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Socio-economic correlates of fertility among Peruvian women, demographic health survey, 1986

Madeleine Francis Ocola

To the Graduate Council:

I am submitting herewith a thesis written by Madeleine Francis Ocola entitled "Socio-economic correlates of fertility among Peruvian women, demographic health survey, 1986." I have examined the final electronic copy of this thesis for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Arts, with a major in Sociology.

Donald W. Hastings, Major Professor

We have read this thesis and recommend its acceptance:

David L. Sylwester, Donald A. Clelland

Accepted for the Council:
Carolyn R. Hodges

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Signature Madeleine Francis Cole

Date Oct. 18, 1991

Socio-Economic Correlates of Fertility

Among Peruvian Women

Demographic Health Survey, 1986

A Thesis

Presented for the

Master of Arts

Degree

The University of Tennessee, Knoxville

Madeleine Francis Ocola

December 1991

DEDICATION

I would like to dedicate this thesis to my parents, Oswaldo and Silvia, and my sisters, Rosemarie and Eveline.

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I would like to thank to the members of my committee, Drs. Donald W. Hastings, David L. Sylwester, and Donald A. Clelland. Also I would like to thank Dr. Donald R. Ploch.

ABSTRACT

This thesis examines the effect of selected socio-economic and demographic variables on fertility for Peruvian women using data from the Demographic Health Survey (DHS, 1986).

Linear and Poisson regression were used to predict family size at the time of the survey. Poisson regression best quantifies the effect of the independent variables on the number of children ever born, because the regression directly models the increasing variance, since the variance of a Poisson variable is a function of its means.

The log-linear Poisson model used for Poisson distributed data belongs to the family of generalized linear models of Nelder and Wedderburn (1972). In the log-linear regression analysis, the logarithm of the mean of the number of children ever born was modeled as a linear function of the following independent variables: woman's age, woman's years of schooling, husband's years of schooling, interaction of woman's age with place of residence, and interaction of woman's age with woman's years of schooling. The findings basically agree with previous studies, except that husband's occupation was not found significant.

TABLE OF CONTENTS

PAGE

LIST OF TABLES

LIST OF FIGURES

FIGURE PAGE

CHAPTER I

INTRODUCTION

A. NATURE OF TOPIC

Demographers have long been interested in fertility as a factor of growth because fertility is the most explosive component of population growth. Latin America has a history of high fertility, i.e., large family size, but since the 1960s, the region has been experiencing a fertility decline. Various studies have looked at the socio-economic correlates on fertility which explain lower fertility in this region.

Within this research tradition, the purpose of this thesis is to determine an appropriate regression function that quantifies the effect of socio-economic and demographic variables on fertility. The socio-economic variables are: woman's age, woman's education, partner's education, and partner's occupational status. The demographic variables are: place of residence (urban and rural) and region of residence (coast, mountains, and jungle). The dependent variable is fertility. The measure of fertility is the number of children ever born (CEB) to a woman. The goal is to predict family size at the time of the survey.

C. ORGANIZATION OF THESIS

This thesis is organized as follows:

Chapter I covers the Introduction, Statement of the Problem, and the Organization of Thesis. Chapter II covers the Literature Review. The Literature Review is arranged in three parts: the Fertility Transition in Peru, the Fertility of the

Couples and Statement of the Problem. Only the variables to be examined in this thesis are covered. Chapter III covers information about the Demographic Health Survey (DHS, 1986) sample design and core questionnaire. Also the Method Solution and the Problems with Survey Data are presented. Chapter IV describes the characteristics of the total sample and the characteristics of the subsample. Chapter V contains the Statistical Analysis, this chapter is divided into parts: Linear and Possion Regression Analysis. Chapter VI discusses the Adequacy of the Log-Linear Poisson Regression Model. Next, Conclusions, References, Appendix, and Vita.

CHAPTER II

LITERATURE REVIEW

Different studies document the decline of fertility in Peru. Most of these studies use either World Fertility Survey (WFS) data (1977-78) or Demographic Health Survey (DHS) data (1986). Two perspectives shape these research projects: the fertility transition process and the fertility of couples. Other studies not using the data from the WFS and the DHS also fit into the above two perspectives.

A. THE FERTILITY TRANSITION IN PERU

The fertility transition process distinguishes four stages and places Latin American countries in one of five groups classified by the level of total fertility rate (TFR) and magnitude of fertility decline from 1985 to 1990 (Chackiel and Schkolnik, 1990). The four stages of the fertility transition process include: "complete or very advanced transition" (TFR < 3 children), "advanced transition" (3 < TFR < 4.5 children), "intermediate transition" (4.5 < TFR < 5.5 children), and "high fertility" (TFR > 5.5 children). Peru is in the third group of the advanced transition stage with "high fertility at the beginning of the period and medium low at present" (Chackiel and Schkolnik, 1990: 3). The total fertility rate is: "an estimate of the average number of children that would be born to a woman at the end of her childbearing years if she conforms to the current age-specific fertility rates" (Bogue, 1969: 215).

Ferrando and Aramburu (1990) argue that both modernization and the economic crises drive the fertility transition in Peru leading to fertility declines. The modernization process in the social, economic, and cultural realms engender the necessary conditions that favor the transition from high to low fertility. But the economic crises accelerates change and spreads it throughout the country. The processes of hyperinflation, recession, and the decline in real wages affect all socio-economic groups, but especially impact the poorer groups in urban and rural areas.

Ferrando and Aramburu (1990) use the TFR for five year periods from 1940 to 1990 to examine the trend of falling fertility. In 1940 the TFR was 5.81 children. In the periods 1950-55, 1955-60, and 1960-65 it remained constant at 6.85. The decline in fertility began in the late sixties. In 1965-70 the TFR was 6.56 children per woman. By 1980-85 the TFR had dropped to 4.65. In 1985-90 it reached 4 children per woman. Ferrando and Aramburu (1990) suggest that the severe economic crises of the 1970s and the increased use of contraceptives account for this sharp decline, especially from 1985 to 1990.

The fertility decline is not a homogeneous process. It varies according to place of residence and socio-economic status. In the 1950s, fertility began to decline in the urban areas of Lima. In the 1960s, fertility decline occurred among the sectors with high and medium income in the most modern cities of the country, such as Lima, Arequipa, and Trujillo. Then, this process of lowering fertility reached the sectors with low income in the urban areas of the three regions of residence (coast, mountains, and jungle). Conversely, fertility in the rural areas rose. At the end of the 1970s the process of lower fertility spread gradually throughout the country.

Ferrando and Aramburu (1990) observe that these years with low fertility coincide with severe economic crisis. In summary, the decline in fertility varies according to place of residence (urban and rural), regions of residence, and socio-ecological stratum.

For place of residence, Table 1 shows that the TFR in the urban areas has steadily declined from 1961 to 1986. Conversely, fertility continued to grow in the rural areas. However, beginning in 1972 there has been a steadily decline in the TFR in both areas.

Table 1

TOTAL FERTILITY RATE (TFR) BY PLACE OF RESIDENCE IN PERU

Place of Residence	Census Year 1961	1972	1981	DHS 1986
Urban	6.00	5.53	4.40	3.77
Rural	7.80	8.12	7.62	6.65

Source: *Adapted from Ferrando and Aramburu, 1990. Table 4: p. 13*

For the regions of residence, Table 2 indicates that Lima is the only region with a steady pattern of decline in TFR. The TFR in the coast declined at a slower rate than Lima. The TFR in the mountains remained consistently high. The TFR in the jungle gradually dropped from 7.92 in 1961 to 5.97 in 1986.

Table 2

CHANGE IN THE TOTAL FERTILITY RATE, 1961-1986 BY REGION OF RESIDENCE

Census Year/DHS	Region of Residence			
	Lima	Coast	Mountains	Jungle
1961	5.60	6.83	6.64	7.92
1972	4.36	6.80	7.50	7.90
1981	3.46	5.29	6.46	6.54
1986	3.13	4.13	6.45	5.97

Source: *Adapted from Ferrando and Aramburu, 1990. Table 5: p. 15*

Ferrando and Aramburu (1990) combine the regions of residence with the places of residence calling them socio-ecological stratum. Lima is divided into upper and middle class, and lower class. The regions of residence (coast, mountains, and jungle) are divided into urban and rural areas. For Lima, the lower class had a high fertility. In other regions, the rural areas traditionally had higher fertility than the urban areas. Fertility differences narrowed between classes and between urban and rural areas from 1961 to 1981.

B. FERTILITY OF COUPLES

Much literature exists on the impact of socio-economic factors on fertility in Peru. Socio-economic factors influence fertility, both directly and indirectly. Some authors examine various intervening variables to assess their mediating influences on socio-economic factors and fertility.

Simmons and Noordam (1977) look at the association between education and contraceptive knowledge in rural areas and small urban areas in Peru. The variables in the study include woman's and husband's education, community level of education, and woman's newspaper reading. The findings reveal that these four independent variables are normally distributed and are linear and additive in their effects on the dependent variable, woman's contraceptive knowledge. Woman's education, woman's newspaper reading, and community level of education are the best main effect predictors of woman's contraceptive knowledge. Woman's education has the strongest independent effect, followed by community level of education. Also there is an interaction effect between woman's newspaper reading and woman's education. Women with some level of education tend to read newspapers more than uneducated women. Educated women tend to read newspapers if they live in a community where the average level of education is high. Communities with a high level of education tend to provide contraceptive knowledge through friends, relations, and neighbors. Therefore, as woman's education increases, fertility decreases. When the husband's education is introduced into the model, the effect of a woman's education on her contraceptive knowledge is weakened.

Tienda and Gonzales (1983) examine the effect of socio-economic variables and intermediate variables on both recent and completed fertility. The completed fertility refers to the number of children ever born to ever-married women aged

40-49. The recent fertility refers to the number of children ever born to all ever-married women in the five years prior to the survey. The socio-economic variables are woman's educational attainment, husband's occupation, migrant status, ethnicity, and age at first marriage. The intermediate variables are length of time in union and use of contraception.

The examination of the effect of socio-economic variables on fertility shows that a negative relationship exists between education and fertility. This relationship is stronger for completed fertility than for recent fertility. Woman's education is a better predictor of fertility than husband's education. The effect of woman's education is greater on completed fertility than on recent fertility. Completion of primary school (6 years of schooling) is critical in reducing recent fertility. The husband's occupation influences fertility. Wives of professional and technical workers have the lowest fertility level, and wives of unskilled laborers or agricultural workers have the highest fertility level.

The examination of the effect of the intermediate variables on fertility reveals that the relationship between contraceptive use and completed fertility is not significant. However, there is a significant and negative relationship between effective contraceptive use (no risk taking) and completed fertility. This effect is attenuated when the indirect effects of socio-economic characteristics are controlled. The use of efficient methods accounts for the reduction in recent fertility of one-third of a child (Tienda and Gonzales, 1983).

Tienda and Gonzales (1983) also study the effect of two ecological variables on both recent and completed fertility. The two ecological variables are community's median educational level and levels of accessibility to the benefits of development. The underlying assumption is that the social environment influences the individual's fertility behavior. In other words, women from highly developed and educated communities generally will have lower fertility than less educated women from less developed communities. The findings suggest that:

> Both community variables exerts [sic] independent effects on fertility, above and beyond those due to individual-level variables, but the increment to explained variation is small by comparison to the explanatory power of individual-level variables. Additive effects of the ecological variables were particularly small for recent fertility, although these are slightly larger for completed fertility. (Tienda and Gonzales, 1983: 19).

In contrast to the two previous studies, Tucker (1986) conducted a field work study in a rural community of Quechua-speaking Indians located in Cusco. Cusco is located in the mountain region of Peru. She investigated the factors that influenced the choice of type of contraceptive (modern and traditional), and inhibited the adoption of modern contraceptive methods. Eighty-five percent of the couples interviewed (46 of 54) were aware of the financial problems that arise from large families. Yet, 27% of the couples interviewed (15 of 54) used modern contraceptives (pill, condom, injections, IUD, or tubal ligation); half of the couples preferred traditional methods, such as herbal teas, rhythm, and withdrawal. Twenty-two percent of the couples (12 of 54) interviewed did not use either modern or traditional contraceptive methods.

To examine these differences among users and nonusers of contraceptive methods and the choice of modern versus traditional contraceptive methods, socio-economic and cultural factors were used. Some of these factors are: couple's access to urban culture, couple's income, woman's employment status, and schooling. Under a system of "machismo," the husband play a crucial role in whether the wife adopts contraceptives and also the type of contraceptive. In general, husbands who work in other communities for wage labor are exposed to the urban materialism and to a more moderate Spanish value system that plays down traditional "machismo." This urban "modernism" favors smaller family size and woman's use of modern contraceptives. Thus, men tend to encourage their wives to use modern contraceptive methods as a means to limit family size. But husband's use of modern contraceptive methods (condoms) is minimal. The couple's income is also important. Couples who earn higher than the average monthly salary of United States $100 in the Quechua community tend to use modern contraceptive methods. In sum, the higher the income, the lower the fertility.

Similarly, Tucker (1986) indicates that a significant relationship exist between woman's employment status and the practice of contraception. Women, especially if they do not work, tend to be attached to the traditional Quechua values of a large family size as a means of demonstrating "femenina" self-esteem. Users of modern methods tend to work full-time; users of traditional methods either do not work full-time or do not work at all. Women who work tend to have lower fertility than women who do not work.

Fort (1989) conducted a qualitative study using focus groups. Focus groups were interviewed in Cusco and Iquitos. Cusco is a city in the mountains region, Iquitos is a city in the jungle region. He found that women use family planning as a means to limit family size, rather than spacing births. Woman's low status in society and their lack of knowledge of the physiology of reproduction works against woman's ability to exercise control over their own fertility. Women live up to the demand and expectations of their husbands. The ideal interval between union and first birth is two to three years, but most women felt compelled to bear children soon after they were married. In other words, "union and pregnancy occur almost simultaneously" (Fort, 1989: 90).

C. STATEMENT OF THE PROBLEM

This thesis will look at the impact of selected socio-economic and demographic variables on fertility. The purpose is to determine an appropriate regression function that quantifies the effect of the socio-economic and demographic variables on the number of children ever born at the time of the survey. The socio-economic variables are: woman's age, woman's education, partner's education, and partner's occupational status. The demographic variables are: place of residence (urban and rural) and region of residence (coast, mountains, and jungle). The dependent variable is fertility. The fertility measure is the number of children ever born to a woman.

Based on the literature on Peruvian woman's fertility, demographic factors, and socio-economic factors associated with fertility, the following hypotheses are anticipated:

1. *Hypothesis 1*

Women in the rural areas will have higher fertility than women in the urban areas.

2. *Hypothesis 2*

Women from Lima will have lower fertility than women from the rest of the country. Women from the coast region will have lower fertility than women from the mountain and jungle region.

3. *Hypothesis 3*

Age has an effect on fertility. As woman's age increases, fertility increases.

4. *Hypothesis 4*

The higher the education level of women and partners the lower the fertility. The lower the education level the higher the fertility.

5. *Hypothesis 5*

The occupation of the partner will have an effect on fertility. Wives of professional and technical workers have the lowest fertility level, and wives of unskilled laborers or agricultural workers have the highest fertility level.

Figure 1 summarizes the variables considered in each of the models.

INDEPENDENT VARIABLES

Region of Residence

Place of Residence

Woman's Age

Woman's Education

Partner's Education

Partner's Occupation

DEPENDENT VARIABLE

Number of Children
Ever Born (CEB)

Figure 1. Variables considered in each of the models

CHAPTER III

METHODOLOGY

A. DATA SOURCES

Although there are a number of country-specific surveys on population and health, such as the 1977-78 World Fertility Survey (WFS) and 1986 Demographic Health Survey (DHS), this thesis will use the 1986 Demographic Health Survey data set for Peru. The Institute for Resource Development (IRD) and the U.S. Agency for International Development (USAID) administered and funded the DHS program (Moore and Croft, 1990).

DHS conducts national sample surveys to collect data on population and maternal and child health in various developing countries in Africa, Asia, Latin America, and the Caribbean. The DHS program is a nine year project with two phases. The first phase covers the years 1984 to 1988. Thirty-four surveys were undertaken in 29 countries. The second phase covers the period 1988 to 1993. Twenty-five surveys are scheduled. The major objective of this second phase is "training, dissemination of findings, and further analysis of survey data" (closely summarized from Moore and Croft, 1990: 216).

To collect data on the areas of fertility, contraceptive use, and maternal and child health, DHS developed a core questionnaire. The core questionnaire consists of the following subject areas:

> Background characteristics, marriage, fertility, contraceptive knowledge and use, maternal and breast-feeding, infant and

> childhood mortality, immunization of children, diarrhea, fever, and cough in children, height and weight of children, husband's background, and woman's work status (Moore and Croft, 1990: 217).

The DHS core questionnaire has two versions: model A and model B, for countries with high and low contraceptive prevalence, respectively. DHS modifies questions in both questionnaires, to meet the specific needs of the country. Similarly, DHS works closely with the authorities of developing nations in conducting these national sample surveys. (Moore and Croft, 1990; Goldman, Moreno, and Westoff, 1989).

DHS, in conjunction with two Peruvian institutions, INE (Instituto Nacional de Estadistica), and the CNP (Centro Nacional de Poblacion) organized and administered the national sample surveys. Two national surveys, the standard DHS survey and the experimental survey, were completed in Peru between September and December of 1986. For these two surveys, two questionnaires were used, the "core" questionnaire for the standard DHS survey and the "experimental" questionnaire for the experimental survey (Instituto National de Estadistica, 1988; 1989).

B. DEMOGRAPHIC HEALTH SURVEY (DHS) SAMPLE DESIGN

The sample design of the standard DHS survey and the experimental survey was based on a multi-stage cluster sample design developed for the National Survey of Nutrition and Health. The National Survey of Nutrition was conducted by the Peruvian government in 1984. DHS updated and modified the sample design of 1984 according to its needs (Goldman, Moreno, and Westoff, 1989).

The multi-stage sample design consists of a stratified cluster sample with two stages of sampling. The first stage involves the selection of clusters. Peru was divided into 17 geographical domains, and clusters were selected randomly in each domain. The number of the clusters selected ranged from under 10 in some coastal and jungle regions to over 100 in metropolitan Lima. The second stage included the selection of dwellings and eligible women aged 15-49 in each of the selected clusters. The dwelling list of 1984 was updated (Goldman, Moreno, and Westoff, 1989). After these two stages of sampling, a systematic subsample of 1 in 3 dwelling was allocated to the experimental survey and the rest to the standard survey. The sample design is a self-weighing design "every eligible woman had an equal probability of selection..." (Instituto National de Estadistica, 1988; adapted directly from Goldman, Moreno, and Westoff, 1989: 3).

The DHS survey's aim was 9,600 women aged 15-49 with 20% designated for under-coverage and nonresponse. These projections were expected to produce 7,500 interviews. From the 7,500 interviews, DHS planned to administer the core questionnaire to 5,000 women and the experimental questionnaire to 2,500 women (Instituto National de Estadistica, 1988, Goldman, Moreno and Westoff, 1989). The actual result was close to that predicted. From 6,800 households, 7,533 women aged 15-49 were interviewed. From these 7,533 women, 4,999 women aged 15-49 were interviewed with the core questionnaire and 2,534 women were interviewed with the experimental questionnaire (Instituto National de Estadistica, 1988; Goldman, Moreno, and Westoff, 1989). The female population from the areas with terrorist activity, Ayacucho, Apurimac, and Huancavelica were excluded from the study (Instituto National de Estadistica, 1988). The sample covered 94% of the total Peruvian population (DHS summary of Instituto National de Estadistica, 1989).

The statistical package used to process the DHS data for Peru was the ISSA (Integrated System for Survey Analysis). To evaluate the precision of the data, the sampling error was calculated using an updated version of the WFS program CLUSTERS (Computation and Listing of Useful Statistics on Errors of Sampling). The results show that standard errors are under 5% for most of the variables in the sample. The following is a summary of the statistics of the core questionnaire. The average relative error (the standard error divided by the estimate in % terms) is 2.6%. The mean design effect is 1.14. The mean design effect is "the ratio between the standard error from the actual sampling design and the standard error from a simple random sampling scheme" (Goldman, Moreno, and Westoff, 1989: 6). These statistics suggest that the sample yield precise estimates (Instituto National de Estadistica, 1988).

C. DEMOGRAPHIC HEALTH SURVEY (DHS) CORE QUESTIONNAIRE

This thesis will focus on the standard DHS survey with its core questionnaire. The core questionnaire used in Peru was the model "A." The questionnaire "A," besides the standard questions of the standard DHS survey, includes specific questions on contraceptive methods of interest for the Peruvian population.

The core questionnaire "A" consists of 725 questions divided in seven sections. These sections are: **1)** respondent's background, **2)** reproduction (including full birth history), **3)** contraceptives (use and practice), **4)** health and breast feeding (include health history and maternity), **5)** marriage, **6)** fertility preferences, and **7)** husband's characteristics and woman's employment.

This thesis looks at the following variables: background characteristics, socio-economic variables, and reproduction variables. The background characteristics are place of residence, region of residence, and woman's age. The socio-economic variables are woman's and partner's education, and partner's occupation. The reproductive variable is children ever born (CEB). The number of children ever born is the total number of children a woman has ever born who were alive at the time of birth, irrespective of whether or not the children have since died (Bogue, 1969).

D. METHOD SOLUTION

Multiple regression analysis is used to quantify the effect of the socio-economic and demographic variables on the number of children ever born. Specifically, linear and Poisson regression is used to predict family size at the time of the survey. First, a linear model using least square regression technique, with the error assumed to have normal distribution is fit to the data. Second, a log-linear Poisson model for Poisson distributed data is fit to the data. This log-linear Poisson model belongs to the family of generalized linear models of Nelder and Wedderburn (1972).

SAS and a SAS macro for fitting non-linear models to Poisson distributed data are used. The SAS macro was created by E. Frome (1984).

E. PROBLEMS WITH SURVEY DATA

1. *Full Versus Truncated Birth History*

To establish the reliability of the DHS fertility data collected in Peru, Goldman, Moreno, and Westoff (1989) compared two strategies for the collection of data on birth: the full birth history vs. the truncated history.

The standard DHS survey and the experimental survey differ in their approach to collect data on births. The core questionnaire of the standard DHS survey collected a full birth history. The full birth history approach solicits information on all births to the date of the survey. The experimental questionnaire collected a truncated birth history. The truncated history approach is "information for all and only those births which occurred during the five year period prior to survey" (Goldman, Moreno, and Westoff, 1989: 11).

The standard and the experimental surveys reveal similar TFRs for the period 1980 to 1986; 4.58 and 4.59 respectively. But the comparison of the TFR by single years shows significant differences for 1981 and 1985. Similarly, when the years are grouped for periods, 1980-82 and 1983-86, the standard and the experimental reveal different magnitudes in the decline of fertility. This difference cannot be attributed to a particular age group because the estimated age-specific fertility rate for the two periods 1980-82 and 1983-86 do not reveal significant differences. The standard DHS survey shows a decline for the periods 1980-82 and 1983-86 twice as large (20%) as the experimental (10%). According to Goldman, Moreno, and Westoff (1989: 15) "the difference between surveys imply either a forward displacement of births in the truncated history (i.e., with the period 1983-86 receiving births from the period 1980-82), or a backward displacement of recent births in the core."

Although information is insufficient to assess which of these two factors operates, Goldman, Moreno, and Westoff (1989) used two approaches to explore the reasons for the differences between surveys.

The first approach compares the estimates of the TFR for 1980 from the 1981 Contraceptive Prevalence Survey (CPS) with the estimates of the DHS core questionnaire for the period 1984-86. This comparison shows a decline from 5.0 to 4.0; this decline is translated into a decline of one child. However, if only the DHS core questionnaire is analyzed, their estimates tend to be higher, so the decline of TFR for the period of 1980-86 is greater. Further, a comparison of the proximate determinants of fertility, such as, the proportion of women married, the prevalence and efficacy of contraceptive use, and the extent of lactational amenorrhea indicate that these estimates have not experienced change in the period from 1980 to 1986 in both survey CPS and DHS. This finding agrees with Bongaart's model of the proximate determinants of fertility, "the relevant indices would imply no change in the expected TFR over this time period" (Goldman, Moreno, and Westoff, 1989: 15).

From the above discussion of the first approach, Goldman, Moreno, and Westoff (1989: 17) propose the following two explanations: "(1) underestimates of recent fertility from the core (and possibly also from the experimental) questionnaire; or (2) a large increase in the number of abortions over this period."

The second approach compares the age-specific fertility rate of the standard DHS survey with the age-specific fertility rate of the 1977-78 WFS survey for the following periods 1962-64, 1965-67, 1968-70, 1971-73, and 1974-76. Also, it compares the mean number of children ever born per five-year group of women from the standard DHS survey with the mean number of children ever born from the 1977-78 WFS for the period 1977-78. Likewise, the mean number of children ever born per five-year age group from the standard DHS survey is compared with the mean number of children ever born from the 1975-76 National Demographic Survey (EDEN) for the period 1975-76. The comparisons reveal that the estimates from the DHS survey tend to be higher than the estimates from the WFS survey for the 1970s. Similarly, the reported number of births in the DHS survey exceed the number of births reported on both of the earlier surveys (WFS and EDEN) for most age groups for the mid and late 1970s (adapted directly from Goldman, Moreno, and Westoff, 1989: 15-19).

From the above comparisons, Goldman, Moreno, and Westoff (1989: 17) infer that:

> ...it is not clear from these comparisons whether this surplus of births in the past is produced partly as a result of backward displacement of dates of birth from the 1980s, a type of error which would, of course, greatly exaggerate the estimated recent decline in fertility. It is also possible that the DHS survey obtained a more complete count of births than did the earlier surveys, although the general agreement between WFS and EDEN

(Cespedes, 1982) casts doubt of this hypothesis.

The two approaches lead Goldman, Moreno, and Westoff (1989) to assume that the slightly higher estimate of fertility for 1980 from the core questionnaire could either be: 1) the result of heaping on the calendar year 1980 or 2) a displacement of dates of births on the part of the interviewer. The latter could have happened because the core questionnaire contains questions to be answered only for women whose births occurred during 1981 or later. Therefore, this displacement of dates of births would have occurred from 1981 to 1980 because there have been contentions from other DHS surveys that displacement of births occurred from the first year eligibility (women whose birth occurred during 1981 or later) to the preceding year (1980).

2. *Selectivity and Censoring*

The DHS data for Peru are cross-sectional so the information collected refers to the reproductive experiences of women up to the date of the survey. The oldest cohorts of women have completed fertility history, the youngest cohorts of women have not.

Two problems arise with incomplete nature of the data: selectivity and censoring. According to Rodriguez and Hobcraft (1980: 8), selectivity results from the fact that "the transition from parity i to i+1 can only be studied for women who have reached parity i or more at the time of the survey, who tend to be selected on a number of characteristics and are thus not representative of the whole population." (Parity is the number of children ever born to a woman). For instance, the study of the transition from parity 2 to parity 3 for women ages 20 to 24 will include only those women with 2 or more children at the time of the survey. Such women are not truly representative of the cohort aged 20-24 because these women married earlier or are more fertile, among other things. Censoring results from the fact that at the time of the survey some of the women selected for analysis have reached parity i, these women could either stay at parity i or reached parity i+1 (closely summarized from Rodriguez and Hobcraft, 1980). Thus, the sample of women has disproportionately more lower order than higher order births.

Because of these two problems, the goal of this thesis is to predict family size at the time of the survey.

3. *Occupational Classification*

The Demographic Health Survey (DHS, 1986) used the code of occupations from the Peruvian Institute of Statistics to classify information on the occupation of the partners of the women interviewed. The code of the Peruvian Institute of Statistics contained 99 occupations. DHS grouped the 99 occupations into eight categories: 1) never worked; 2) professionals, technical, and managers; 3) clerical; 4) sales; 5) agricultural-self employed; 6) agricultural employee; 7) services; and 8) skilled manual.

To ascertain which of the 99 occupations were placed in these 8 categories, a comparison was made of the frequencies for the detailed and aggregated distributions. The DHS clerical category included the administrative support people as well as the workers. The DHS sales category included salesmen, salespeople, and street venders. The agricultural self-employed included owners, renters, and administrators of forestry, plant farming, and animal farming. The DHS agricultural employee category included people that work for the people in the previous categories. Also, workers in forestry, plant farming, animal farming, fishery, and related occupations were included. The DHS services category included owners, managers, and administrators of hotels, bars, and other services, as well as workers in food and beverage preparation and services, workers in barbering and beauty salons, workers in laundering and dry cleaning, guards and watchmen, and workers in any other related service occupations. The DHS skilled manual occupation included skilled and unskilled manual workers. Finally, DHS used a never worked category, but the Peruvian Institute of Statistics does not consider this category.

This classification raises an issue. The problem was that owners, administrators, and workers were placed in the same category without questioning their lifestyles and the acute differences in level of education, access to resources, and socio-cultural status. Therefore, the eight categories do not represent the occupational status of the Peruvian population within the cultural, social, and economic context of Peru. Neither the code of occupations from the Peruvian Institute of Statistics nor the DHS make distinctions between owners, administrators and renters in the agricultural self-employed category. In Latin American countries there is a sharp distinction between a landowner and tenant in the level of education, access to material commodities, and social and cultural status. The same logic applies to the rest of the categories; particularly, sales and services. A salesman cannot be compared to a street vender; the former works in a formal economy, the latter works in the informal economy of the country. An owner of a service place cannot be compared to one who works there.

An alternate classification of partner's occupation was done by Rodriguez (1989). Rodriguez regrouped the eight categories provided by DHS into four categories: **1)** professionals, technical, managers and clerical, **2)** sales and services, **3)** agricultural self-employed and agricultural employed, and never worked, and **4)** skilled manual. Rodriguez classified partner's occupation according to whether the occupation had traditionally high or low fertility.

CHAPTER IV

SAMPLE CHARACTERISTICS

This thesis used the data from the DHS standard survey collected in Peru from September to December of 1986.

A. CHARACTERISTICS OF THE TOTAL SAMPLE

1. *Age*

The sample size of the DHS standard survey was 4,999 women. The interviews were restricted to women in their reproductive careers, ages 15 to 49. The mean age of the sample women was 28 year. A glance at the percentage distribution of the females by age grouped in 5 years intervals reveals that the majority of the population was young (see Figure 2). Approximately 41% were under 30 years of age.

2. *Regions by Place of Residence*

The regions of residence (coast, mountains, and jungle) were subdivided by place of residence (urban and rural); Lima was considered as a separate region. Figure 3 presents the percentages for these urban and rural regions. Thirty-eight percent of the women resided in Lima. Lima is a "primate city." It is the capital, the most populous city in the country, the most economically developed, and the most culturally and intellectually advanced. Of the 68% who resided in urban areas, 36.3% lived in urban regions outside of Lima. The remaining 31.8% of women lived in rural areas.

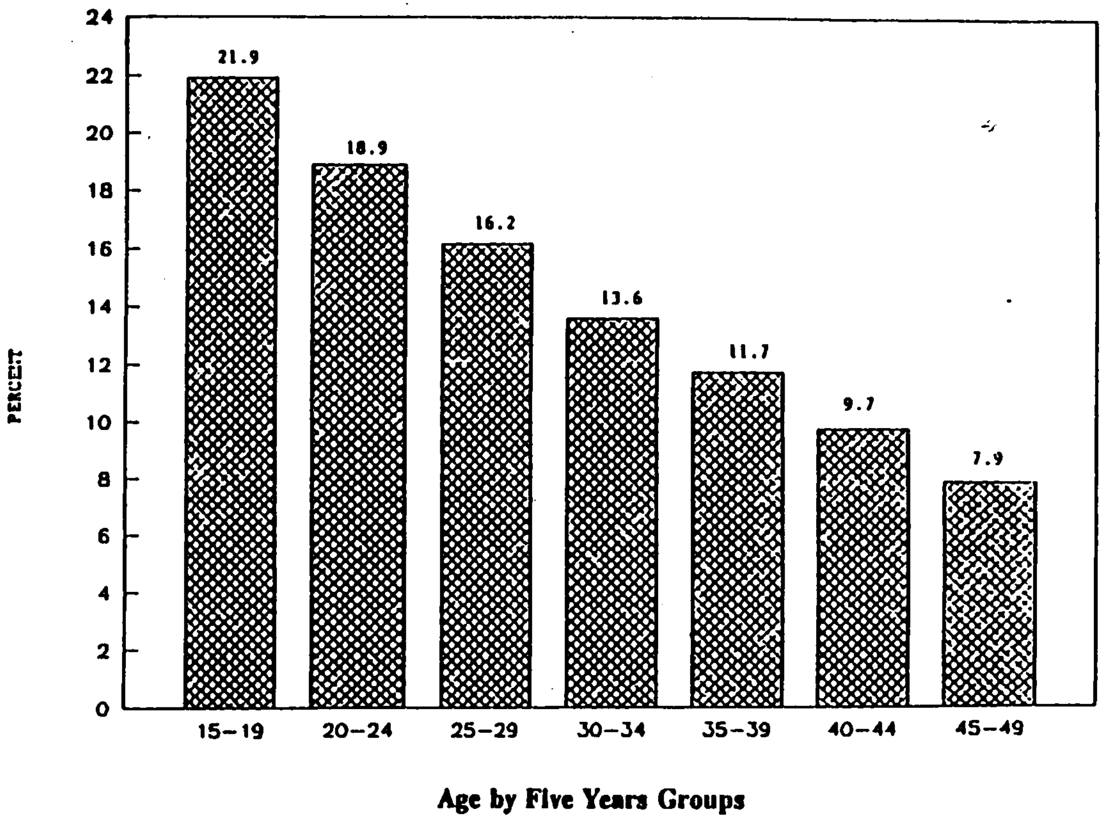

Figure 2. Percentage Distribution of Woman's Age by Five Year Groups for the Total Sample (DHS, 1986)

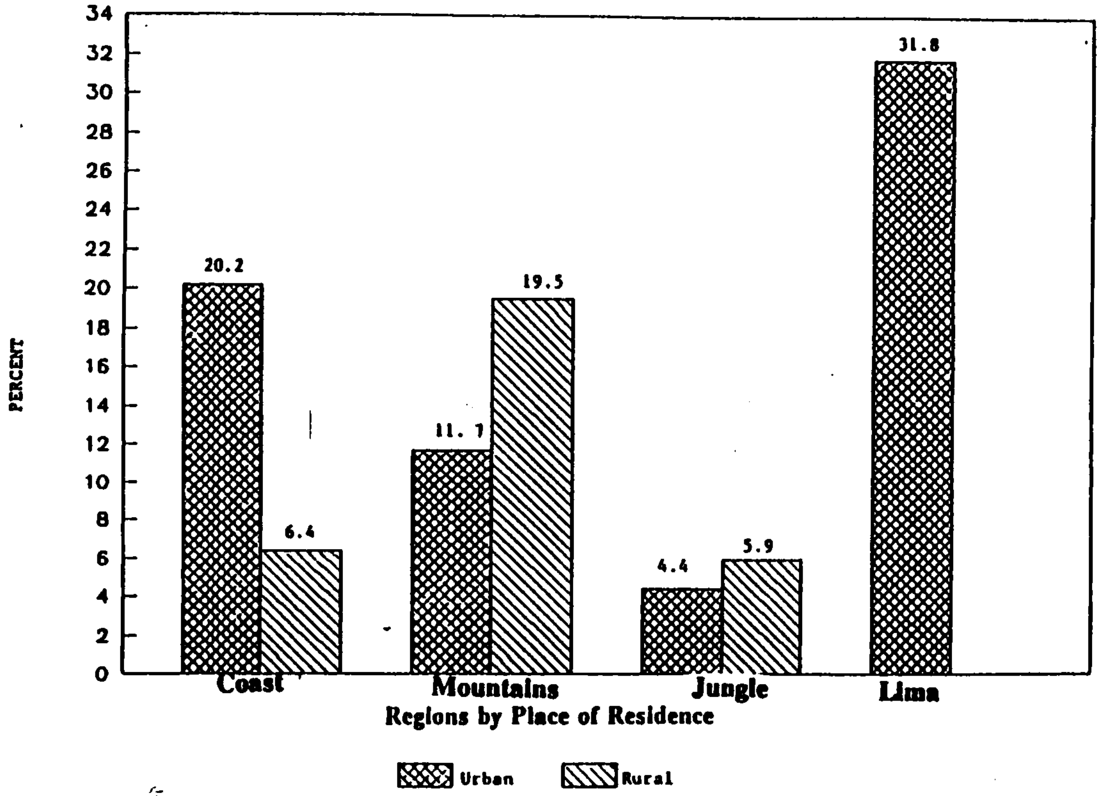

Figure 3. **Percentage Distribution of Woman by Regions and by Place of Residence (DHS, 1986)**

3. *Marital Status*

Among the sample of 4,999 women, 1,761 (35.2%) were never married, 2,900 (58%) were currently married (or living with a partner), and 338 (6.8%) were formerly married, widowed, divorced, separated or women who had lived with a partner, but no longer did so (Instituto Nacional de Estadistica, 1989).

B. CHARACTERISTICS OF THE SUBSAMPLE; WOMAN LIVING WITH A PARTNER

The population of interest in this thesis was married women with spouse present and women who were currently living with a partner. The subset was 2,900 women. This subset of women with a partner was further limited to include only those women who had complete information on husband's years of schooling and husband's occupation. Any cases with missing values on any of the variables examined in the statistical model (see Chapter V) were excluded; the final subset was 2,856.

1. *Age*

Women with a partner had an average age of 32 years. In Figure 4 the percentage distribution of age by five year groups shows that most women who enter union were older than 19 years of age. This pattern is typical of Latin American women who have an older age at entry into union than women in other developing countries. Most women with a partner are in the prime childbearing years 19-44.

The percentage distribution of age (by five year intervals) by place of residence shows that in urban and rural areas most of the women were concentrated in the age categories from 19 to 39 (see Figure 5). In the rural areas the percentage

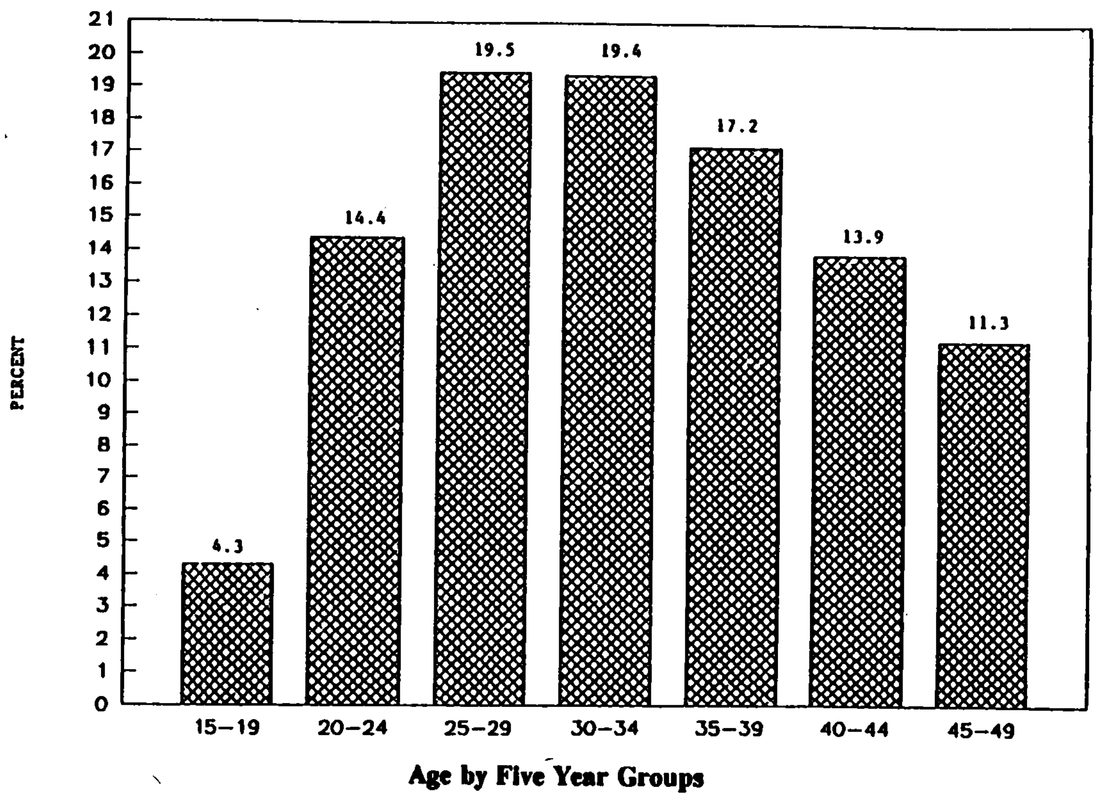

Figure 4. Percentage Distribution of Woman's Age by Five Year Groups for the Subsample (DHS, 1986)

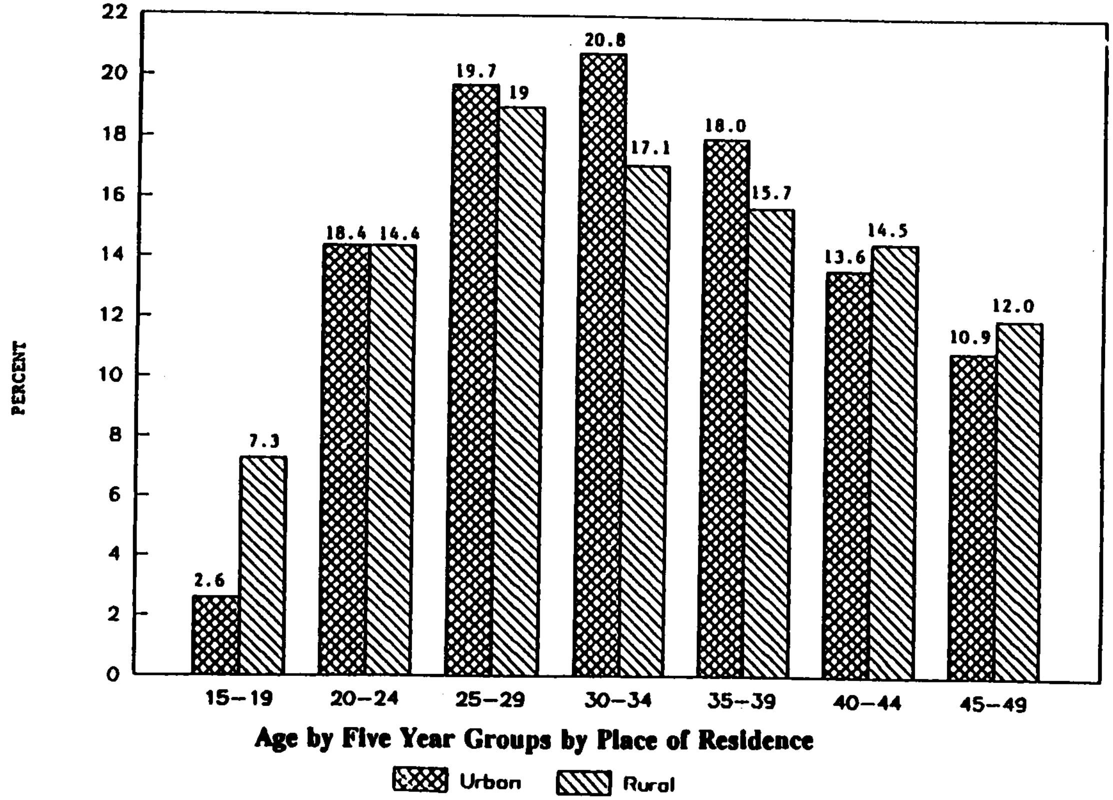

Figure 5. Percentage Distribution of Woman's Age by Five Year Groups and by Place of Residence (DHS, 1986)

of the women aged 15-19 is 4.7% higher than in the urban areas. Both urban and rural areas had approximately the same percentages for ages 20 to 39. In the urban areas the percentage of women ages 30 to 39 is 6% higher than in the rural areas. In the rural areas the percentage of women ages 40-49 is 2% higher than in the urban areas. Slightly more women in the rural areas were closer to the end of their reproductive years than in the urban areas. Since women closer to the end of their reproductive careers generally have higher fertility, it will be expected that among women ages 40 to 49, the number of children will be higher in the rural areas than in the urban areas.

2. *Place of Residence*

The percentage distribution for place of residence shows that among women with a partner, 1,814 (63.5%) reside in the urban areas, 821 (28.7%) reside in Lima and 993 (34.8%) live in urban regions outside of Lima; and the remaining 1042 (36.5%) live in rural areas.

3. *Years of Education Completed*

The educational system in Peru has six years of primary school (grades 1-6) and five years of secondary school (7-11). DHS set the range for years of schooling from 0 to 19. Women's mean number of years of schooling is 5 and partner's mean number of years of schooling is 7. Women generally had fewer years of schooling than their partners; partners had two more years of schooling than women. Women in urban areas have 7 years of schooling and their partners have 9 years of schooling. Women in rural areas have 2 years of schooling and their partners have 4 years of schooling. Women and partners from urban areas had higher mean number of years of schooling than women and partners from rural areas. On the average, women in urban areas also had 5 more years of school than women in rural areas; and partners in urban areas also had 5 more years of schooling than their counterparts in the rural areas.

4. *Highest Educational Level Attended (Completed)*

An examination of the percentage distributions on the highest level of education attended for partners and for women shows that women and their partners have substantial differences for no education and higher education, but slight differences for attendance at primary and secondary school. The percentage for women with no education is 10% lower than their partners, and the percentage for women with higher education is 5.6% lower than their partners. For primary school, the percentage of women is 1% higher than their partners. Conversely, for secondary school, the percentage of partners is 5.9% higher than women (see Figure 6).

5. *Education Completed by Place of Residence*

A comparison of place of residence reveals that women in rural areas had higher percentages of no education and primary school than women in urban areas. The difference between the percentages for no education was 25%, and the difference for primary school was 20.3%. Women in urban areas had higher percentages of sec ondary school and higher education attended than women in rural areas. The difference between the percentages for secondary school was 35.6% and for higher education was 10.5%.

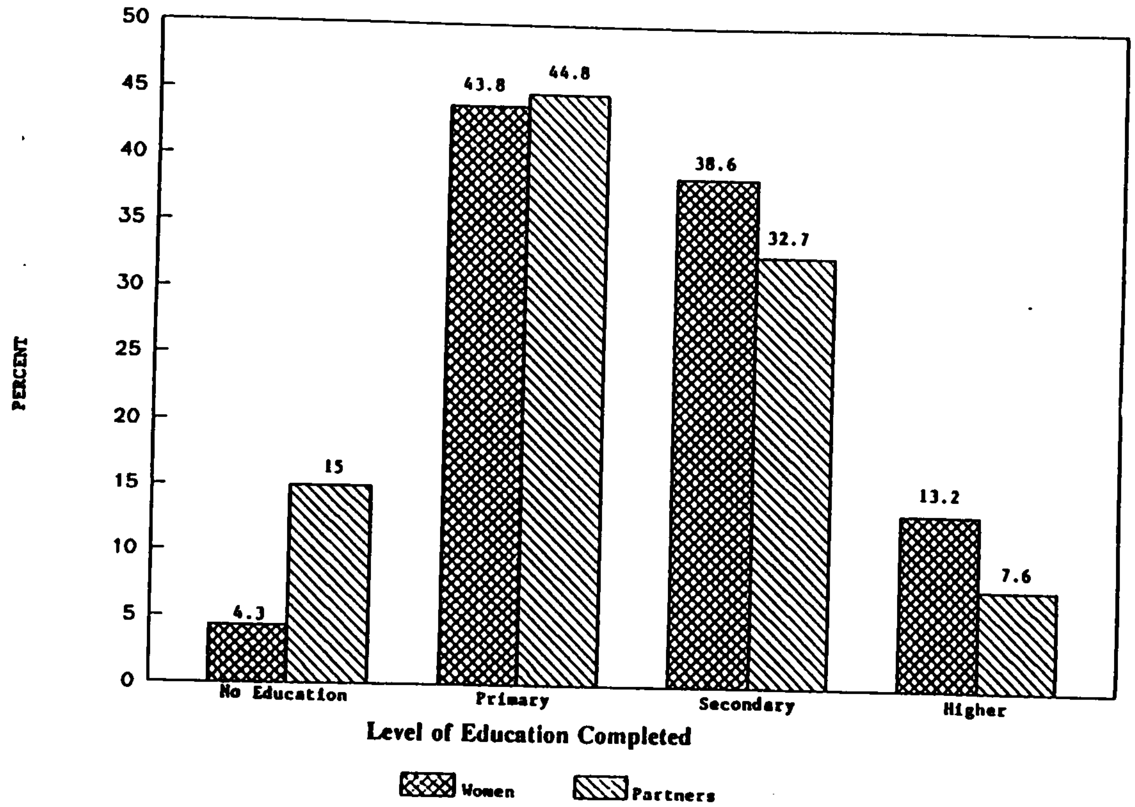

Figure 6. Percentage Distribution of the Highest Level of Education Completed for Women and for Partners (DHS, 1986)

A comparison between rural and urban partners reveals that partners in rural areas had higher percentages of no education and primary school than husbands in rural areas. The difference between partners for no education was 8.7%, and for primary school, it was 39.6%. Partner's in urban areas had higher percentages of secondary school and higher education than their counterparts in rural areas. The difference for secondary school was 30.6%, and for higher education, it was 17.8%.

In the urban areas, the percentages of women with no education and primary school were higher than their husbands'. The difference for no education was 4.3%, and 8% was for primary school. Conversely, partners had a higher percentage in secondary school and a higher percentage in higher education than women. The difference for women and partners for secondary school was 4.1%, and for higher education it was 8.3%. In the rural areas, the percentages of women with no education and primary school attended were higher than their partners'. The differences for no education were 21.5% and 11.3% for primary school. Conversely, partners had higher percentages for secondary school and higher education than the women. The difference for secondary school was 9.1%, and for higher education, it was 1%.

In short, the level of education was higher in urban areas than in rural areas; the attendance of primary school was higher among women than for their partners, regardless of place of residence. Conversely, the attendance of secondary school and higher education was higher among partners, regardless of place of residence (see Figure 7 and 8).

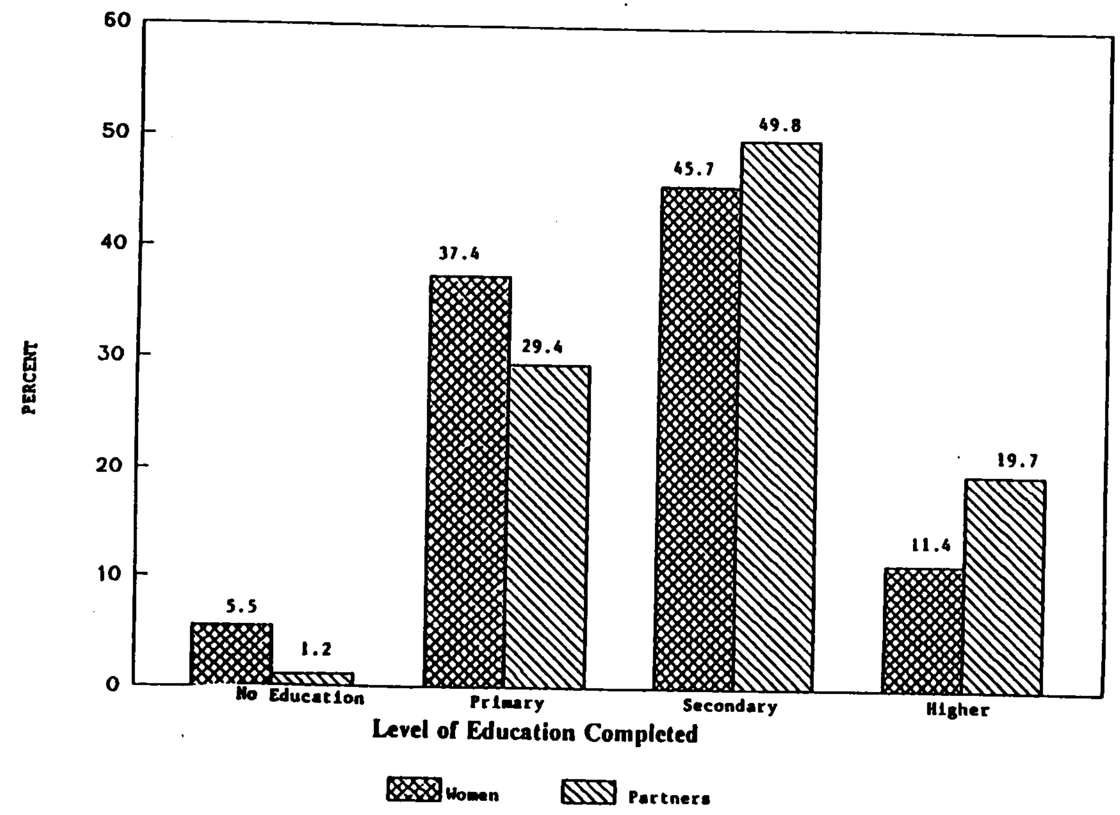

Figure 7. Percentage Distribution of the Highest Level of Education Completed for Women and for Partners for Urban Areas (DHS, 1986)

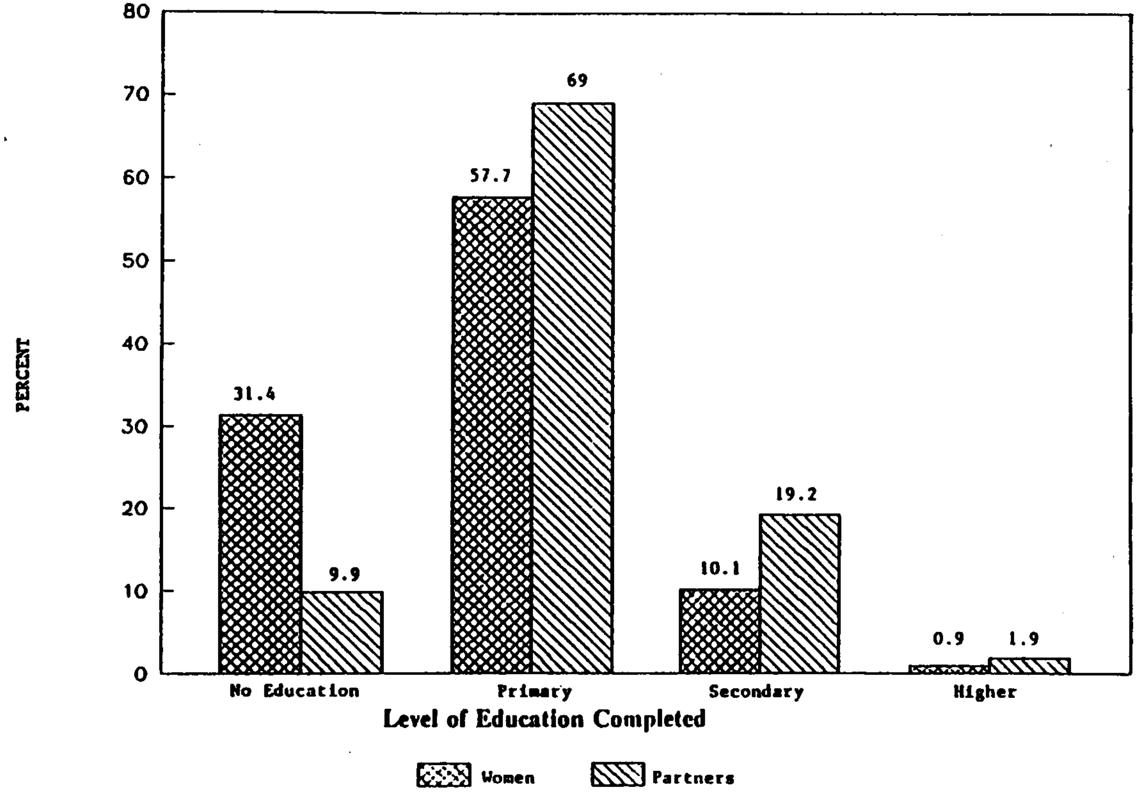

Figure 8. Percentage Distribution of the Highest Level of Education Completed for Women and for Partners for Rural Areas (DHS, 1986)

6. *Partner's Occupation*

The Demographic Health Survey (DHS, 1986) used the code of occupations from the Peruvian Institute of Statistics to classify information on the occupation of the partners of the women interviewed. The code of the Peruvian Institute of Statistics contained 99 occupations. DHS grouped the 99 occupations into eight categories: **1)** never worked; **2)** professionals, technical, and managers; **3)** clerical; **4)** sales; **5)** agricultural-self employed; **6)** agricultural employee; **7)** services; and **8)** skilled manual.

According to this classification, the majority of the women's partners (31.1%) worked in skilled and unskilled occupations, followed by the self-employed agricultural occupations (23%). The agricultural employee, clerical, and services workers account for only 9%, 6.5%, and 5.7% respectively (see Figure 9).

7. *Number of Children Ever Born at the Time of the Survey*

The number of children ever born is the dependent variable of this thesis.

The range of the number of children ever born was from 0 to 15 children, with a mean number of 4 children. The majority of cases of the number of children ever born were concentrated at the lower end of the distribution, meaning that the data were not symmetrical, it was skewed to the right. More women were concentrated in the lower parities from 1 to 4, and fewer women were in the higher parities from 5 to 15.

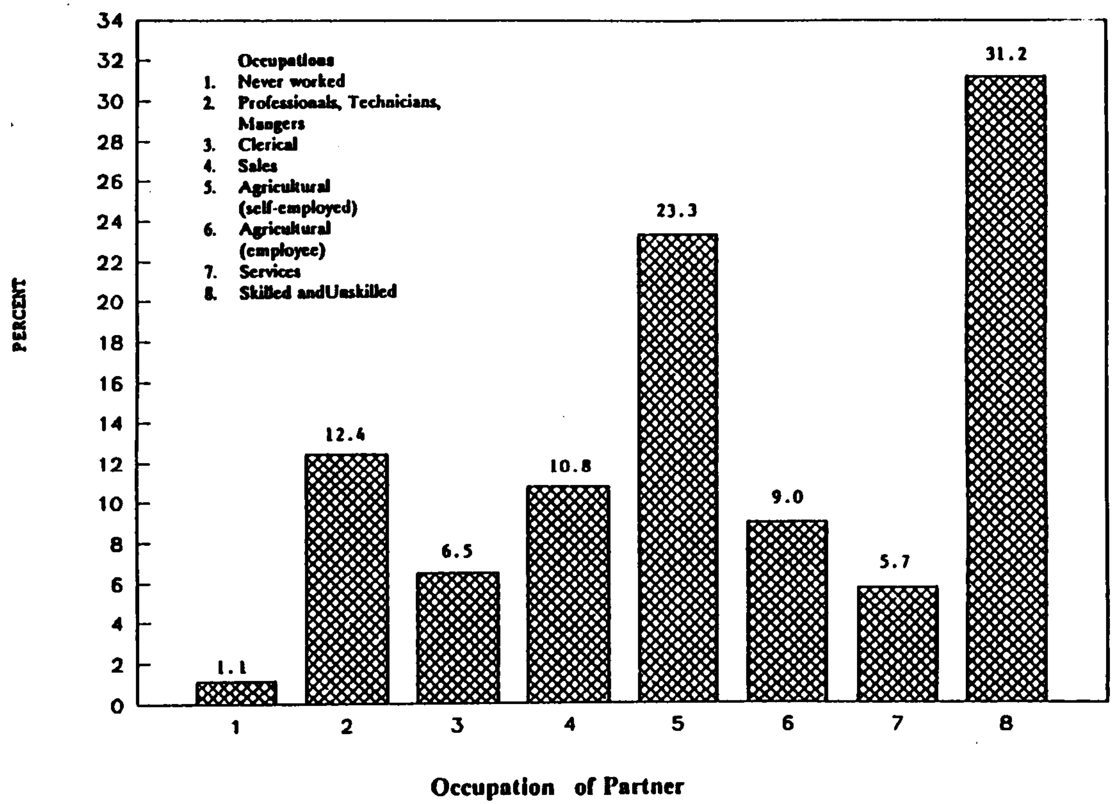

Figure 9. **Percentages on Partner's Occupation (DHS, 1986)**

The percentage distribution of children ever born by place of residence reveals that in rural areas couples had a mean of 5 children, and in urban areas the mean was 3. Women in urban areas tended to be concentrated in the lower parities. The percentage distribution shows higher percentages in urban areas than in rural areas for parities 1 through four. Conversely, women in rural areas had higher percentages than urban areas for parities 5 through 15 (see Figures 10 and 11).

The mean number of children ever born, at the time of the survey, by place of residence is presented in Table 3. Rural areas have a higher mean number of children than urban areas.

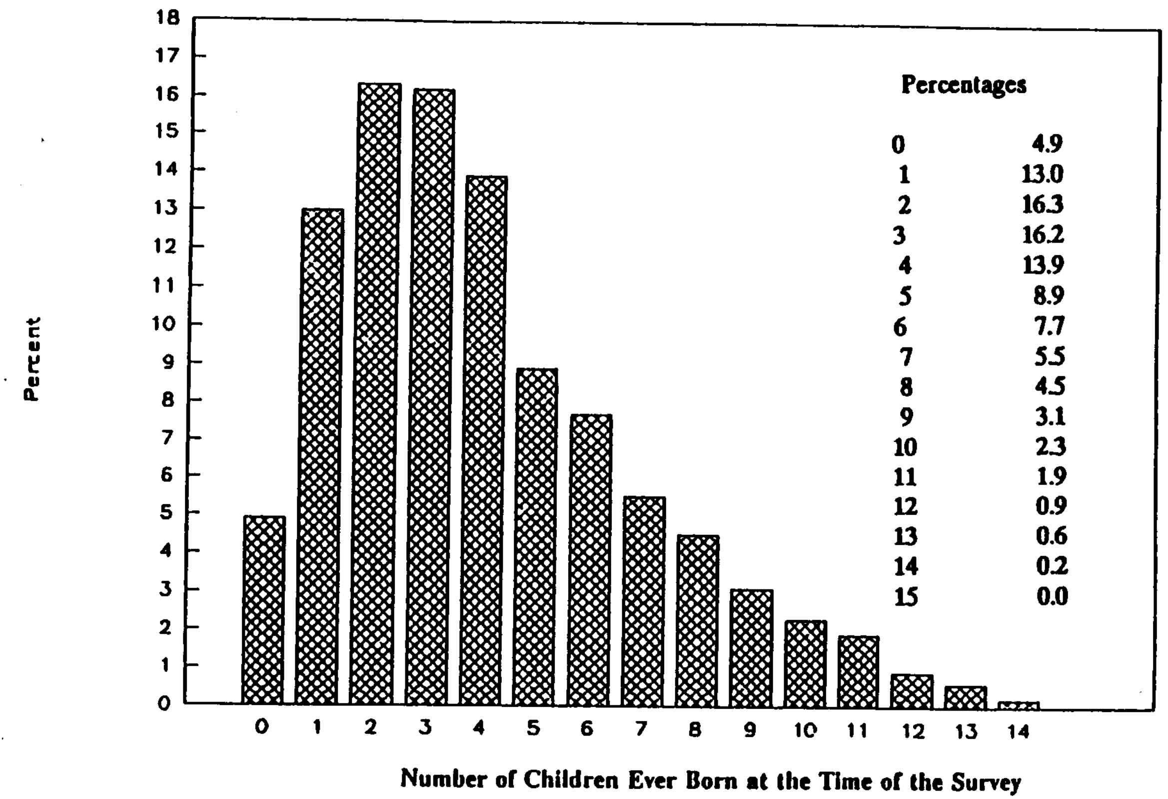

Figure 10. **Percentages on the Number of Children Ever Born at the Time of the Survey for Women Living with a Partner (DHS, 1986)**

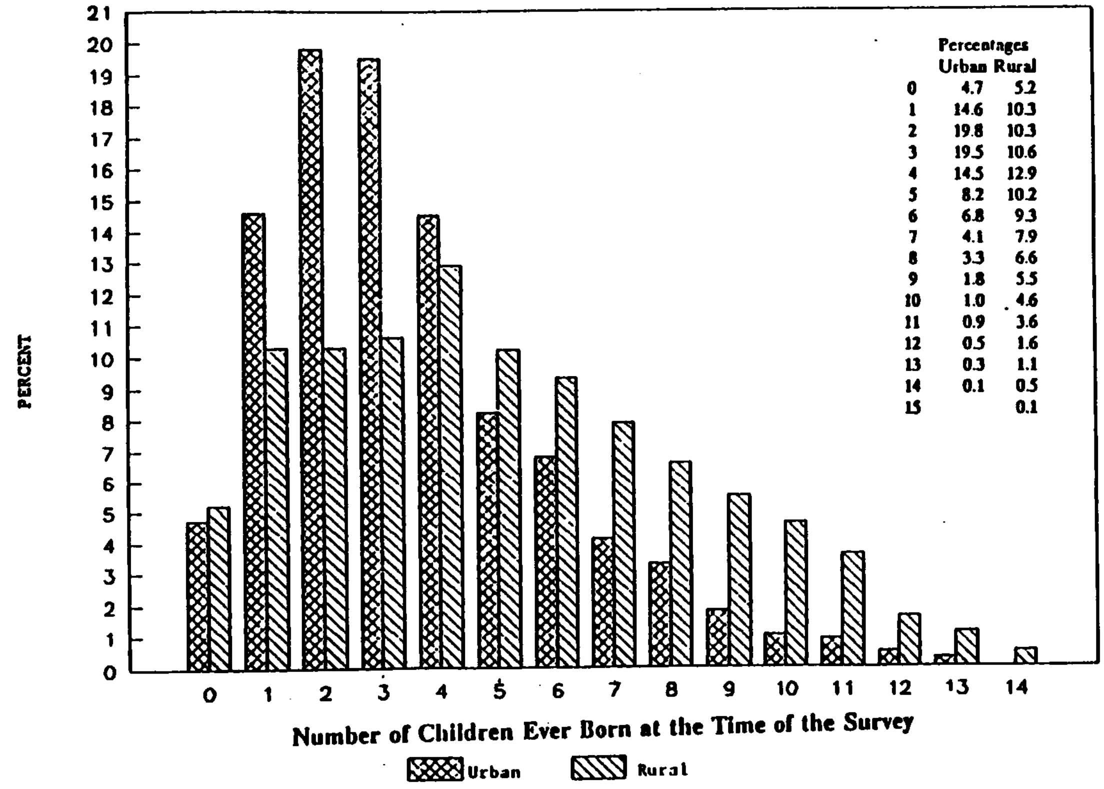

Figure 11. **Percentages on the Number of Children Ever Born at the Time of the Survey for Women Living with a Partner by Place of Residence (DHS, 1986)**

Table 3

MEAN NUMBER OF CHILDREN EVER BORN AT THE TIME OF THE SURVEY BY WOMAN'S AGE IN FIVE YEAR GROUPS AND BY PLACE OF RESIDENCE (DHS, 1986)

	Mean Number of Children Ever Born		
Age Group	Total	Urban	Rural
15-19	0.95	0.93	0.96
20-24	1.70	1.54	1.97
25-29	2.90	2.58	3.47
30-34	3.92	3.30	5.23
35-39	5.20	4.35	6.92
40-44	5.95	5.00	7.47
45-49	6.98	5.85	8.03

CHAPTER V

STATISTICAL ANALYSIS

The purpose of this thesis was to determine an appropriate regression function that quantifies the effect of socio-economic and demographic variables on the number of children ever born. The socio-economic variables were: woman's age, woman's years of schooling, partner's years of schooling, and partner's occupation. The demographic variables were place of residence and regions of residence. Based on regression analysis, the sole demographic variable included was place of residence.

Since the data are censored, the goal was to predict family size at the time of the survey. Two types of linear regression analysis were used, based on the assumption made about the dependent variable. The two types of regression analysis were linear and Poisson. The first assumes the difference between the actual observations and the expected count has a normal distribution. The second assumes the observations have a Poisson distribution.

A. LINEAR REGRESSION

1. *Model Description*

A linear model using the least square regression technique, with the error assumed to have normal distribution, was fit to the data. All main effects and their two-way interaction terms were considered, and the terms that were not statistically significant at 0.01 were deleted.

Different models were tried, but they did not fit well. Analyses of the residuals from the regression equations were carried out to check the adequacy and assumptions of the linear models. These equations were executed for the untransformed dependent variable and for the various transformations of the dependent variable. The plot of the residuals against the predicted values from these regression equations showed that the assumption of homocedasticity of variances was violated. The variance of the residuals increased directly with the expected values of the dependent variable (see Figure 12).

To check the assumption of normality of residuals, the residuals were divided into five groups defined by the expected values of the dependent variable. The mean, the standard deviation, the skewness, and the p-value for the test of normality were evaluated for each of these groups. The test for normality and probability plots of the residuals revealed that the assumption of normality was rejected for 3 of the groups. Groups 1, 4, and 5 were non-normal; groups 2 and 3 were normal (see Table 4).

2. *Model Fitting*

Two transformations of the dependent variable, the log and the square root, and weighted least square technique were used to address the problem of hetero-scedasticity (inequality of error variance) and to better satisfy the assumption of normality (see Table 5).

3. *Results*

None of the models used with the transformations of the dependent variable listed in Table 5 completely satisfied the assumption of normality or homogeneity of variance. The plot of the residuals against the expected values showed that the

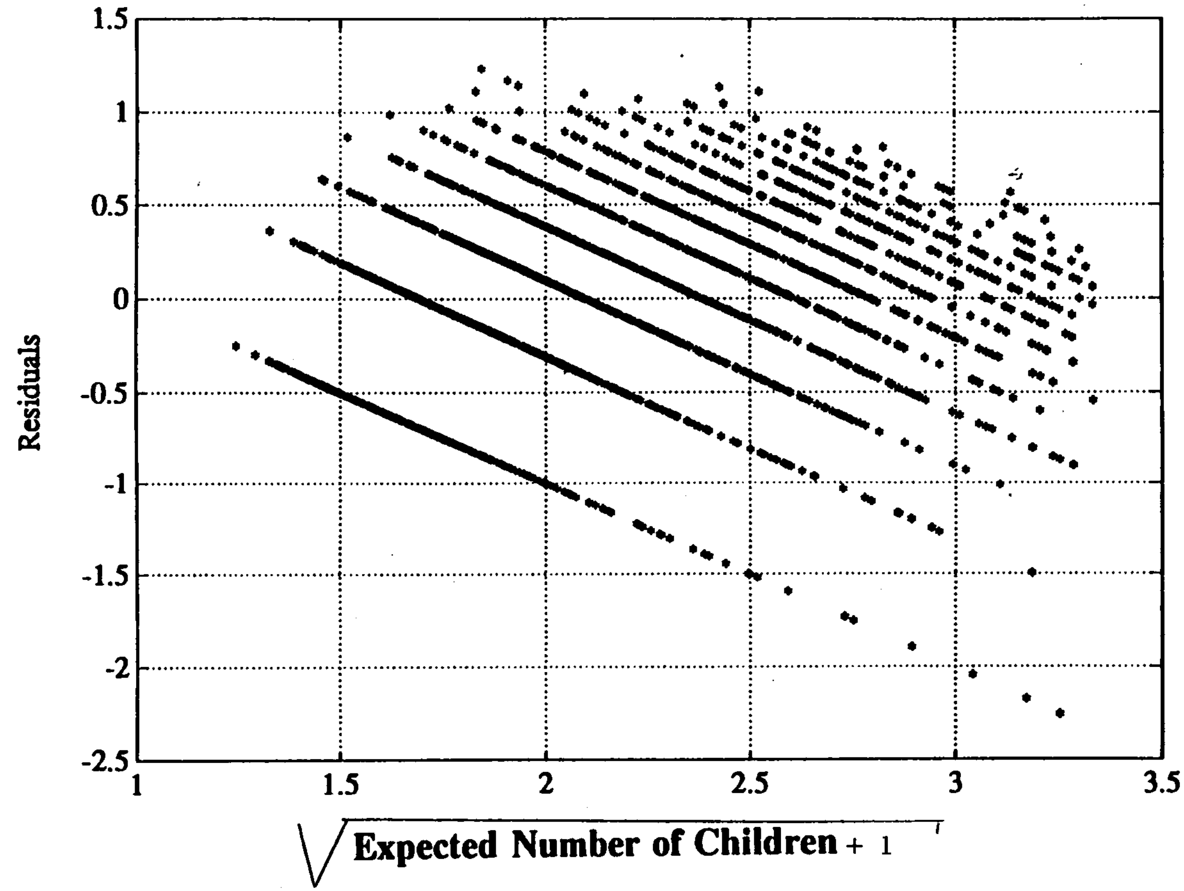

Figure 12. Plot of the Residuals Against the Expected Number of Children for the Square Root Transformation of the Dependent Variable (DHS, 1986)

Table 4

ANALYSIS OF RESIDUALS

Group of Residuals		N (Size)	Mean	Standard Deviation	Skewness	P-value (test for Normality)
Group 1	(1.0-1.5)	126	-0.092	0.27	0.21	0.0001
Group 2	(1.51-2.0)	1080	-0.008	0.34	-0.05	0.1356
Group 3	(2.1-2.5)	905	0.044	0.42	-0.3	0.0749
Group 4	(2.6-3)	612	0.012	0.53	-0.49	0.0001
Group 5	(3-3.5)	133	-0.200	0.57	-1.08	0.0001

Table 5

TRANSFORMATIONS OF THE DEPENDENT VARIABLE

Log Transformations	Square Root Transformation
1. $\ln(y + .5)$	
2. $\ln(y + 1.5)$	4. $\sqrt{(y+1)}$
3. $\ln(y + 2.5)$	

y = *number of children ever born at the time of the survey*

variance of the residual increased directly with the predicted values of the number of children ever born at the time of the survey.

The evaluation of the regression models also revealed that the following terms were significant for each model: woman's age, woman's years of schooling, partner's years of schooling, place of residence, and the interaction between woman's age with place of residence. Despite the problems with the dependent variable, these results are consonant with the research results reported in the literature.

B. POISSON REGRESSION

1. *Model Description*

This thesis also used the log-linear model for Poisson distributed data to investigate the effect of socio-economic and demographic variables on the expected number of children ever born. This model belongs to the family of generalized linear models of Nelder and Wedderburn (1972).

In the Poisson distribution the expected value and the variance of the dependent variable, Y, are equal

$$\lambda = E(Y) = Var(Y).$$

This means that the variance of the dependent variable, number of children ever born, is not constant. The plot of the residuals against the predicted values showed this over dispersion of the variance when the least square technique was applied.

In log-linear regression analysis, the logarithm of the mean, λ, is modeled as a linear function of the set of explanatory variables:

$$\ln(\lambda) = \alpha + \beta_1 x_1 + \beta_2 x_2 + ... + \beta_n x_n$$

where the x's are the explanatory variables, α is the constant, and the β's are the linear coefficients describing how the logarithm of the mean is related to changes in the x's.

2. *Model Fitting*

An ANOVA-like table was constructed by fitting a sequence of models to the data (see Table 6). The goodness of fit of each regression function was determined using the observed values of the deviance. The comparison of the observed values of the deviance with the chi-square distribution was used to indicate whether the assumption of Poisson variation and the assumed regression model were appropriate (Frome et al., 1973; Frome, 1986). The deviances of the models were used to produce likelihood ratio tests. The differences between pairs of deviances were compared to the chi-square distribution to select the best model. To estimate the amount of variation explained by the models, the R-square value for each model was calculated using the values of the deviance (see Table 7).

The formula for the R-square (Frome, 1986) is:

$$\mathbf{R^2 = 100\ (D_1 - D_2)/D_1}$$

where D_1 is the total likelihood Ratio (the likelihood ratio of the model plus the likelihood ratio of the deviance), and D_2 is the likelihood ratio of the deviance.

The final model (model 4 in Table 6) for the number of children ever born includes four main effects: woman's age, woman's years of schooling, partner's years of schooling, place of residence (urban and rural), and two-way interaction terms: woman's age with place of residence, and woman's age with woman's years of schooling. These main effects and two-way interactions are statistically significant. The Pearson chi-square is 2514.76 with 2849 degrees of freedom (p=.99994). This p-value indicates that the regression function fits the data very well. The deviance for the model is 2813.41 with 2849 degrees of freedom (p=0.678), indicating that both the regression model and the Poisson assumption are appropriate. The amount of variation explained by this model was calculated using the deviance. The

Table 6

ANALYSIS OF VARIANCES TO COMPARE MODELS TO PREDICT THE LOG (EXPECTED NUMBER OF CHILDREN EVER BORN AT THE TIME OF THE SURVEY)

Model	R^2	Deviance	df	Likelihood Ratio Test Statistics
1. Urban-Rural Woman's Age Woman's School	50.35425	2878.17887	2852	
				6.8132
2. Urban-Rural Woman's Age Woman's School Urban-Rural*Age	50.47177	2871.36563	2851	
				25.8079
3. Urban-Rural Woman's Age Woman's School Urban-Rural*Age Woman's Age*School	50.91693	2845.5573	2850	
				32.1431
4. Urban-Rural Woman's Age Woman's School Urban-Rural*Age Woman's Age*School Partner's School	51.47137	2813.4146	2849	

Table 7

ANALYSIS OF VARIANCES FOR MODEL 4

Source	df	Likelihood Ratio		Mean
Model	6	2984.01807	D_1	497.33635
Deviance	2849	2813.41458	D_2	0.98751
Total	2855	5797.43265	D_3	2.03062

R-square indicates that the model explains 51.47% of the variation.

Other models with additional main effects terms and interaction terms were evaluated, but the practical improvement obtained in the R-square for these models were not significant. Partner's occupation was one main effect term included in these models since it is often reported in the literature, but eventually it was deleted. Thus, the final model was chosen because it is statistically significant and also the most theoretically elegant.

3. *Results*

The general equation for the final model is:

$$\ln(\lambda) = \alpha + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 + \beta_4 x_4 + \beta_5 x_1 x_2 + \beta_6 x_1 x_4$$

where λ is the mean number of children ever born at the time of the survey, x_1 is the age of the woman, x_2 is the years of schooling of the woman, x_3 is the years of schooling of the partner, x_4 is a dummy variable for place of residence, $x_1 x_2$ is the interaction of the age of the woman with their years of schooling, x_1x_4 is the interaction of the age of the woman with the place of residence (see Table 8).

The general equation takes two forms depending on the place of residence. The dummy variable x_4 takes the values of 0 for urban areas and 1 for rural areas. Replacing $x_4=0$ in the general equation for urban areas:

$$\ln(\lambda) = \alpha+\beta_1x_1+\beta_2x_2+\beta_3x_3+\beta_4(0)+\beta_5x_1x_2+\beta_6x_1(0)$$

Collecting terms in the last equation:

$$\ln(\lambda) = \alpha+\beta_1x_1+\beta_2x_2+\beta_3x_3+\beta_5x_1x_2$$

Substituting the appropriate coefficients:

$$\ln(\lambda)=0.771+.028x_1-0.108x_2-0.018x_3+0.002x_1x_2$$

Replacing $x_4=1$ in the general equation for rural areas:

$$\ln(\lambda) = \alpha+\beta_1x_1+\beta_2x_2+\beta_3x_3+\beta_4(1)+\beta_5x_1x_2+\beta_6x_1(1)$$

Collecting terms in the last equation:

$$\ln(\lambda) = (\alpha+\beta_4)+(\beta_1+\beta_6)x_1+\beta_2x_2+\beta_3x_3+\beta_5x_1x_2$$

Substituting the appropriate coefficients:

$$\ln(\lambda)=[0.771+(-.387)]+(0.028+0.013)x_1+(-0.108)x_2+(-0.018)x_3+(0.002)x_1x_2$$

$$\ln(\lambda)=0.384+0.041x_1-0.108x_2-0.018x_3+0.002x_1x_2$$

Table 8

PARAMETER ESTIMATES AND THEIR ESTIMATED STANDARD ERROR FOR FINAL MODEL

Parameter		Estimate	Std. Error
Constant		0.7709	0.1043
Woman's Age	(β_1)	0.0280	0.0026
Woman's School	(β_2)	-0.1081	0.0122
Partner's School	(β_3)	-0.0177	0.0031
Place of Residence	(β_4)	-0.3866	0.0982
Residence*Age	(β_6)	0.0131	0.0026
Age*School	(β_5)	0.0018	0.0003

a. Main Effects

Age has a positive effect on the expected value of the number of children ever born at the time of the survey. This finding supports the expected relationship that when the other variables are held constant and age increases, the number of children increases. The effect of age is greater in the rural areas (coefficient=0.041) than in the urban areas (coefficient=0.028). Woman's years of schooling has a negative effect (coefficient=-0.108) on the expected value of the number of children when the effect of the other variables have been held constant. Its effect on both regions is the same. The effect of partner's years of schooling is also negative (coefficient=-0.018) when woman's age, and her years of schooling are held constant. But this effect is smaller than the woman's years of schooling. The negative effect of years of schooling indicates that as the years of education increase, the number of children decrease.

b. Interaction of Woman's Age with Place of Residence

Two regression equations, one for urban areas and another for rural areas, were plotted to observe the interaction between woman's age and place of residence. Figure 13 shows the plot of the log of the expected number of children against woman's age when the other predictors, woman's and partner's years of school, were held constant at their mean values of 5 and 7 years. Since, the slopes of the lines for urban and rural areas are not parallel, an interaction effect is present. Therefore, the relationship between the expected number of children and woman's age is conditioned by place of residence. Rural areas have a larger slope than urban areas, this differential suggests that the effect of age is greater in the rural areas than in the urban areas.

Figure 14 presents the expected number of children against woman's age. The estimated mean number of children for rural women at age 15 is 1.5, and for urban areas is 1.8. However, one must interpret this difference with caution since the predicted line was based on all the woman in the sample (including those older than 20 years). It makes more sense to compare the estimated mean number of children for urban and rural areas at age 40. At age 40 the estimated mean number of children for urban areas is 4.7 and for rural areas is 5.5.

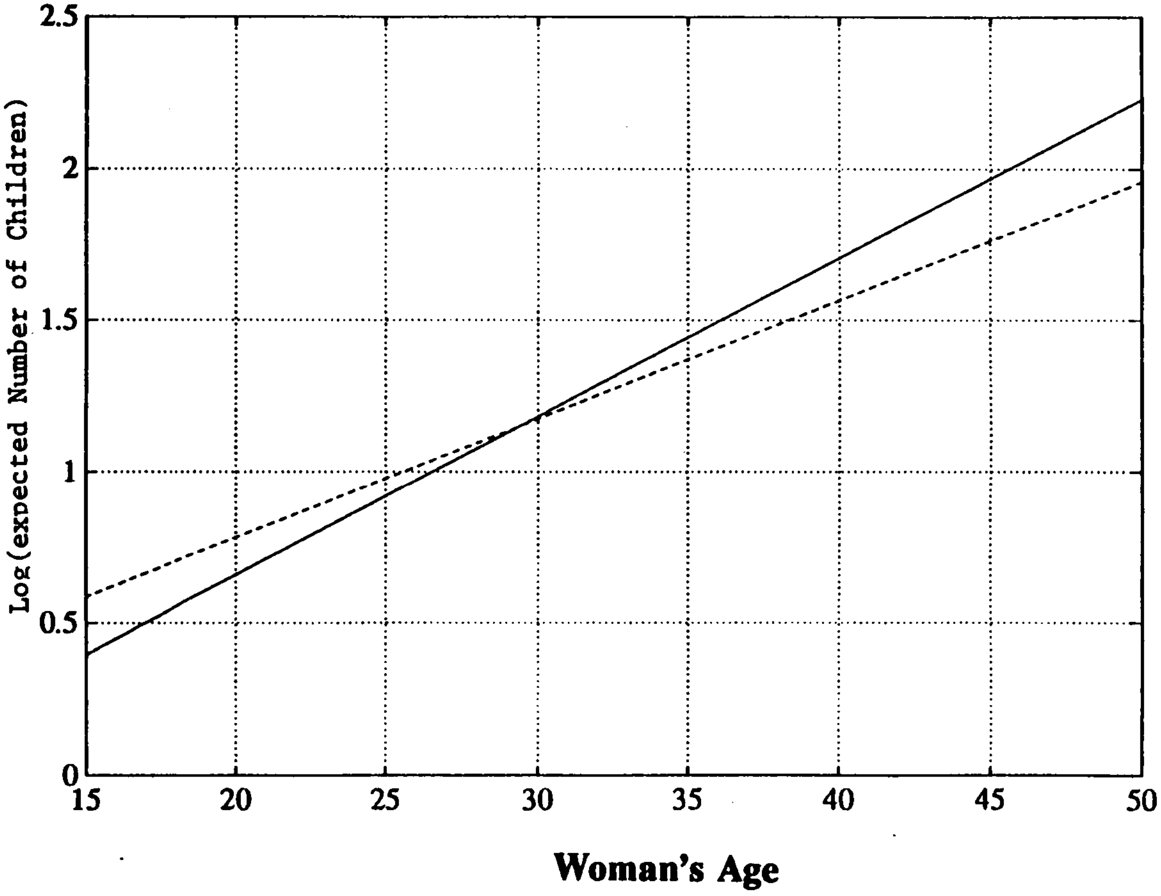

Figure 13. Plot of the log(expected number of children) as function of Woman's Age and place of residence (—) Rural (--) Urban

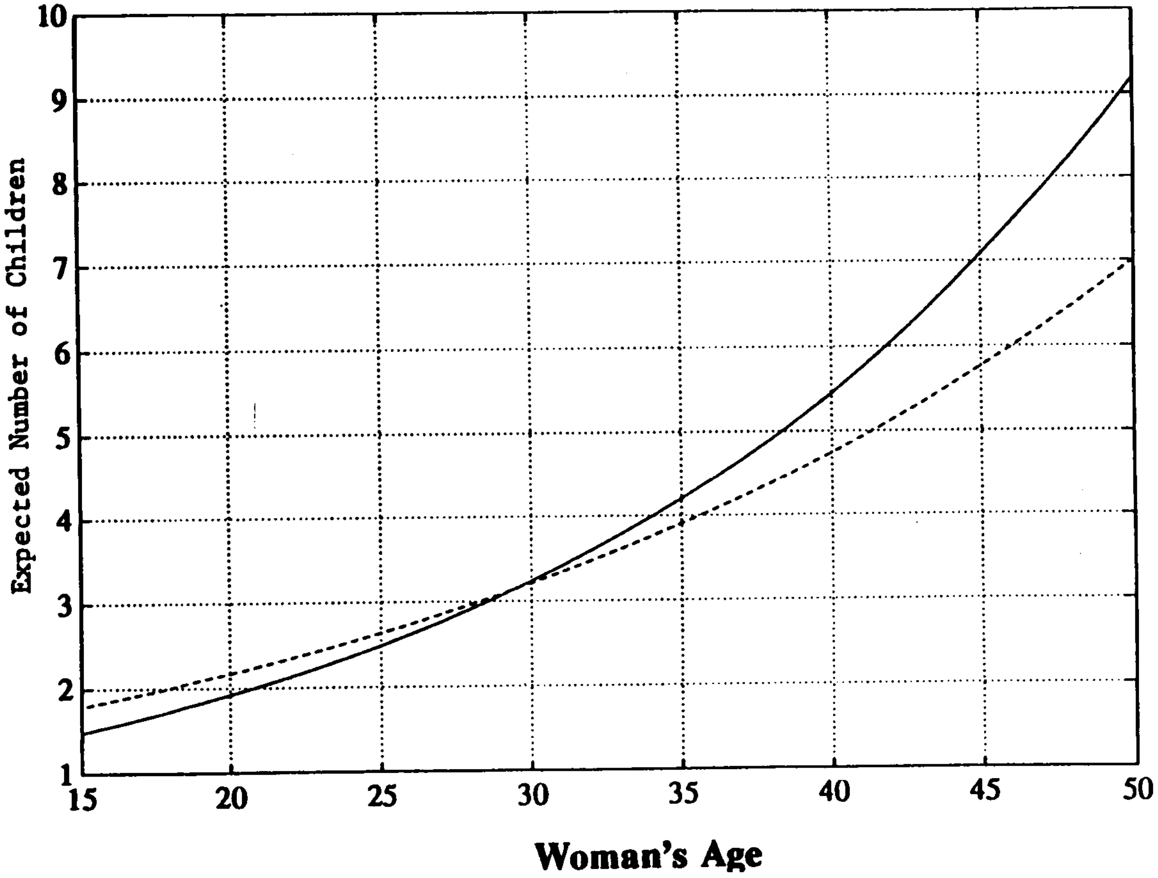

Figure 14. **Plot of the expected number of children as function of Woman's Age and place of residence (—) Rural (--) Urban**

c. Interaction of Woman's Age With Woman's Years of Education Completed

Four regression equations for 4 levels of education completed by place of residence were plotted to observe the interaction between woman's age with woman's years of schooling. For urban and rural areas (see Figure 15 and 16) each regression line represents a level of education completed for woman. Line 1 represents no education, line 2 represents 6 years of education (primary), line 3 represents 11 years of education (secondary), and line 4 represents 17 years of education (higher education). Partner's years of schooling was held constant at its mean value for the women in the particular group of education completed. For example, for woman with no education, her partner's mean number is 3 years, for woman with 5 years of education, her partner's mean number is 7 years, for women with 11 years of education, her partner's mean number is 12 years, for women with 17 years of education, her partner's mean number is 16 years.

For urban and rural areas, the four regression lines have different slopes and intercepts, this non-parallelism indicates the presence of interaction. The relationship between the expected number of children and age is conditioned by the number of years of schooling. The differences between the slopes reveals that the expected number of children varies according to the years of education completed. The slopes for the 4 level of education of rural areas are steeper than the slopes observed in urban areas (see Figures 15 and 16).

In Figures 17 and 18 the differences between the intercepts of the four regression line reveals that the estimated mean number of children varies according

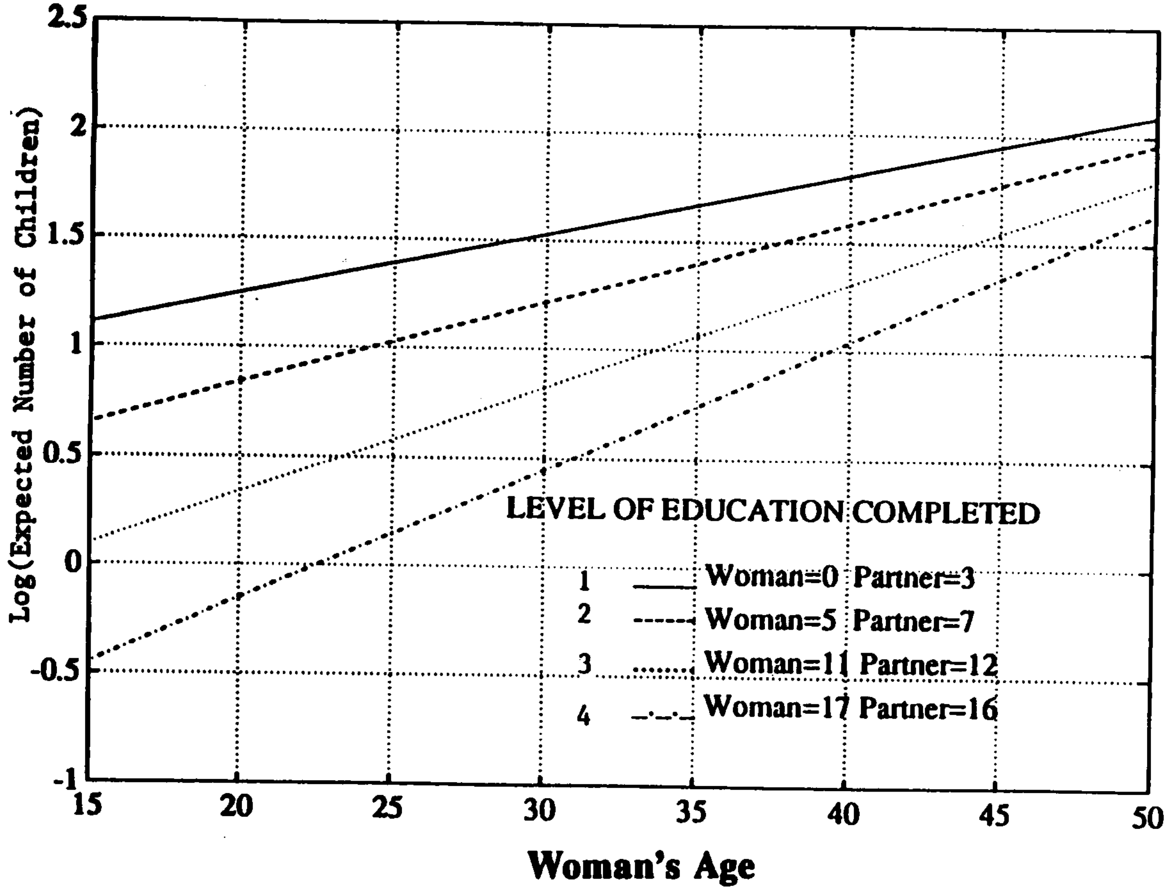

Figure 15. Plot of the log(expected number of children) as function of Woman's Age and level of education completed for Urban Areas

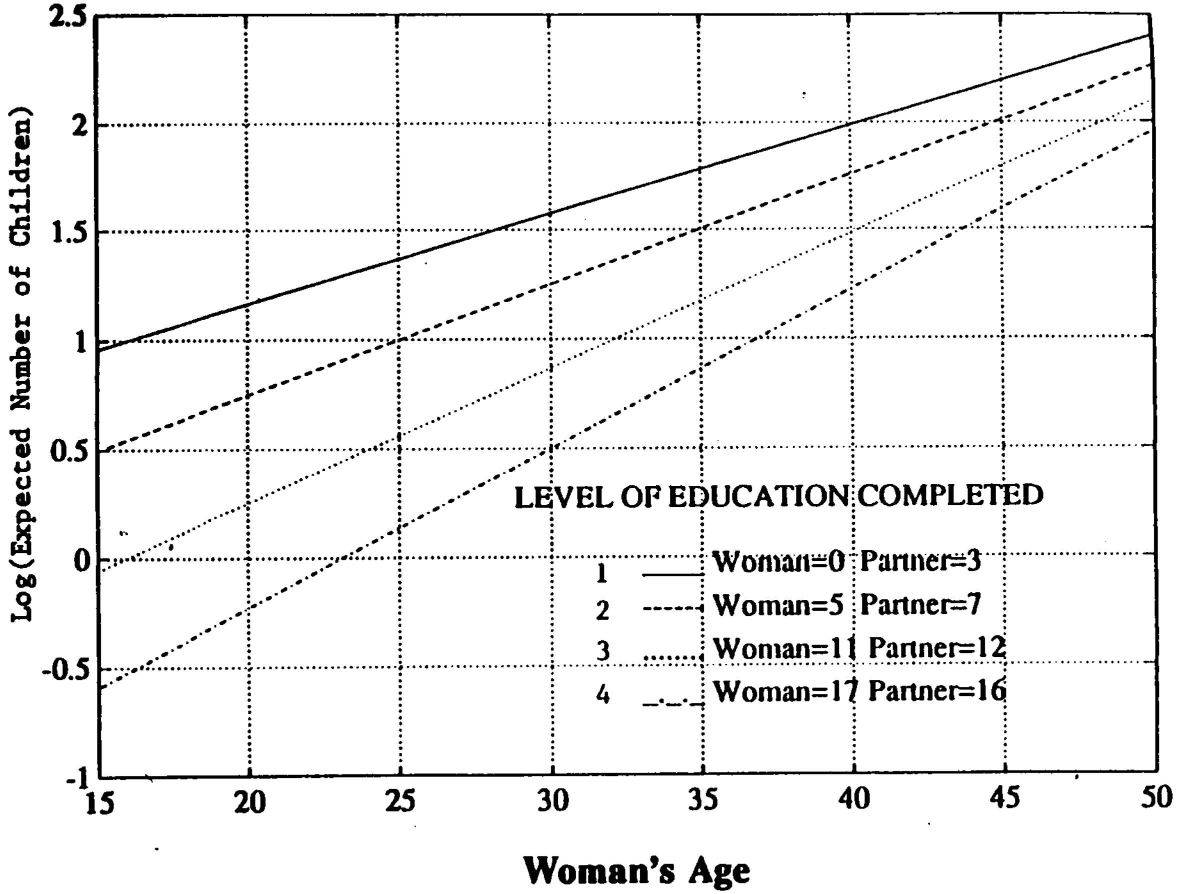

Figure 16. Plot of the log(expected number of children) as function of Woman's Age and level of education completed for Rural Areas

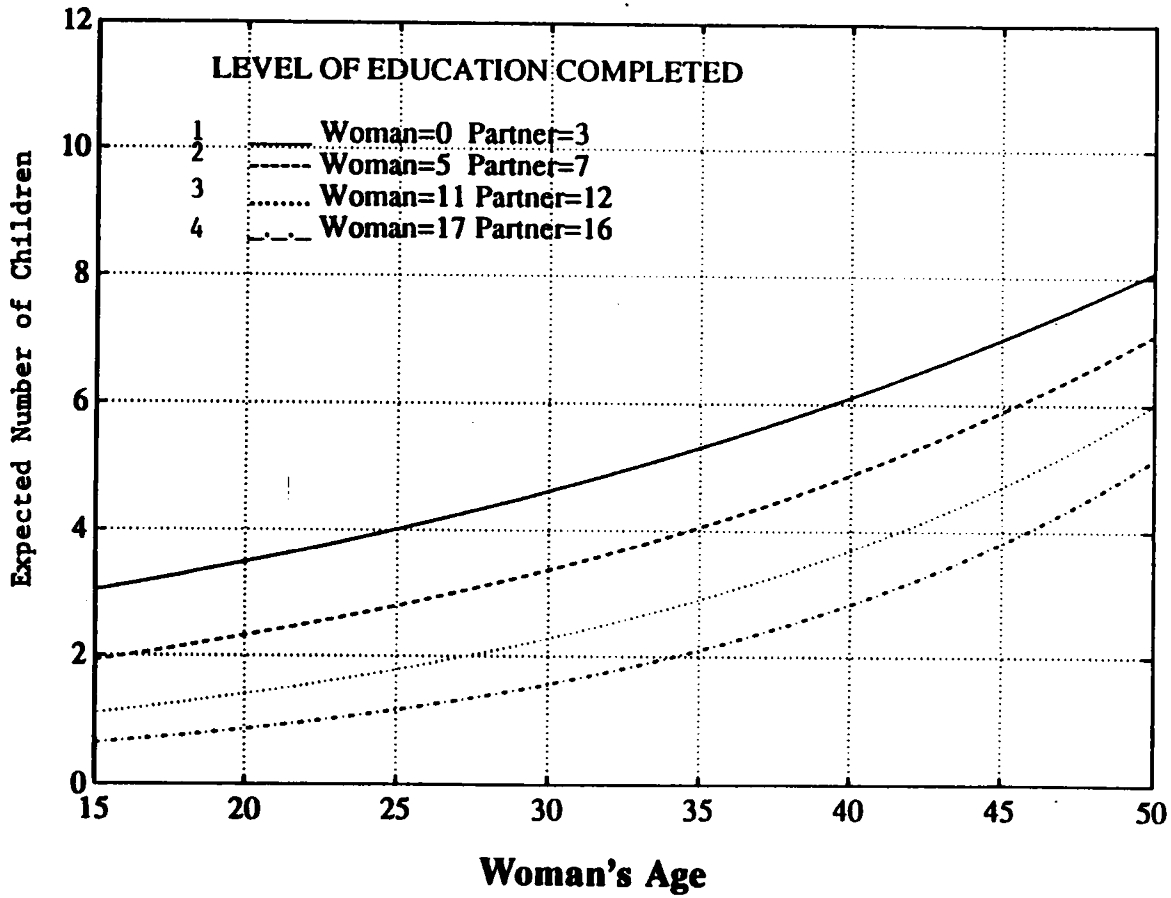

Figure 17. Plot of the expected number of children as function of Woman's Age and level of education completed for Urban Areas

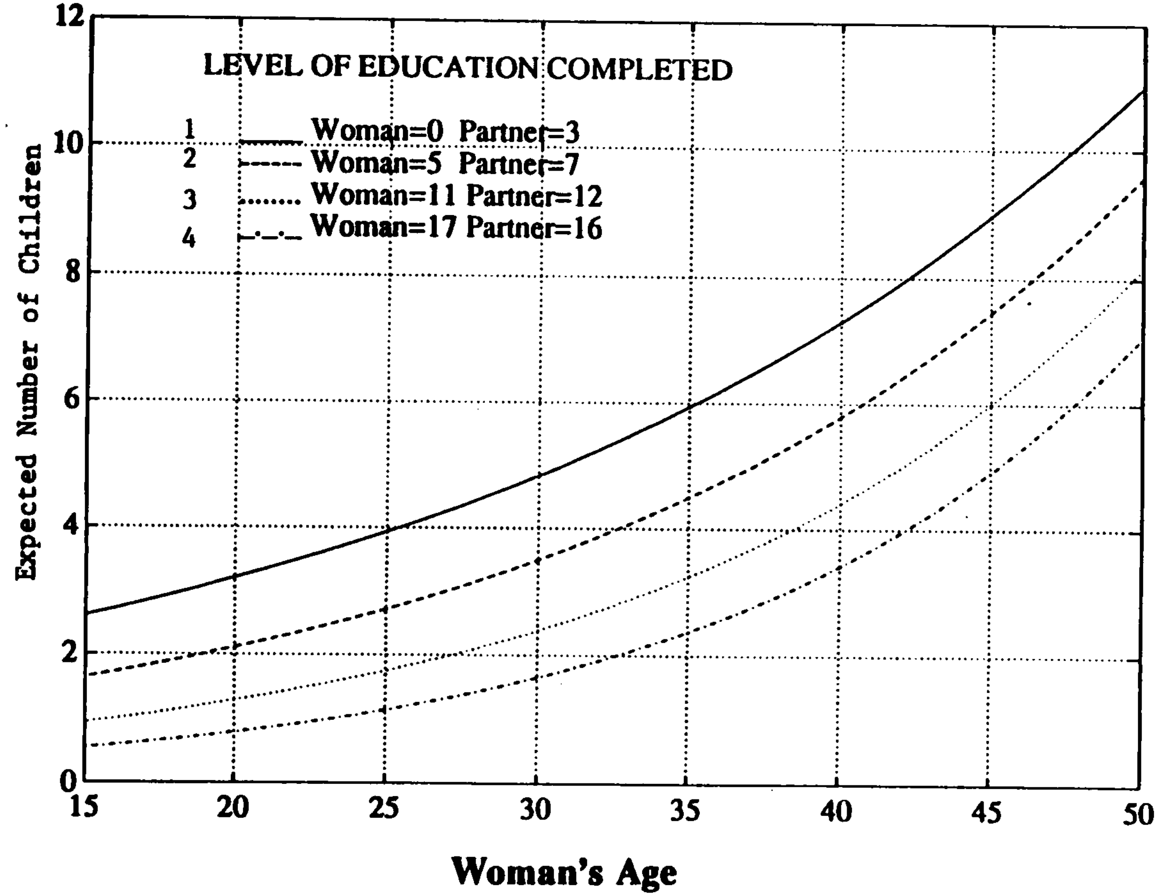

Figure 18. Plot of the expected number of children as function of Woman's Age and level of education completed for Rural Areas

to the level of education completed. The differences in the estimated mean number of children for young women (15 to 24) should be interpreted with caution since the prediction line was based on all the women in the sample.

For urban areas the estimated mean number of children at age 30 for women with no education is 4.6 , for women with 5 years of education is 3.34, for women with 11 years of education is 2.3 and for women with 17 years of education is 1.6 (see Figure 17). For rural areas, the estimated mean number of children at age 30 for women with no education is 4.8, for women with 5 years of education is 3.5, for women with 11 years of education is 2.4, and for women with 17 years of education is 1.8 (see Figure 18).

CHAPTER VI

DISCUSSION OF THE ADEQUACY OF THE MODEL

A. ANALYSIS OF THE EXPECTED VALUES OF THE NUMBER OF CHILDREN EVER BORN AT THE TIME OF THE SURVEY

After the log-linear regression model was obtained, a series of plots of expected number of children against woman's age, woman's years of schooling, and partner's years of schooling were examined for the subsample of 2856 women and for women in urban areas and rural areas.

For the subsample of 2856, the expected number of children increases with the age of the woman; this result was expected and agrees with the literature (see Figure 19). This positive relationship also is observed in urban and rural areas (see Figures 20 and 21).

For the subsample, the plots of the expected number of children against woman's years of school (see Figure 22) and partner's years of school (see Figure 23) show a negative relationship. Also, three blocks of points are distinguished in the two plots: the first block covers from 0 to 5 years, the second block covers 7 to 11 years, and the third block covers 13 to 17 years. The first block includes people with no education as well as people with 5 years of primary education completed, the second block corresponds to the completion of secondary education, and the third group corresponds to the completion of college education. Further, women and partners in a given block tend to behave similarly. For instance, individuals with 0 to 5 years of school have a similar range of expected number of children.

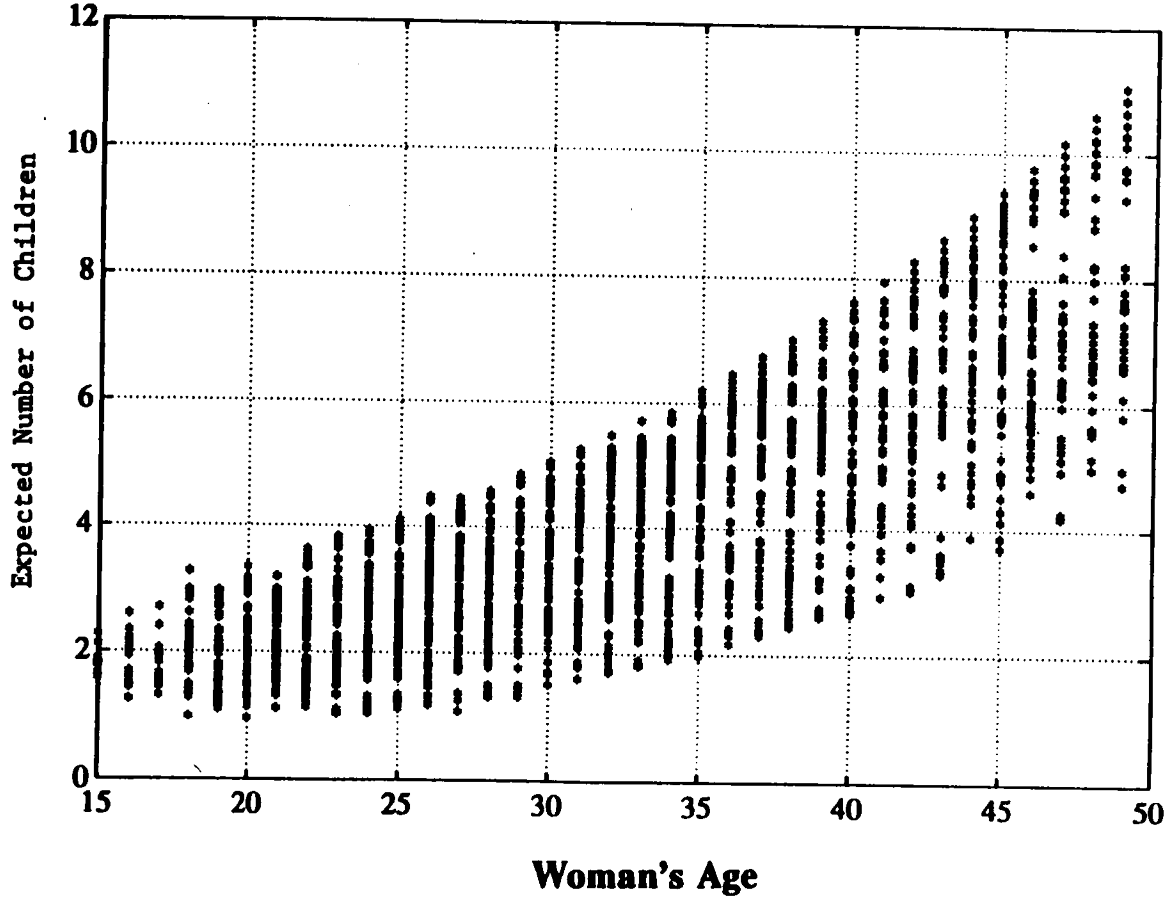

Figure 19. Plot of the expected number of children against Woman's Age for subsample

Figure 20. Plot of the expected number of children against Woman's Age for Urban Areas

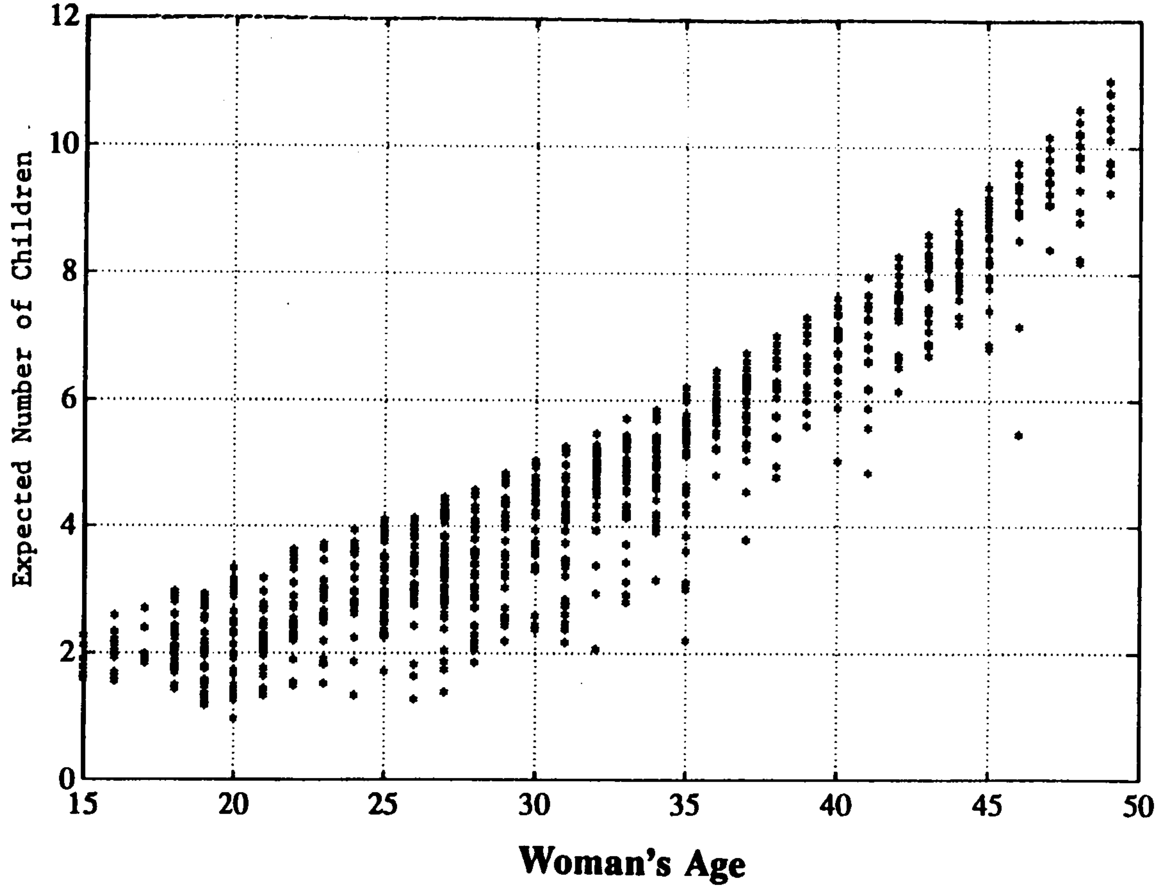

Figure 21. Plot of the expected number of children against Woman's Age for Rural Areas

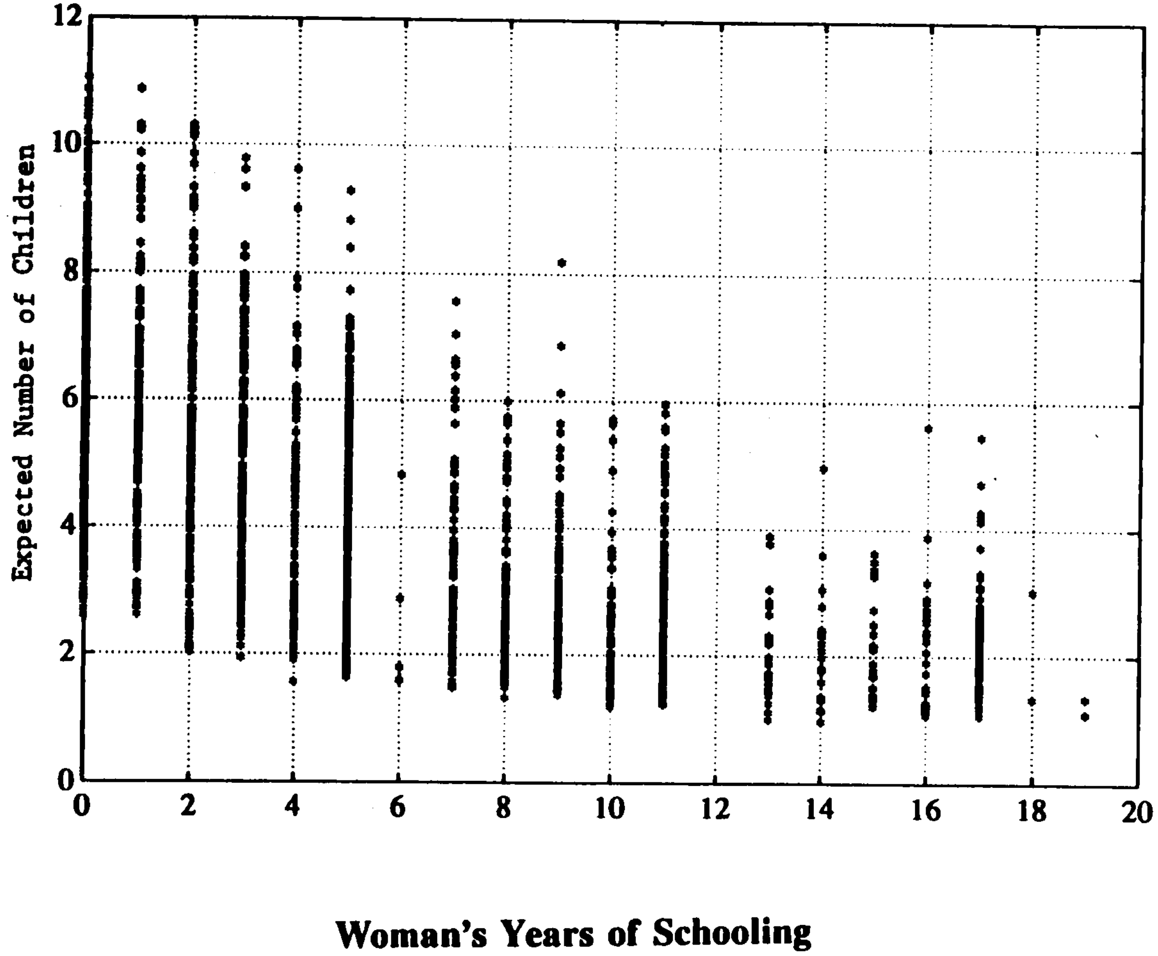

Figure 22. Plot of the expected number of children against Woman's years of schooling for the subsample

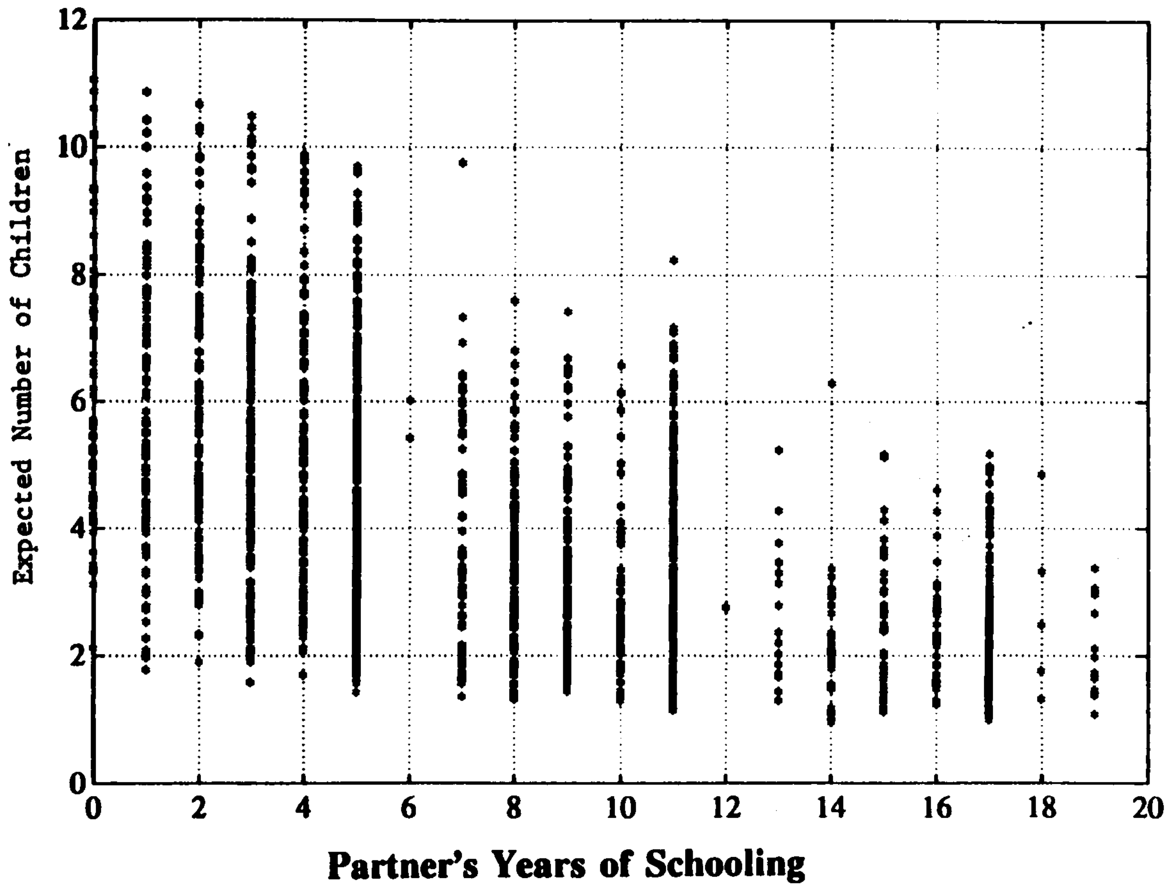

Figure 23. Plot of the expected number of children against Partner's years of schooling for the subsample

The negative relationship between the expected number of children and education is also observed in urban and rural areas. In Figure 24, the same pattern of three blocks is noted in urban areas. The first block covers women with 0 to 5 years of schooling. The range of expected number of children for these women is between 8 and under 2 children. The second block covers women with 7 to 11 years of schooling. The range of expected number of children for these women is 7 to under 2 children. The third block covers women with 13 to 17 years of schooling. The range of expected number of children for these women is 4 to 1 child.

In Figure 25, two blocks of education are observed in rural areas. The first block covers women with 0 to 5 years of schooling. The range of expected number of children for these women is 11 to under 2 children. The second block covers women with 6 to 11 years of schooling. The range of expected number of children for these women is 4 to 1 child. There are too few cases of women with more than 11 years of schooling, to observe a pattern.

The same pattern that was observed for woman's years of schooling is observed for partner years of school (see Figures 26 and 27). Partner's years of school does not reduce the range of the expected number of children in each educational block as dramatically as women's years of schooling does. The place of residence, urban or rural, operates the same way for the partner's years of schooling as woman's years of schooling in reducing the ranges of the expected number of children in each educational block.

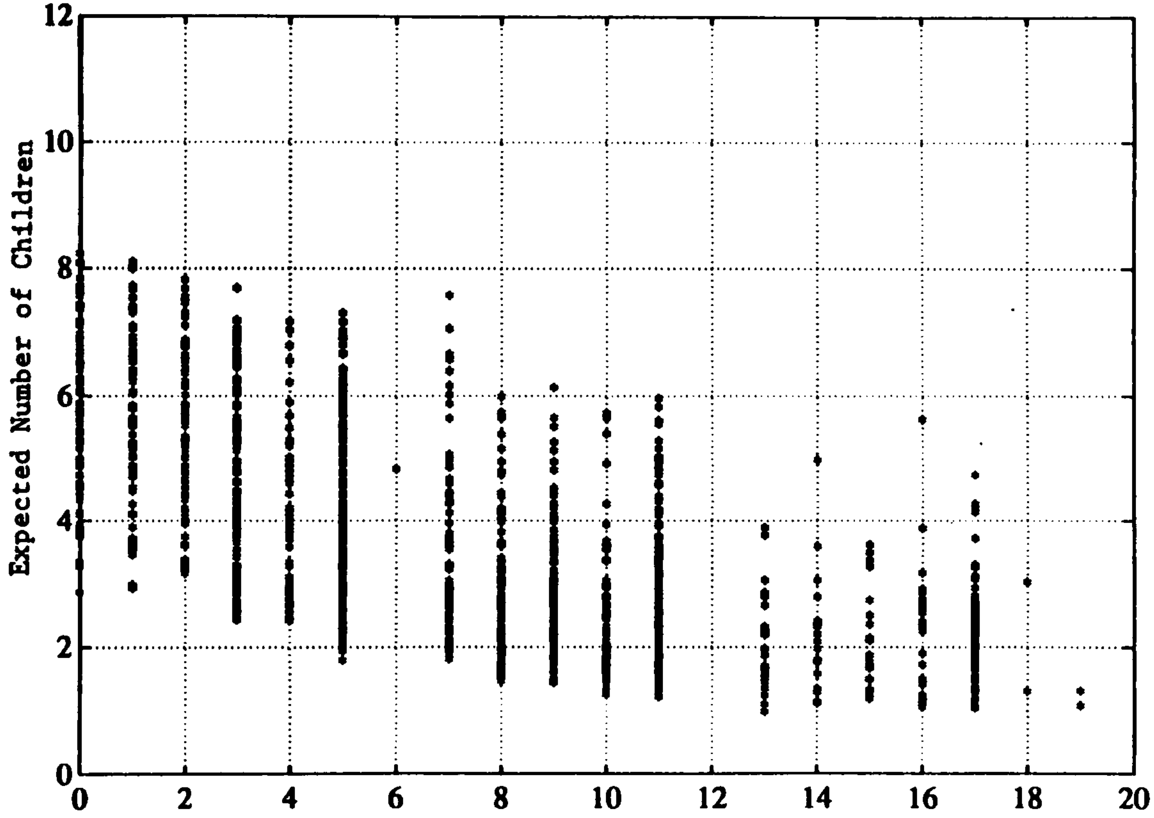

Figure 24. Plot of the expected number of children against Woman's years of schooling for Urban Areas

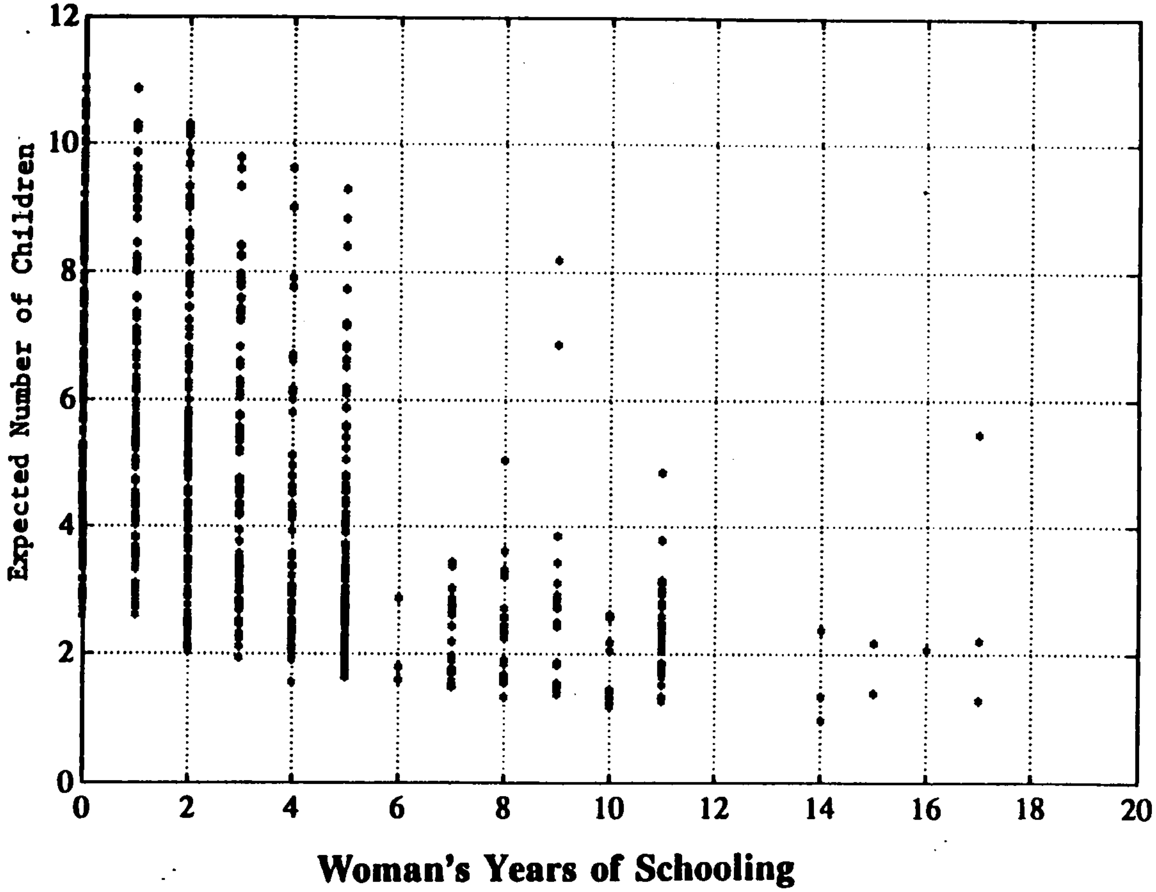

Figure 25. Plot of the expected number of children against Woman's years of schooling for Rural Areas

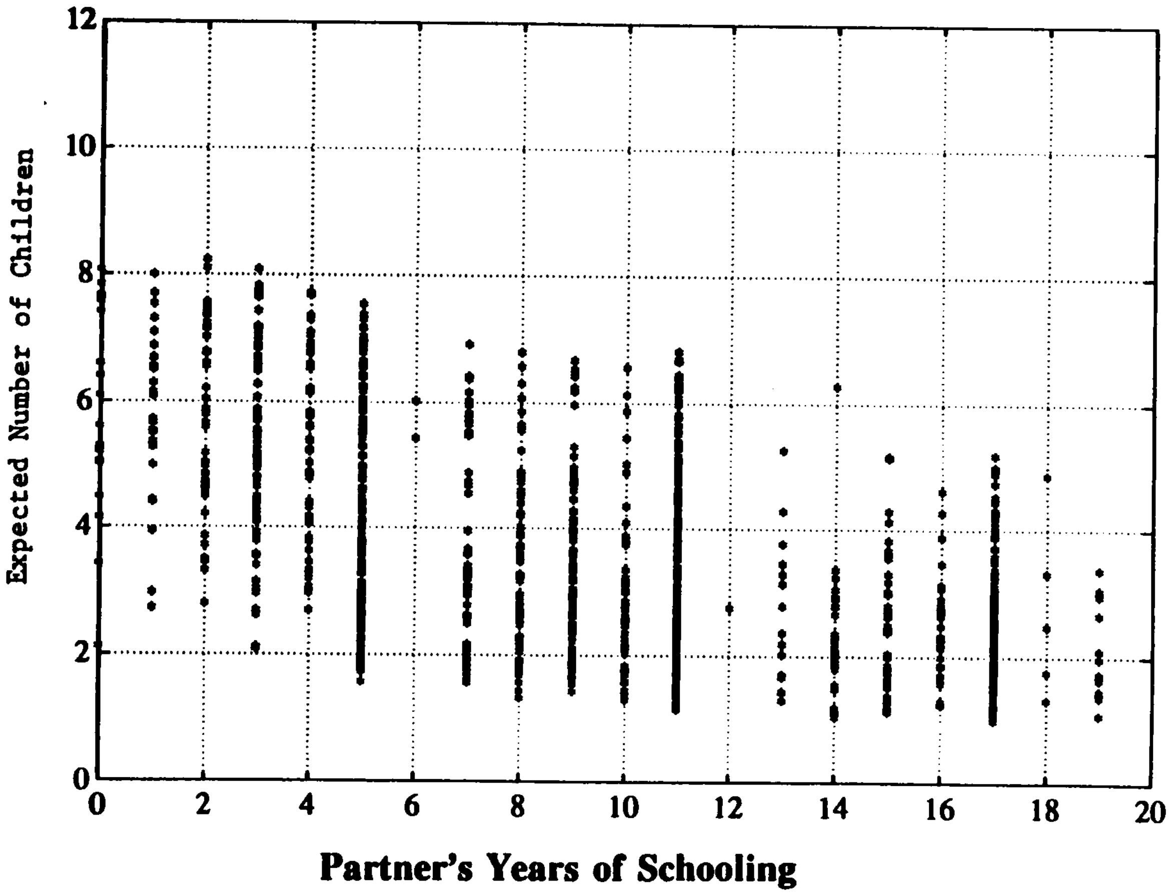

Figure 26. Plot of the expected number of children against partner's years of schooling for Urban Areas

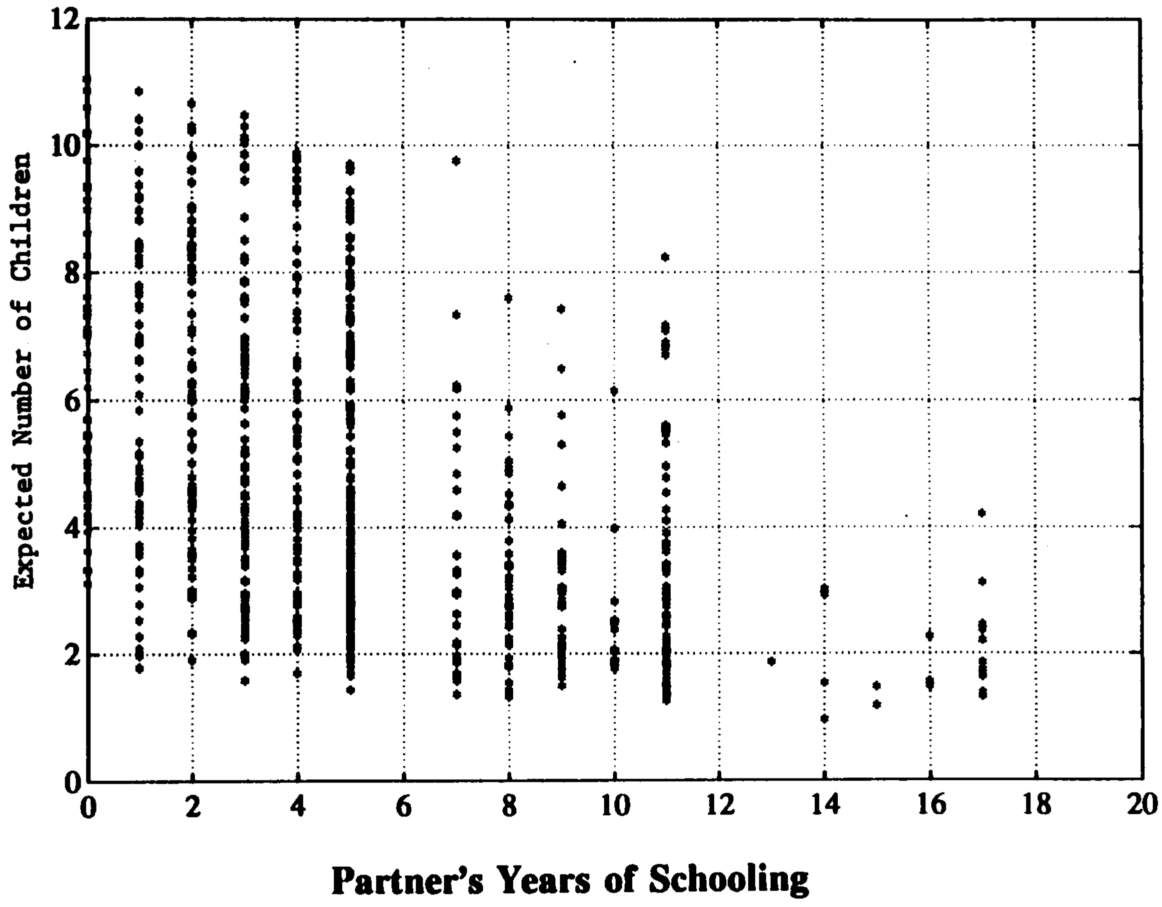

Figure 27. Plot of the expected number of children against partner's years of schooling for Rural Areas

B. ANALYSIS OF RESIDUALS

Plots of residuals were used to examine the adequacy of the log-linear model and the validity of its assumptions. Twelve plots are included: three plots of residuals against the expected values, and nine plots of the residuals against the independent variables.

In Figure 28 the plot of residuals against the expected values of the number of children is presented for the subsample of 2,856 women. These values were calculated as follows: Residuals = $(y - \hat{y})$ where y is the observed value and $\hat{y}$ is generated according to the log-linear Poisson model. This model is presented in the following equation:

$$\ln E(Y) = \alpha+\beta_1x_1+\beta_2x_2+\beta_3x_3+\beta_4x_4+\beta_5x_1x_2+\beta_6x_1x_4$$

At first sight the plot reveals the occurrence of parallel lines. Searle (1988) points out that parallel lines in residual plots occur when the dependent variable in a linear model is discrete. The series of parallel lines have a slope of -1 when the "observed values of Y are repeated in the data" (Searle 1988: 211).

In Figures 29 and 30 the plots of the residuals against the expected values of number of children are presented for urban areas and for rural areas. A comparison of the urban and rural plots suggests that the model provides a better fit for urban areas than for rural areas; for instance, the plots reveal that the data are more dispersed for rural areas than for urban areas. The residuals for urban areas are more concentrated around zero than the residuals for rural areas. The dispersion in the plot for urban areas ranges from 1 to 8; whereas for the rural areas the disper-

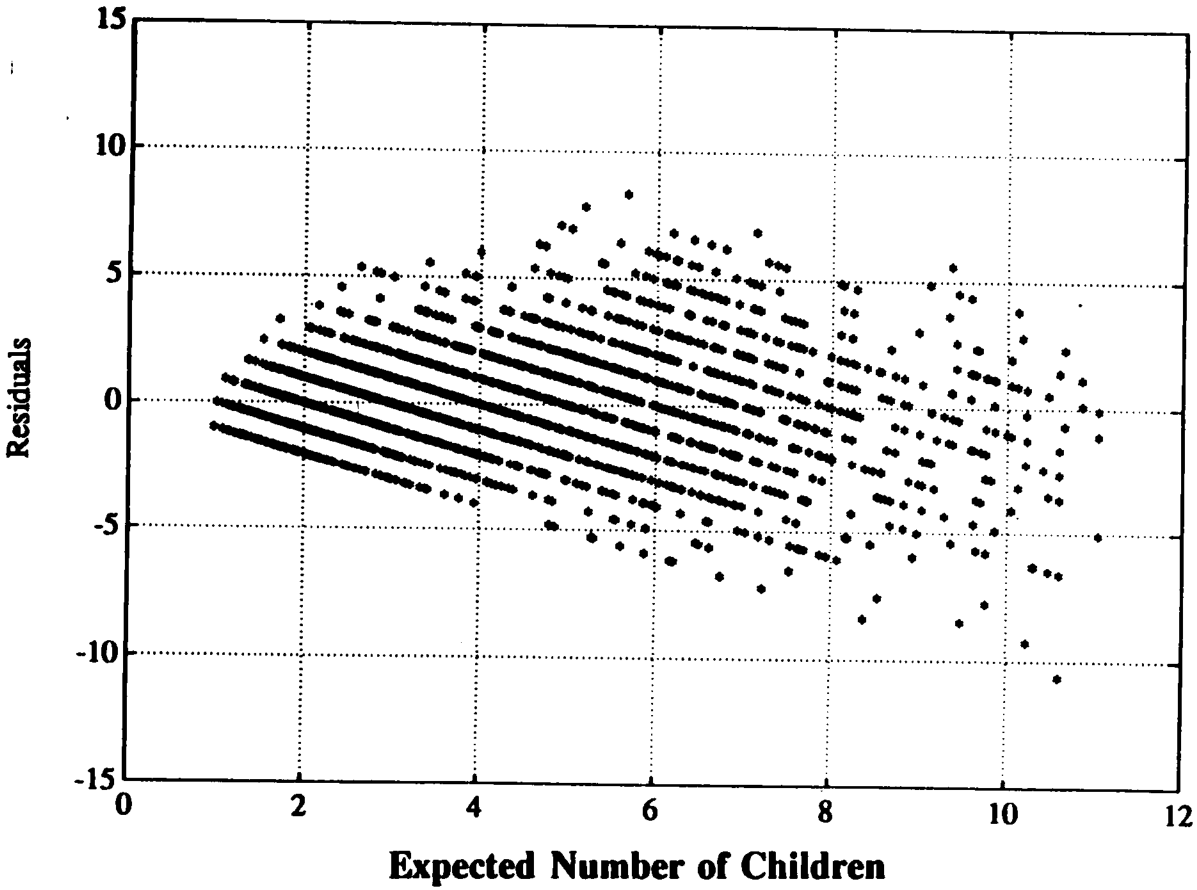

Figure 28. Plot of the residuals against the expected number of children for Subsample

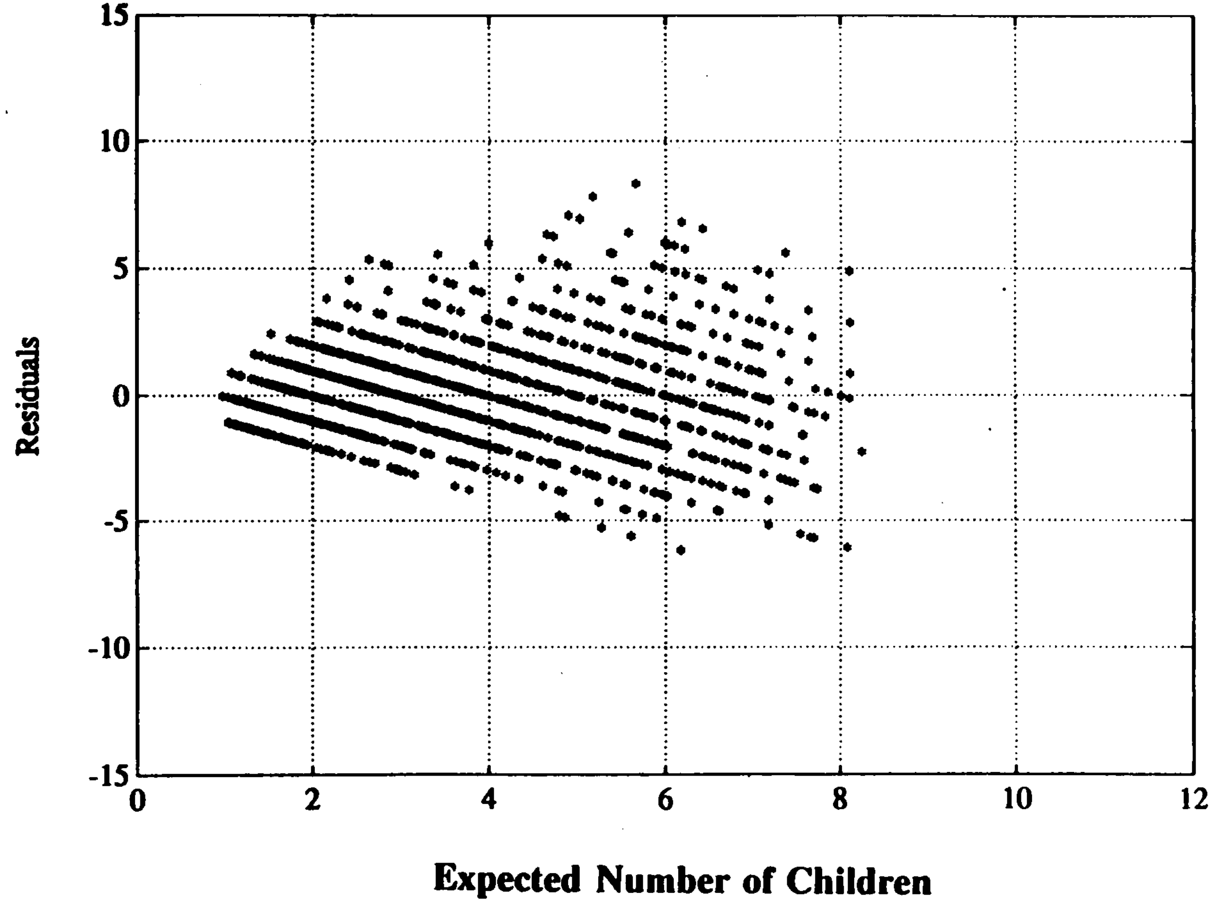

Figure 29. Plot of the residuals against the expected number of children for Urban Areas

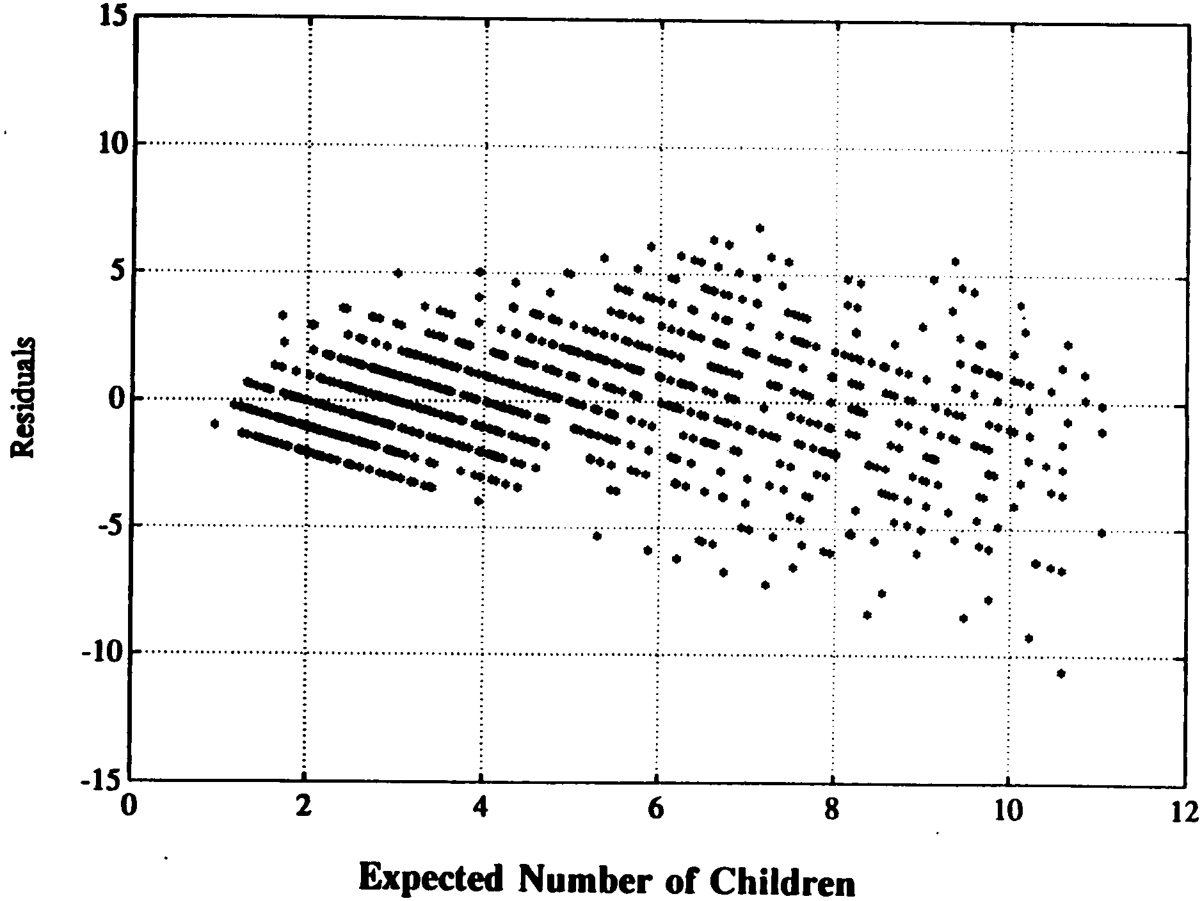

Figure 30. Plot of the residuals against the expected number of children for Rural Areas

sion ranges from 1 to 11.

In Figure 31, the plot of residuals against woman's age for the subsample shows that there are three distinctive age ranges. The first covers ages 15 to 24. In this age range, the residuals are mostly negative, which indicates that the expected values are greater than the observed values. The second covers ages 25 to 39, in this age range the residuals are almost equally distributed around zero. The majority of the data fall in this region. The third covers ages 40 to 49. This range has the biggest values of the residuals. The residuals in this region are mostly negative. The over estimated number of children for older ages (31 to 49) may be the result of the presence of women who have generally completed their childbearing. The source of the over estimation for younger ages (15 to 29) is unclear. These differences may suggest the necessity of using piecewise regression to fit three lines to the data (one for ages 15 to 24, another for 25 to 39, and other for 40 to 49).

When the residuals are plotted against woman's age by place of residence the three age ranges also are present. For urban areas the dispersion increases. In the first age range (15 to 24), the model over estimates; in the second range (25 to 39), the estimation looks balanced; in the third age range (40 to 49) the model over estimates (see Figure 32).

For rural areas, the first age group (15 to 24), and the third age group (40 to 49), the model dramatically over estimates (see Figure 33).
Apparently, the model over estimates the number of children ever born for women in the older age (40 to 49), for both urban and rural areas.

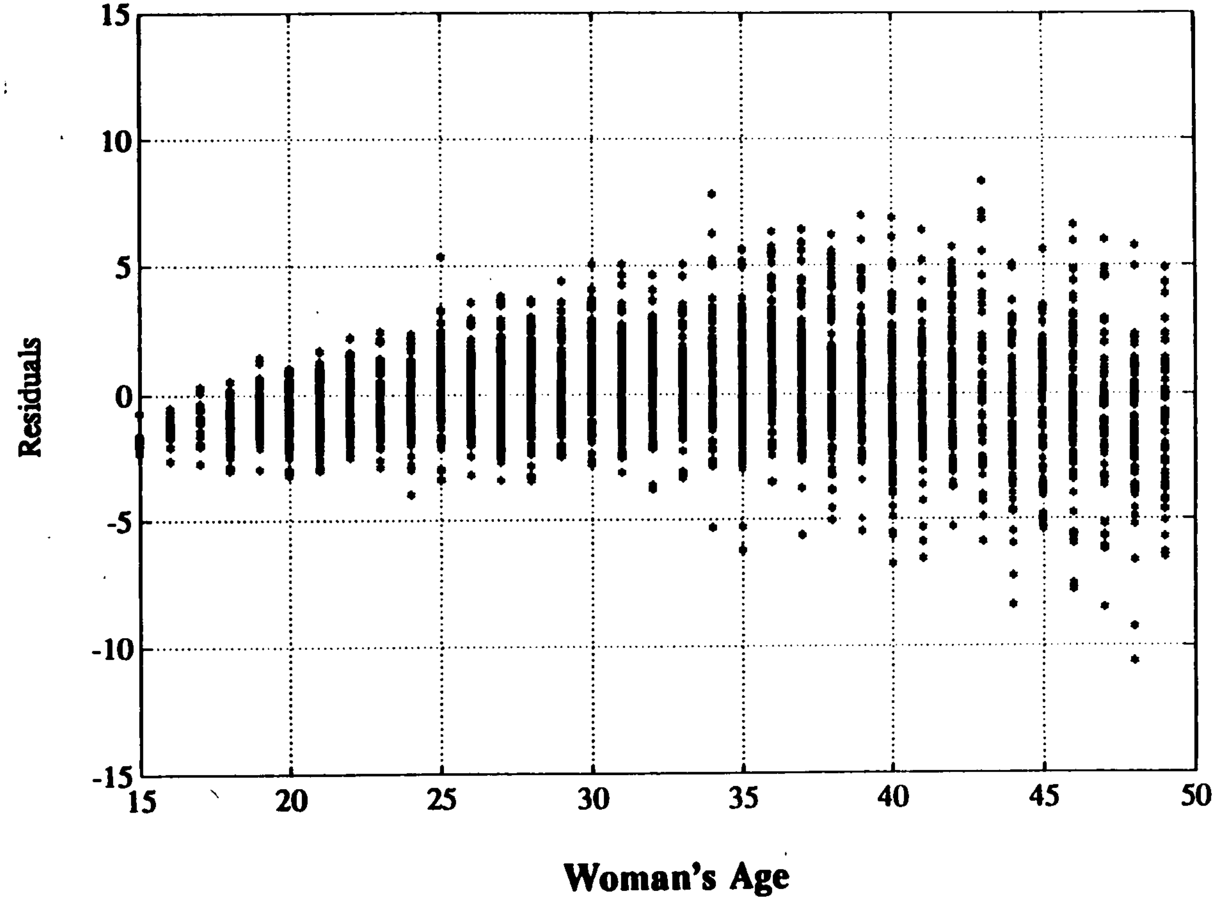

Figure 31. Plot of the residuals against Woman's Age for the subsample

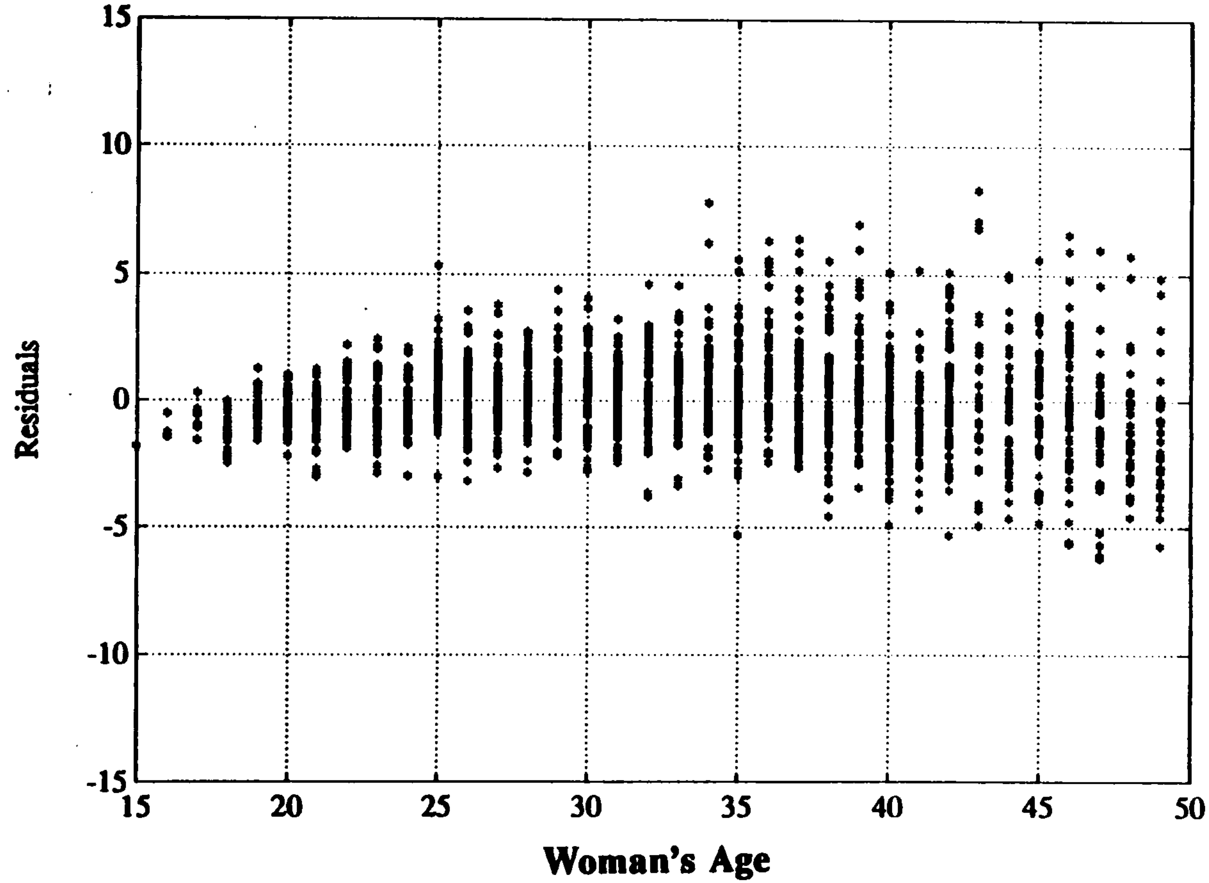

Figure 32. Plot of the residuals against Woman's Age for Urban Areas

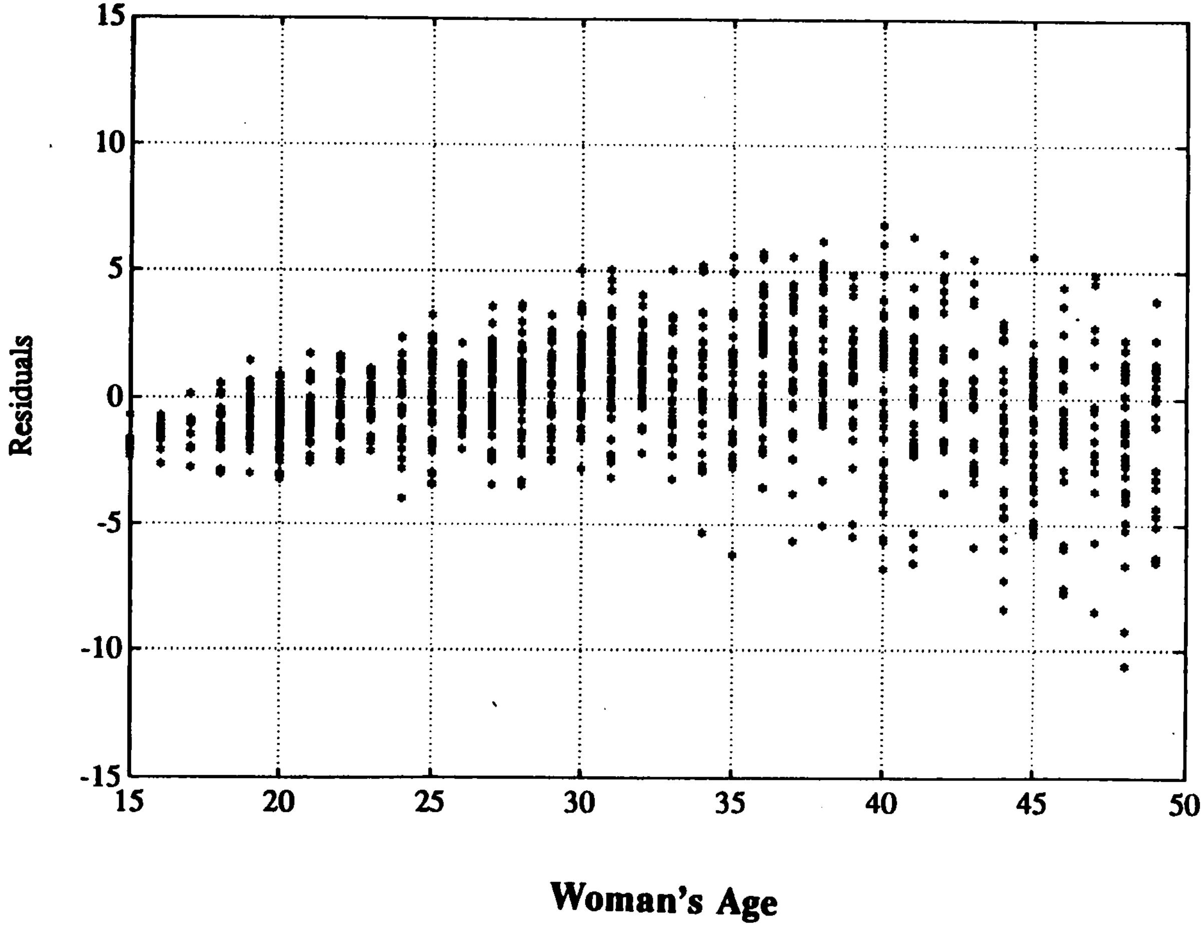

Figure 33. Plot of the residuals against Woman's Age for rural areas

In Figure 34, the plot of residuals against woman's year of schooling for the subsample shows a horizontal band of points around zero. Three blocks are distinguished: the first covers women with no education to women with 5 years of education, the second covers women with secondary education (from 7 to 11 years), and the third covers women with higher education (13 to 17 years).

The three blocks are also observed in the plots of residuals against woman's years of schooling by place of residence. In Figure 35, the plot for urban areas shows the three blocks: the first covers women with no education and 5 years of schooling; the second covers women with secondary education; and the third covers women with higher education. In Figure 36 the three blocks are also present in rural areas. However, their distribution of residuals differs from the blocks of the urban areas. In the rural areas most of the residuals are negative in the first block. Most of the residuals are positive in the second block. There are few residuals in the third block. Figure 37 presents the plot of residuals against partner's year of schooling for the subsample. A horizontal band of points around zero is observed. The three blocks for different education are present. The first covers partner with no education to partners with 5 years of education. The second covers partners with secondary education (from 7 to 11 years). The third covers women with higher education (13 to 17 years). The three blocks are also observed in the plots of residuals against partner's year of schooling for urban and rural areas (see Figure 38 and 39).

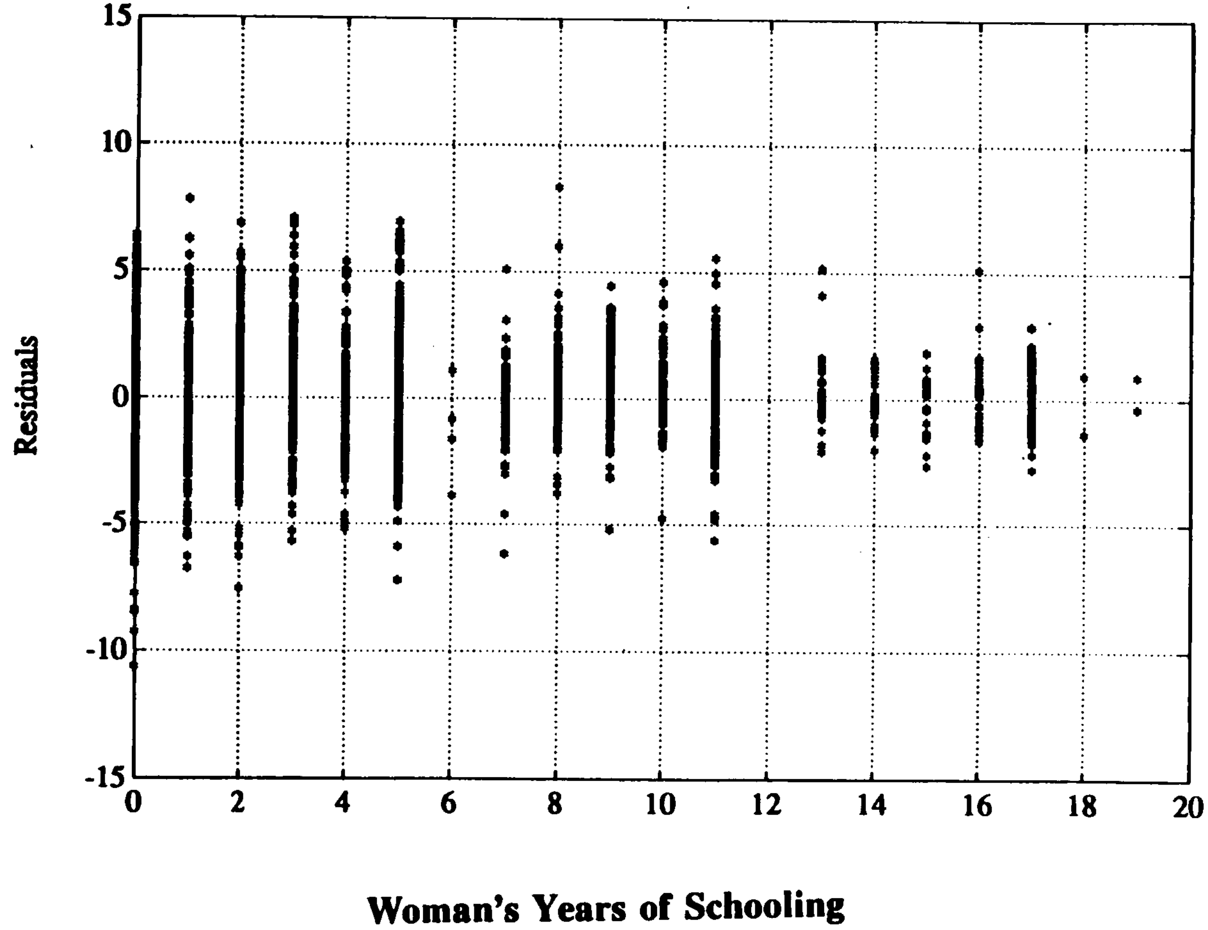

Figure 34. Plot of the residuals against Woman's years of schooling for the subsample

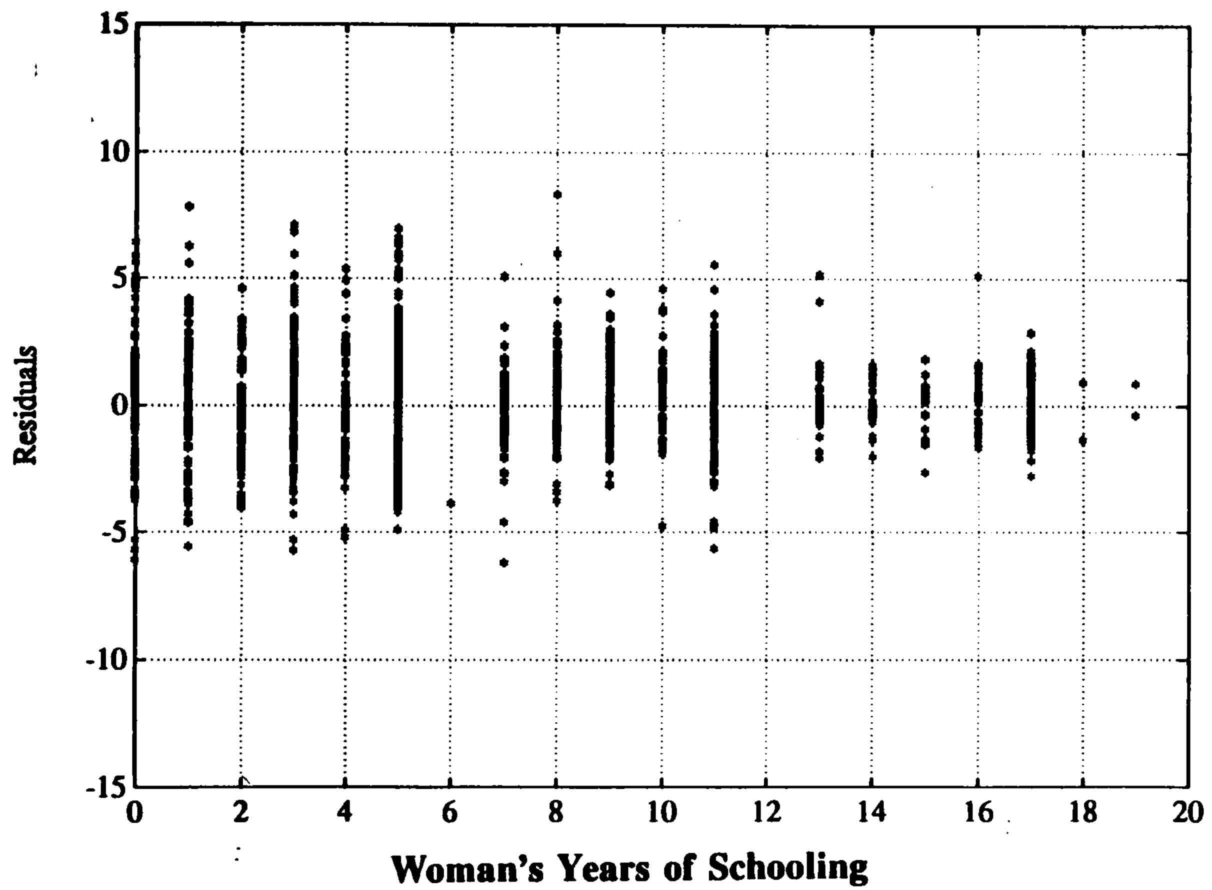

Figure 35. Plot of the residuals against Woman's years of schooling for Urban Areas

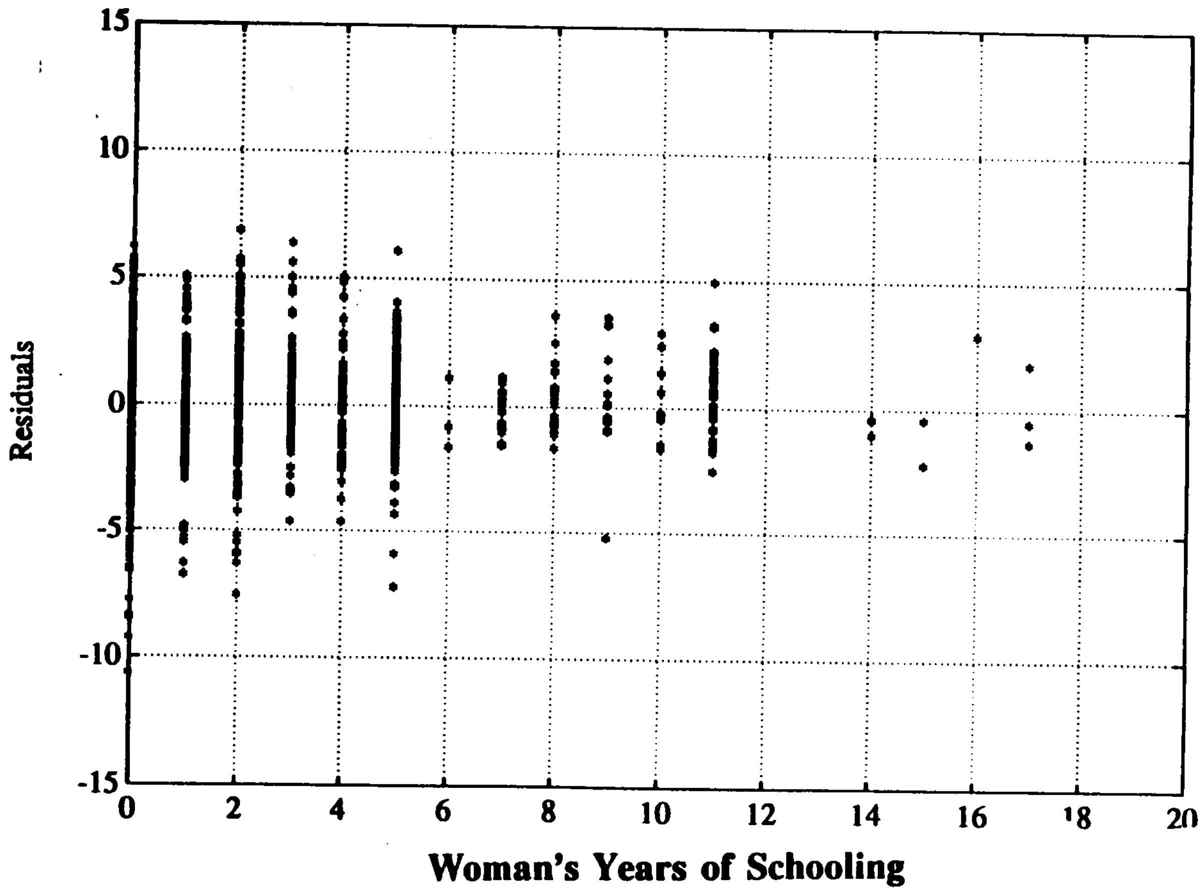

Figure 36. Plot of the residuals against Woman's years of schooling for Rural Areas

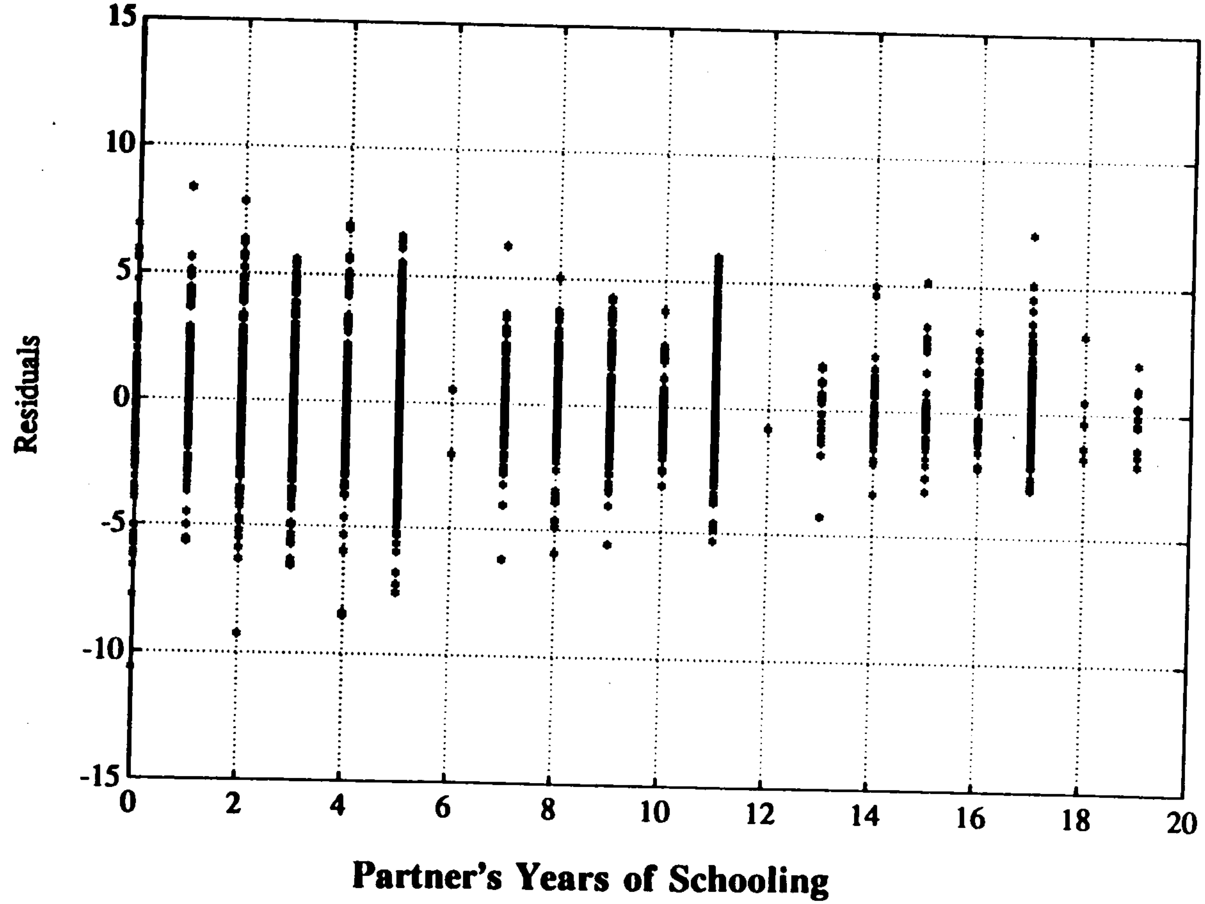

Figure 37. Plot of the residuals against Partner's years of schooling for the subsample

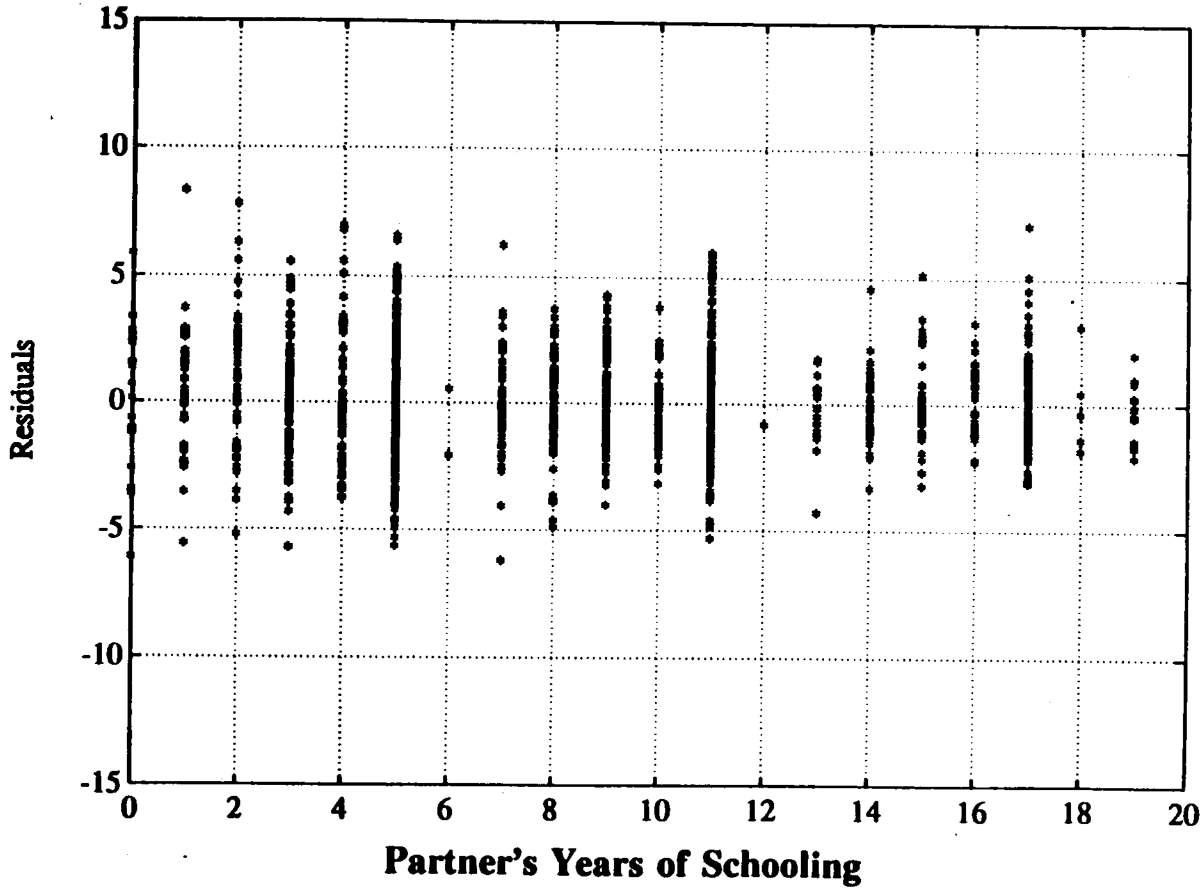

Figure 38. Plot of the residuals against Partner's years of schooling for Urban Areas

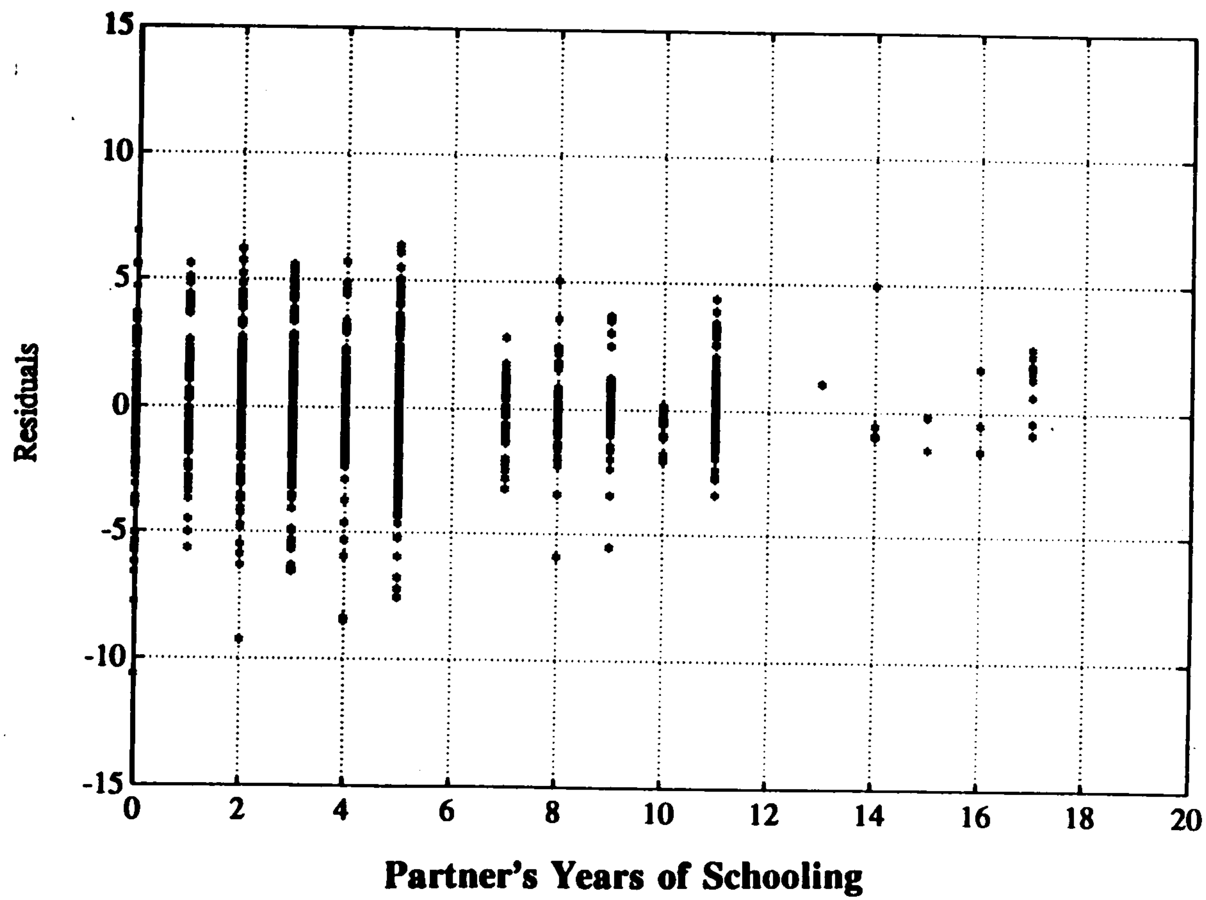

Figure 39. Plot of the residuals against Partner's years of schooling for Rural Areas

CONCLUSIONS

This thesis developed a model that quantifies the effect of selected socio-economic and demographic variables on fertility for Peruvian women. Two types of linear regression were used to predict family size, at the time of the survey, based on the assumptions made about the dependent variable. The two types of regression analysis were linear and Poisson.

1. Poisson regression best quantifies the effect of the independent variables on the number of children ever born, since the variance of the dependent variable satisfied the Poisson assumption that the variance is equal to its mean. The R-square for the log-linear Poisson regression indicates that the model explains 51.47% of the variation. The following independent variables were found to be statistical significant at 0.0001: woman's age, woman's and partner's years of education completed, place of residence (urban and rural), the interaction between woman's age and place of residence, and the interaction between woman's age and her years of education completed. The findings agree with previous studies done in Peru and in other Latin American countries.

2. Five hypothesis were tested. The final model confirmed the following three hypotheses: 1) women in rural areas have higher fertility than women in urban areas, 2) woman's age has a positive effect on fertility, 3) woman and partner with more years of education completed have lower fertility than woman and partner with few years of education completed.

Two hypotheses were not satisfied: the model used to test the first hypothesis included a variable that categorized Peru into four regions (Lima, coast, mountains, and jungle). These four regions were further subdivided into urban and rural areas. Regression analysis revealed that there was not statistical gain by including this regional distinction. However, the sole demographic distinction of urban and rural was sufficient. The second hypothesis tested was the effect of partner's occupation on fertility. Two different classifications of partner's occupation were used: the DHS and one by Rodriguez (1989). Neither classification adequately reflects the socio-economic status of the partners. If the occupations had been appropriately defined to reflect gradations in skills, access to resources, or status, then the variation in occupations probably would have explanatory significance in accounting for differences in fertility. However, since the categories do not specify such an order, any variation obtained is difficult to interpret. A better classification of occupations could not be used because the DHS information on woman's partner was insufficient. For instance, the DHS survey did not collect information on the income of the partner or the area of the farm for the landowners.

3. The findings agreed with the previous studies done in Latin America. Rural areas traditionally have had higher fertility than urban areas. Woman's education has always been a better predictor of fertility than partner's education. Women, who only completed primary school, have always had higher fertility than more educated women. The findings for fertility differences among occupations of the partners were inconclusive due to the problems of classification as mentioned before.

4. The analysis of the residuals (Chapter VI) revealed that the use of one model to describe the data may be inadequate due to the presence of three age ranges observed in the plot of the residuals against woman's age. When only one model is used, it tends to fit the majority of the data that lies in the age range that covers ages 25 to 39, and over estimates the number of children for younger and older ages. A better fitting of the data may be obtained by using three different models.

Another alternative to improve the fitting of the data may be to categorize age and years of schooling, and create a contingency table for Poisson distributed data.

5. It is recommended to collect information on family's income for a new study. This information will allow a better classification on the partner's occupation.

6. The number of children ever born was used as measure of fertility in this study. This variable represents the cumulative fertility and it does not give any information of current fertility. A more complete study can be done by using the number of children ever born in the five years prior to the survey.

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APPENDIX

CHART OF THE DISTRIBUTION OF THE VARIABLES IN THE DATA

1. AGE BY 5 YEAR GROUPS FORPERUVIAN WOMEN FOR THE TOTAL SAMPLE (DHS, 1986)

Age at interview	N	Percent
15-19	1097	21.9
20-24	943	18.9
25-29	811	16.2
30-34	682	13.6
35-39	584	11.7
40-44	486	9.7
45-49	396	7.0
Total	4,999	100.0

2. REGION BY PLACE OF RESIDENCE (DHS, 1986)

Region	N	Percent
Coast Urban	1012	20.2
Mountains Urban	584	11.7
Jungle Urban	219	4.4
Coast Rural	319	6.4
Mountains Rural	977	19.5
Jungle Rural	297	5.9
Lima	1591	31.8
Total	4,999	100.0

3. AGE BY 5 YEAR GROUPS FOR PERUVIAN WOMEN FOR THE SUBSAMPLE (DHS, 1986)

Age Group	N	Percent
15-19	123	4.3
20-24	411	14.4
25-29	556	19.5
30-34	555	19.4
35-39	491	17.2
40-44	398	13.9
45-49	322	11.3
Total	2,856	100.0

4. AGE BY 5 YEAR GROUPS FOR BY PLACE OF RESIDENCE FOR THE SUBSAMPLE (DHS, 1986)

	Urban Areas		Rural Areas	
Age Groups	N	Percent	N	Percent
15-19	47	2.6	76	7.3
20-24	261	14.4	150	14.4
25-29	358	19.7	198	19.0
30-34	377	19.7	178	17.1
35-39	327	20.8	164	15.7
40-44	247	13.0	151	14.5
45-49	197	10.9	125	12.0
Total	1814	100.0	1042	100.0

5. LEVEL OF EDUCATION COMPLETED FOR WOMEN AND FOR PARTNERS (DHS, 1986)

Level of Education	Women N	Women Percent	Partners N	Partners Percent
No Education	124	4.3	427	15.0
Primary	1252	43.8	1279	44.8
Secondary	1103	38.6	934	32.7
Higher	377	13.2	216	7.6

6. LEVEL OF EDUCATION COMPLETED FOR WOMEN AND FOR PARTNERS FOR URBAN AREAS (DHS, 1986)

Level of Education	Women N	Women Percent	Partners N	Partners Percent
No Education	100	5.5	21	1.2
Primary	678	37.4	533	29.4
Secondary	829	45.7	903	49.8
Higher	207	11.4	357	19.7

7. LEVEL OF EDUCATION COMPLETED FOR WOMEN AND FOR PARTNERS FOR RURAL AREAS (DHS, 1986)

Level of Education	Women N	Women Percent	Partners N	Partners Percent
No Education	327	31.4	103	9.9
Primary	601	57.7	719	69.0
Secondary	105	10.1	200	19.2
Higher	9	0.9	20	1.9

8. PARTNER'S OCCUPATION (DHS, 1986)

Occupation	N	Percent
Never Worked	32	1.1
Professional Tech., Manager	354	12.4
Clerical	185	6.5
Sales	308	10.8
Agri-Self Employed	666	23.3
Agr-Employee	257	9.0
Services	163	5.7
Skilled and Unskilled	891	31.2
Total	2,856	100.0

9. NUMBER OF CHILDREN EVER BORN AT THE TIME OF THE SURVEY (DHS, 1986)

Number of Children Ever Born	N	Percent
0	139	4.9
1	371	13.0
2	466	16.3
3	463	16.2
4	397	13.9
5	254	8.9
6	221	7.7
7	157	5.5
8	129	4.5
9	89	3.1
10	67	2.3
11	54	1.9
12	26	0.9
13	16	0.6
14	6	0.2
15	1	0.0
Total	2,856	100.0

10. AGE BY 5 YEAR GROUPS FOR BY PLACE OF RESIDENCE FOR THE SUBSAMPLE (DHS, 1986)

	Urban Areas		Rural Areas	
Number of Children Ever Born	N	Percent	N	Percent
0	85	4.7	54	5.2
1	264	14.6	107	10.3
2	359	19.8	107	10.3
3	353	19.5	110	10.6
4	263	14.5	134	10.6
5	148	8.2	106	12.9
6	124	6.8	97	10.2
7	75	4.1	82	9.3
8	60	3.3	69	7.9
9	32	1.8	57	6.6
10	19	1.0	48	5.5
11	17	0.9	37	4.6
12	9	0.5	17	3.6
13	5	0.3	11	1.1
14	1	0.1	5	0.5
15			1	0.1
Total	1814	100.0	1042	100.0

VITA

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