the time of children is substitutable for the time of the wife within the home and that household activities constitute another constraint on enrollment of children in school. The significance of the variables representing the opportunity cost of children's time within the household
indicates that this is an important factor explaining enrollment rates. This finding constitutes an important contribution to the theory.

Conclusions and Suggestions for Further Research

The results of this study suggest that the perspective of the new household economics with its emphasis on the opportunity cost of time does not provide a comprehensive model of the facts of educational attainment, and that there are certain deficiencies in the model which should be explored in future research in order to shed more light on the problem of low educational attainment in rural areas. One factor which could affect the demand for schooling in rural areas is the quality of schooling. This subject was not analyzed in this study due to the lack of appropriate data. Low quality schooling in effect raises the costs of schooling (shifts down the production function for education) and thus should cause demand for schooling to be less. Further research on this subject could compare the quality of schooling between rural and urban areas and evaluate the demand for education in rural areas while including costs due to lower quality.

Another aspect not covered by the study is the importance of informal schooling. The significance of the literacy indices used in the study for the parents indicate that informal schooling is important in rural areas. Thus, children may not attend school because they are receiving an equivalent education at home. A
more complete analysis of the demand for education could include
the time parents or older children spend in teaching the children
at home.

A further area of analysis in terms of the opportunity cost
of time of schooling would be to analyze information on absences.
As the results of this study suggest, in areas where the demand
for children's labor is seasonal, enrollments in school may not
be affected to a great extent by demand for children's labor.
Instead, the demand for children's labor might affect the demand
for schooling through absences at certain times of the year.
Absences from school can affect the educational process by making
it difficult for children to learn and to pass from one level to
the next. Thus, a more complete analysis should include informa-
tion on absences from school in order to more fully evaluate the
role of opportunity costs as constraints on education.

A final area not covered by this thesis would be to examine
the costs of education of children from the viewpoint of the
institutional arrangements of the Brazilian schooling system itself.
In Brazil, while primary schooling is tuition free, secondary
schooling was not tuition free until recently, and even now
students must still pass a rigid entrance examination in order to
attend. In effect, this raises the costs of schooling beyond the
primary level to a very high level, especially for rural households
which are handicapped by low incomes and lower quality schooling.
In the sample of data used for this study, only three of the children were attending school at levels above the fifth grade.\(^\ddagger\)

This suggests that the costs of secondary school attendance may be very high due to institutional arrangements, with the result that only a few of the student's from rural areas are able to attend.

This study has provided some insight into the educational problem in rural Brazil by evaluating the demand for education in terms of opportunity costs. However, future research of a more exhaustive nature should focus on the role of institutional constraints to education as well as the quality of schooling and the role of informal education. Given the potential of education as a policy instrument to alleviate the rural income problem, further research in this area could have a high payoff in achieving a more equitable distribution of income.

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\(^\ddagger\) Primary schooling is from 4-5 years in Brazil. Of the offspring in the sample who were in the age range 16-22, 13 had completed schooling levels above 5 years. A separate analysis was not made of this group because many of the children in this age bracket were not at home. The larger number of children in the older age bracket which had entered secondary schooling suggests that part of this problem may be due to the late age at which children start to school.
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APPENDIX A

Definitions of Variables
APPENDIX A

Definitions of Variables

Definitions for selected variables employed in the demand-for-education model are provided in this section. For those variables not in this section, definitions can be found in Chapter 3 of the thesis.

Percent Enrollments of Children

The percentage of children aged 7-15 enrolled in school during the 1972/73 agricultural year represents the demand for education of children in each household. In the first questionnaire, which was applied to the sample area in July 1973, each household was requested to state the principal activity of each child currently living at home. The activity choices included: no activity, student, helps the family on the farm, salaried worker in agriculture, salaried urban worker, or other. This information was used to estimate the percentage of children enrolled in school.

Some underreporting of enrollments was evidenced in the sample, however. Since the questionnaire was applied when school was not in session, many of the families entered no activity for children who were actually enrolled during the school year. Also, some
children were not reported as attending school because only one activity could be reported and some children were working as well as attending school.

In order to get around these problems, information on absences from school obtained from the first questionnaire was utilized. In addition, in the third questionnaire, applied during July 1974, households reported those children aged 7-14 that were currently enrolled in school. The information on absences and enrollments was used to supplement the activity data when there was some question as to whether a child was enrolled in school or not. It is believed that the enrollment information used in the estimation of the model is a close approximation to actual enrollments in the sample area.

Consumption Expenditures

Consumption expenditures were defined as the value in cruzeiros of consumption expenditures of each household in the 1972/73 agricultural year. This variable includes expenditures on home consumption (value of animals, crops, and other products consumed by the family), education, food, clothing, durable household goods, health, rent, water, electricity, and other miscellaneous expenses. Expenditures on durable goods were discounted over a period of eight years.

Seven households in the sample (3 renters and 4 owners) did not report information on consumption expenditures. Values for these households were set at the sample group means, Cr$5465 for sharecroppers and renters and Cr$5379 for owners.
Net Income

The net income of the household was defined as the value in cruzeiros of the sum of net agricultural income, income from off-farm work of adults living at home, and transfer payments for the 1972/73 agricultural year. The net agricultural income figure was arrived at by summing the income from the sale of agricultural products, implicit income from family consumption and farm use of farm products, income paid in kind, rental income from machines or land, and changes in inventory, and then subtracting from this total the purchases of inputs, farm produced inputs, and income paid to the landlord. Transfer payments include income from pensions, income from relatives sent to the household, and interest income from nonfarm assets.

Land

The land variable was measured by the total number of hectares of land in cultivation and in cultivated pastures per household. For those families which did not own land, this variable measured the total hectares of cultivated land furnished by the landowner.

Livestock

The livestock variable was measured by the value in cruzeiros of the current inventory of livestock per household when the first questionnaire was applied in July 1973. The livestock categories included were the values of chickens, cattle, and swine on hand.

Inputs per Hectare of Cultivated Land

This variable was defined as the value in cruzeiros of expenditures on inputs for the 1972/73 agricultural year divided by
the total acres of cultivated land per household. Purchases of inputs included expenditures on chemical fertilizer, organic fertilizer, lime, insecticide, fungicide, herbicide, improved seeds, oil, common seeds, rice, and other miscellaneous expenditures.

For sharecroppers and renters, the value of purchased inputs included the value of inputs provided by the landowner.

**Hours the Wife Works on the Farm**

The hours of work variable for the wife was indexed to take account of the way in which the data were collected. The indexing was as follows: 1 = does not work, 2 = works less than 4 hours per day, 3 = works 5-6 hours per day, 4 = works 7-8 hours per day, 5 = works 9-10 hours per day, and 6 = works 11-12 hours per day. In the sample, 7 of the households (4 owners, 2 renters, and 1 sharecropper) did not have information for this variable. Values for these households were set at the sample group means, 1.7 for owners and 2.2 for sharecroppers and renters.

**Radio**

The radio variable was measured by the frequency that the head of the household listens to the radio per week. This variable was also indexed, with the index as follows: 0 = never, 1 = less than 2 times per week, 2 = 2-3 times per week, 3 = almost everyday, and 4 = everyday. Six of the households (4 owners and 2 renters) did not provide information for this variable. Values for these households were set at the sample group means, 2.6 for owners and 2.4 for sharecroppers and renters.
Number of Days Sick of the Wife

This variable, which was expected to capture a health effect for the wife, was measured by the number of days the wife was sick in the 6 months prior to the third questionnaire. This questionnaire was applied in July 1974.

It was necessary to index this variable also, with the range being: 1 = not sick, 2 = sick 1-15 days, 3 = sick 16-30 days, and 5 = sick over 61 days. Eight of the households (4 owners, 3 renters, and 1 sharecropper) did not have information for this variable. Values for these households were set at the sample group means, 2.6 for owners and 2.4 for sharecroppers and renters.

Distance of the School From the House

This variable was measured by the distance of the house from the local school in kilometers for each household. Six of the households (4 owners and 2 renters) did not provide information for this variable. Values for these households were set at the sample group means, 2.3 for owners and 1.1 for sharecroppers and renters.
APPENDIX B

Simple Correlation Coefficients
Table B.1 Simple Correlation Coefficients of the Demand-for-Education Model, Vale do Ribeira, 1972/73.

| TYPE   | RACE | GACE | MED | VED | MELEAD | WHENAD | PREDS | FPA | DPEK | RADIO | DEPE | CLAUD | YLIVE | ETHL | YAN | YALE | CASE | YADEX | CASE | EVIT | EVOS | COOS |
|--------|------|------|-----|-----|--------|--------|-------|-----|------|-------|------|-------|-------|------|-----|-----|-----|------|------|------|------|------|-----|------|
| RACE   | .0385 |
| GACE   | .0714  | .7150 |
| MED    | .2353  | -.0478 | -.0512 |
| VED    | .2370  | -.0192 | -.0734 | .1693  |
| MELEAD | -.1615 | .1377  | .5543  | -.7640  |
| WHENAD | -.2049 | .2046  | .0168  | -.3771  | .7074  | -.0764  |
| PREDS  | -.1714  | .2146  | .2956  | -.2025  | .0170  | .0113  | .0184  |
| FPA    | -.3005  | -.42730 | -.52243 | .20446  | .19951  | -.0373  | -.0373  | .07418 |
| DPEK   | -.00412 | -.00716  | .11465  | -.20835  | .10012  | .11976  | .10989  | -.07618 | -.19937 |
| RADIO  | .23721  | .16435  | .27333  | -.11149  | .00428  | .27827  | .11245  | -.14497  | -.25742  | .04396 |
| DEPE   | .25513  | .28356  | .34130  | -.17165  | .04058  | -.34255  | .16775  | -.06132  | -.19017  | .17244  | .03597 |
| CLAUD  | .19874  | .11949  | .07165  | .02134  | .07426  | .02562  | .10733  | .18277  | .03723 |
| YLIVE  | .04928  | .21108  | .20730  | -.06130  | -.11150  | -.11517  | -.39010  | .02727  | .21274  | .15834  | .16481  | .05040  | .15560 |
| ETHL   | -.31216 | -.00244  | .07370  | -.16666  | .24579  | -.05149  | .10309  | -.11373  | .10461  | -.26995  | -.14028  | .07138  | -.19929  | -.17322 |
| YAN    | -.20673 | .20016  | .22233  | -.15159  | .18416  | .03276  | -.11223  | .05919  | -.11615  | .16043  | .14642  | -.14852  | -.02269  | .19150  | .07409 |
| YALE   | .11399  | .22435  | .20379  | .14272  | .21376  | .13705  | .12401  | .39900  | -.14011  | -.17262  | -.13234  | .07436  | .20394  | .16761  | .06547  | -.04123 |
| CASE   | -.32144 | .53644  | .53330  | -.18515  | -.24565  | -.02125  | .12468  | -.59403  | .07060  | .22153  | .25393  | .10515  | .03750  | .12962  | .02749  | .04366 |
| YADEX  | -.23628 | .11037  | .24518  | -.04144  | .12268  | .02211  | .26216  | -.25716  | -.13042  | -.33249  | -.12659  | -.21679  | -.06226  | .16356  | .32706  | .07923 |
| CASE   | .06166  | .23952  | .30566  | -.01933  | .20417  | -.07643  | .34464  | .02022  | .30116  | .20476  | .00051  | -.04312  | .32261  | .02629  | .39935  | .04490  | .37323  | -.01321  | .40182 |
| EVIT   | -.26033 | .03164  | .17730  | -.17496  | .18334  | .10046  | .00632  | .41226  | .49478  | -.35290  | -.11745  | -.08313  | .04657  | -.00960  | .56459  | -.15734  | .23068  | -.22160  | .34427  | .34467 |
APPENDIX C

Means and Standard Deviations for Variables
Table C.1. Sample Means and Standard Deviations for Variables of the Demand-for-Education Model, Vale do Ribeira, 1972/73.

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Table C.2. Sample Group Means for Variables of the Demand-for-Education Model, Vale do Ribeira, 1972/73, by Small Owner and Sharecropper (Renter) Groups.

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* Sharecroppers are grouped with renters in the analysis.
APPENDIX D

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