

930000995/62
HUU

PN-AAP-320
ISN-33470

"THE IMPACT OF HEALTH AND NUTRITION ON THE
NUMBER OF SURVIVING CHILDREN IN A
DEVELOPING METROPOLIS"

by

Jere R. Behrman
Barbara L. Wolfe*

April 16, 1979

(Revised: May 1, 1979)

NPP. 5

*The authors are professor of economics and research associate of the Population Studies Center at the University of Pennsylvania; and assistant professor of preventive medicine and of economics and research affiliate of the Institute for Research on Poverty at the University of Wisconsin, respectively. This working paper is one in a series resulting from a survey and research project to investigate the social-economic-demographic roles of women in the developing country of Nicaragua. Funding for the initial survey and analysis of data from the major metropolitan area of Managua was provided by the Population and Development Policy Research Program sponsored jointly by the Ford and Rockefeller Foundations in the form of a two year grant for 1977 and 1978. Funding for enlarging the Managuan phase of the project and for extending the data base and the analysis thereof to a country-wide sample, including siblings of the initial respondents, is provided by the Agency for International Development Negotiated Contract AID/otr-C-1571 for three years beginning August 1, 1977. The project is conducted by the University of Pennsylvania, the University of Wisconsin, the Centro de Investigaciones Sociales Nicaraguenses (CISNIC) and the Banco Central de Nicaragua. In addition to the two authors of this paper, for the overall project Humberto Belli (Director of CISNIC) and Antonio Ybarra (Head, Division of Social Studies and Infrastructure Banco de Nicaragua) are co-principal investigators. Belli supervised the collection of the survey data for all phases of the project. The authors would like to thank, but not implicate, the funding agencies, our co-principal investigators, and project research associates at the University of Wisconsin. In the last group David Blau, John Flesher, Kathleen Gustafson, Michael Watts and Nancy Williamson merit special acknowledgement.

Section 1: Introduction

For the first two decades of the post-Second World War period the analysis of the economic development process was dominated by focus on the role in growth of aggregate "key factors", such as physical capital, technology, foreign exchange, and human capital. More recently, in part because of the availability of many new empirical studies and in part because of the general acceptance of goals other than growth, the economic development problem has been viewed as much broader and complex than it was in this earlier era. As a result development economists have become more humble. They also have more widely recognized the potential insight to be gained from viewing LDC economic issues within a broader social context. Appreciation has been growing of the need to understand the determinants of a whole set of critical micro behavioral decisions within a given social economic context, as well as how changing that context - as with the passage from traditional through transitional to modern societies - affects those decisions.¹

At the same time there also has been a growing perception that the roles of women in LDC's may be quite distinct from those of men, but are not well understood. Since females comprise about half of the population, understanding their behavior and policy responses is important in formulating development strategies not only in regard to areas of traditional concern, such as fertility, but in a whole gamut of socio-economic interests - from distribution to growth to structural change.²

This paper is one of the outputs of a large multiyear international, interdisciplinary team project. The general purpose of this project is to gain better understanding of the socio-demo-economic role of women in LDC's by analyzing extensive survey data for a particular country, Nicaragua. The role of women is conceptualized as a simultaneous system of micro decisions regarding contraceptive use, fertility, labor force participa-

tion, education, wages, occupational choice, migration, marital status, and health and nutritional status within an environment conditioned by a range of government policies.

Fertility probably has been the most studied aspect of this larger system of micro behavioral relations pertaining to women in developing countries.³ Perhaps the most robust findings of such empirical studies is that one form of investment in human capital, schooling for females, is related inversely to fertility levels (controlling for other variables such as family income and spouse's education).

However other forms of human capital investment in addition to schooling have received ever greater emphasis in recent years. Primarily among these are investments related to health and nutrition status. Of course good health and nutrition states are accepted widely as important goals in themselves. But in addition to their direct impact on welfare, the nature of health and nutrition states may affect significantly the attainment of other important individual and social goals, such as those related to fertility. Nevertheless, with the exception of some recent investigations of "replacement" births in response to infant mortality and of extreme cases of malnutrition, there are very few studies of the empirical impact of health and nutrition on fertility in developing countries. This paucity of studies in substantial part is due to the absence of integrated data sets that permit such explorations.

Our contribution in this study is to use an important new data set to explore the impact of health and nutrition on fertility for women in the developing metropolis of Managua, Nicaragua. We approach the problem by making multivariate regression estimates of this impact on the subset of the overall system of behavioral relations most germane to the determination of the number of surviving children: the number of expected children, contraceptive use, the number of pregnancies per year, and outcomes of such

pregnancies (including pre- and post-natal mortality). A priori the total effect of health and nutrition status on the number of surviving children may reflect the contribution of many opposing partial effects. For example improved health and nutrition status may increase the number of children by improving the efficiency of child care and the possibility of enjoying their presence, but reduce the number of desired children by increasing the opportunity cost of the woman's time due to higher labor market productivity. We attempt to separate out estimates of some of those different, and at times opposing, effects.

There clearly are limitations to our study for conceptual, data and statistical reasons. Our results present some puzzles. Given the dearth of information about the possible impact of important health and nutrition investments on fertility in developing countries, nevertheless, we think that our contribution is a significant one.

We organize our presentation as follows. Section 2 provides some comparative perspective about the economy of Nicaragua. Section 3 describes our data set, with emphasis on the definition and distributions of critical variables for this study and some estimation problems. Section 4 presents the model and the estimates. Section 5 summarizes the results and their implications.

Section 2: General Perspective about Nicaragua

Nicaragua is a Central American Republic with 2.3 million inhabitants (as of mid 1976). Table 1 presents data that helps to place Nicaragua in perspective. For a number of indices relating to the demo-economic and social situation data are included for Nicaragua and the median values for 34 low-income countries, 58 middle-income countries and 19 industrialized countries. These three groups are defined by the World Bank (1978), primarily on the basis of the per capita income estimates (with countries

Table 1: Comparisons between Nicaragua and Medians for 34 Low-Income Countries, 58 Middle-Income Countries, and 19 Industrial Countries.^a

Variables	NICARAGUA			
	34 low-income	58 middle-income	19 industrial	
1. Economic Level and Structure				
1.1 GNP per Capita, 1975 (US\$)	750	150	750	6200
1.2 Energy Consumption per Capita, 1975 (Kgm. Coal Equivalent)	479	52	524	5016
1.3 % Distribution of GDP, 1976				
1.3.1 Agriculture	23	45	21	6
1.3.2 Industry	28	19	32	41
1.3.3 Services	49	39	45	52
1.4 % Distribution of Aggregate Demand, 1976				
1.4.1 Public Consumption	9	13	14	16
1.4.2 Private Consumption	72	81	70	58
1.4.3 Gross Domestic Investment	19	15	24	23
1.4.4 Gross Domestic Savings	19	8	20	24
1.5 % of Exports in Primary Commodities, 1975	83	94	82	24
1.6 % Distribution of Imports, 1975				
1.6.1 Food	9	21	14	11
1.6.2 Fuel	14	10	14	17
1.7 Debt Service in 1976 as % of				
1.7.1 GNP	4.6	1.1	2.0	-
1.7.2 Exports	12.2	7.2	8.0	-
1.8 External Public Debt as % of GNP, 1976	37.8	20.9	17.0	-
1.9 Inflation, % per Year				
1.9.1 1960-1970	1.9	3.1	3.2	4.2
1.9.2 1970-1976	10.8	9.8	12.5	9.3
2. Economic Growth, % per Year				
2.1 GNP per Capita, 1960-1976	2.4	0.9	2.8	3.4
2.2 Energy Production, 1960-1975	20.9	9.4	8.5	3.0
2.3 GDP				
2.3.1 Overall 1960-1970	7.2	3.6	5.7	4.7
1970-1976	5.7	2.9	6.0	3.2
2.3.2 Agriculture 1960-1970	6.7	2.3	3.6	1.5
1970-1976	5.7	1.6	3.2	1.8
2.3.3 Industry 1960-1970	11.0	6.7	7.6	5.7
1970-1976	7.3	4.5	7.2	3.2
2.3.4 Services 1960-1970	5.8	3.6	5.8	4.7
1970-1976	4.8	3.4	6.9	3.5
2.4 Aggregate Demand Aggregates				
2.4.1 Public Consumption 1960-1970	3.6	4.6	6.7	4.8
1970-1976	12.8	2.4	7.2	3.6
2.4.2 Private Consumption 1960-1970	6.8	3.6	5.1	4.3
1970-1976	4.8	2.5	5.4	3.4
2.4.3 Gross Domestic Investment 1960-1970	10.7	5.7	7.4	5.7
1970-1976	6.8	3.1	8.9	0.7
2.4.4 Exports 1960-1970	9.8	3.6	5.2	7.6
1970-1976	5.2	-0.4	3.8	7.8
2.4.5 Imports 1960-1970	10.5	4.6	6.6	8.6
1970-1976	4.5	-1.4	6.3	9.5

Table 1: Comparisons between Nicaragua and Medians for 34 Low-Income Countries, 58 Middle-Income Countries, and 19 Industrial Countries.^a (continued)

Variables	Medians for Country Groups			
	34 low-income	58 middle-income	19 industrial	
3. Structure of Population, 1975				
3.1 % in Urban Areas	48	13	43	76
3.2 % below Age 15	48	44	44	24
3.3 % of Working Age (15-64 years)	49	54	53	64
3.4 % of Labor Force in Agriculture (1970)	51	85	51	11
4. Population and Labor Force Growth, % per Year				
4.1 Total Population 1960-1970	2.9	2.4	2.7	1.0
1970-1975	3.3	2.4	2.7	0.8
4.2 Urban Population 1960-1970	4.1	5.4	4.8	1.9
1970-1975	4.5	5.5	4.5	1.8
4.3 Labor Force 1960-1970	2.6	1.9	2.3	1.0
1970-1975	3.2	2.0	2.7	1.0
5. Demographic Indicators				
5.1 Crude Birth Rates per 1000 people, 1975	46	47	40	16
5.2 Crude Death Rates per 1000 people, 1975	13	20	12	10
5.3 % Change in Crude Birth Rate, 1960-1975	-9.8	-2.1	-9.2	-13.6
5.4 % Change in Crude Death Rate, 1960-1975	-31.6	-21.1	-27.3	0.0
5.5 Total Fertility Rate, 1975	6.9	6.2	6.1	2.3
6. Education				
6.1 Enrollment as % of Age Group, 1975	85	52	94	104 ^b
6.1.1 Primary (Primary, Female)	87	41	91	103 ^b
6.1.2 Secondary	21	8	35	83
6.1.3 Higher Education	6	1	7	22
6.2 Adult Literacy Rate, 1974	57	23	63	99
7. Health Related Indicators				
7.1 Life Expectancy at Birth, 1975	53	44	58	72
7.2 Infant (Aged 0-1) Mortality Rates per 1000, 1975	46	122	46	15
7.3 Population per:				
7.3.1 Physician, 1974	1740	21185	2430	650
7.3.2 Nursing Personnel, 1974	760	6710	1570	230
7.4 % of Population with Access to Safe Water, 1974	46	25	52	

Notes:

^aAll data are from Tables 1-18 in Annex to World Bank (1978).

^bFor countries with universal education the percentages may exceed 100 percent since some pupils may be below or above the official primary school age.

with populations under one million excluded). Nicaragua is in the middle-income group.

The first two sets of variables in this table refer to economic level, growth, and structure. In 1975 Nicaragua's GNP per capita of \$750 ranked at the median level for the middle income countries - and thereby far above that for the low income countries and far below that for the industrial countries (variable 1.1). Over the 1960-1976 period Nicaraguan GNP per capita grew at an average annual rate of 2.4 percent, well above the rate for most low-income countries, but somewhat below the median of 2.8 percent for all middle-income countries and further below the median of 3.4 percent for the industrialized countries (variable 2.1). However the decomposition of this figure into the growth rates of product and of population for the 1960's and the 1970's is instructive (variables 2.3.1 and 4.1). The average annual growth rate of Nicaragua GDP in the 1960's of 7.2 percent ranked substantially higher than the medians for the three country groups of 3.6, 5.7, and 4.7 respectively. For 1970-1976, in part because of the devastating 1972 Managuan earthquake, (in which approximately 10,000 persons died and the main commercial center of the city was destroyed) the Nicaraguan rate dropped to 5.7 percent, slightly below the median of 6.0 percent for the middle-income group, but still significantly above the 2.9 and 3.2 median rates for the low-income and industrialized groups.⁴ Nicaraguan growth in product has been relatively high, although somewhat lower in the 1970's than in the 1960's partially due to the earthquake. However, the growth rates in Nicaraguan population of 2.9 percent for the 1960's and 3.3 percent for 1970-1976 also are significantly above the medians for all three country groups - particularly in the 1970's. For 1970-1976, in fact, only four of the countries in the three groups (i.e., Kenya, Rhodesia, Ecuador, Mexico) had higher population growth. The relatively high population growth rate offset the relatively high product growth rate so that the per capita product growth rate is somewhat below the median for all three country groups combined.

7.

In regard to the structure of the economy, on the production side in 1976 Nicaragua was somewhat more agricultural and service-oriented and somewhat less industrial than the median middle-income countries (variables 1.3.1-3). Moreover during 1960-1976 both agriculture and industry grew quite rapidly in comparison to the median experience of all three country groups, and services grew more rapidly than the medians for the low-income and industrialized groups (variables 2.3.2-4). The relatively strong performance in agriculture also is reflected in the relatively limited dependence on imported food and the slightly above median dependence on primary exports (variables 1.5 and 1.6.1).

On the demand side in 1976, Nicaragua had somewhat lower consumption (with a slightly higher private share offset by a significantly lower public share) and gross domestic investment shares than the medians for the middle-income group (variables 1.4.1-1.4.3). These facts and the national income identity imply that Nicaragua had a relatively high surplus on its international trade account. Nevertheless debt and debt service in 1976 both were quite high in comparison to the medians of the three country groups (variables 1.7.1-2, 1.8). This possible paradox is explained largely by the rapid expansion of foreign debt in the post-earthquake period. The disequilibria resulting from the earthquake also were associated with a worsening of the relative inflation in Nicaragua from a position far below the median of the three country groups for the 1960's to a ranking still below the medians of middle-income countries, but above the medians of the other two country groups in the 1970's (variables 1.9.1-2). The earthquake and responses to it accounts for some of the other shifts in the composition of Nicaraguan aggregate demand between 1960-1970 and 1970-1976: the increase from relatively low to relatively high growth rates for public consumption, and the decreases from relatively high to relatively low growth rates for private consumption and gross domestic investment (variables 2.4.1-5). The latter drop exacerbates

8

the loss of capital stock in the earthquake itself, with negative implications for subsequent growth in product.

The third, fourth and fifth sets of variables in Table 1 refer to the level and change of population and demographic variables. The high population growth rates, especially in the 1970's, already have been noted above (variable 4.1). This reflects a high crude birth rate and a high total fertility rate for a medium-income country, as well as greater relative declines in recent decades in the crude death rate as compared to the crude birth rate (variables 5.1-5). Associated with the high population growth rate is a high labor force growth rate in comparison with other countries (variable 4.3).⁵ However the labor force has not grown as quickly as has population. The result is a relatively large dependency ratio, as reflected in the relatively high proportion of population under 15 years of age and in the relatively low proportion of the population of working age in 1975 (variables 3.2-3). In fact among the 111 countries in the three groups none have a higher proportion of their population under 15 years of age and only Jamaica has a smaller percentage of the population of working age! Also noteworthy is a relatively highly urbanized population for a middle-income country despite median or below median recent rates of growth of the urban population and a relatively high proportion of the working force in agriculture in 1970 (variables 3.1, 3.4, 4.2).

The sixth and seventh sets of variables in Table 1 refer to human capital investment. In regard to all levels of formal education and adult literacy in the mid 1970's, Nicaragua ranked below the medians for the middle-income countries (although far above the medians for low-income countries, variables 6.1.1-3, 6.2). In the only case in which a distinction is made between the sexes, Nicaragua is closer (although still below the median for the middle-income groups) for females than for all students. In regard to health services Nicaragua ranks better than the median middle-income country with regard to

the availability of doctors and nurses, but worse in regard to the access to safe water (variables 7.3.1-2, 7.4). In regard to the indicators of health states in 1975, the Nicaraguan life expectancy at birth of 53 years was five years below the median for all middle-income countries, and the mortality rate for infants aged 0-1 year of 46 per 1000 was at the median for the same group of countries (variables 7.1 and 7.2).⁶

In summary, Nicaragua is a small, open developing economy which in many respects, including per capita income levels, is near the median of the World Bank (1978) middle-income group. The structure of production is somewhat oriented towards agriculture and services, but the population is fairly urban nevertheless. The extent of public activity is relatively limited, although an upward shift apparently occurred in response to the 1972 earthquake. Also in part due to responses to the earthquake, in the mid 1970's foreign debts and inflation both increased significantly (albeit the latter from very low levels). The extent of human capital investments is mixed, with less than median middle-income country investments in education, and in the availability of safe water, but more than median densities of medical professionals. As a result the indices of returns on such investments - such as adult literacy rates, life expectancy at birth, and infant mortality - tend to be at median or worse than median levels for middle-income countries.

Perhaps the most striking features, however, are related to the central interest of this paper: very high and increasing population growth rates and an extremely high dependency ratio. These features, complicated by the impact of the earthquake of 1972 and the civil unrest of the late 1970's, make the outlook bleak for the attainment of many long-run economic development goals. They also make all the more valuable better understanding of the interactions among human capital investments and population growth, the topic on which the present paper aims to shed light.

Section 3: Data Base

The data base for this study is a survey that we conducted in 1977 of 1294 women in Managua, Nicaragua.⁷ Managua is the capital and major metropolitan center of the country, with about 20 percent of the nation's population. The households of the respondents were selected randomly, on the basis of areal photographs.⁸ Within a household, the woman interviewed was selected randomly from all women residents in that household within the age group 15-44, excluding nonworking students.

The survey instrument was developed after studying related questionnaires designed for similar purposes for other LDC's and then going through an iterative process of training interviewers, testing the instrument, and modifying it accordingly. The final questionnaire attempted to acquire current and retrospective information on a wide range of interrelated socio-economic-demographic activities of the respondent, her family, and her and her spouses' parents and on the impact of various policies on their activities. The questions can be divided into four general groups: 1) Demographic and contraceptive characteristics (e.g., actual and desired number of children and their characteristics, pregnancy and child mortality experience, knowledge, use, time and financial costs of contraceptives); 2) Human capital related variables such as years of schooling, training, health and nutrition status of family and use of related facilities (e.g., record of illnesses, current status, time and financial costs of preventive and curative medicine); 3) Economic activity of respondent and other members of household (e.g., wages, hours, labor force participation, occupation, non-wage benefits, non-market activities, employment, job search activity, nonearned sources of income, expenditures, assets, quality of housing and sanitation); and 4) Other background variables for family and parents of respondent and of companion (e.g., marital and migratory status, education and training, composition of living unit, attitudes, intensity of religious observances). We now consider

71

the definitions and the distributions⁹ of the major variables in each of these groups, with emphasis on those that play important roles in the analysis below of the impact of health and nutrition on the number of surviving children.

1) Demographic and Contraceptive Characteristics: Below we focus on the number of pregnancies since the December 1972 earthquake (about 4 1/2 years before the interview) and the outcome of those pregnancies. The earthquake provides a useful reference point for gathering retrospective data since it is a very well known event even among respondents who are not literate, nor very conscious of the passage of calendar time. The immediate post-earthquake period, however, may have been a time of unusual dislocation for some of the respondents. Below we speculate on possible effects on various variables of using this period.

Our first dependent variable is pregnancies per year since the earthquake (or the number of years since the respondent was first accompanied by a male if that accompaniment occurred after the earthquake). Table 2 gives the distribution of this variable. A priori the dislocations caused by the earthquake might be thought to have reduced fertility in the subsequent period. Planned replacement births for children killed in the earthquake, however, would work in the opposite direction. Total crude fertility in Nicaragua in this period was very high by international standards, as is emphasized in Section 2 above.

Our next group of dependent variables refers to three mutually exclusive infant mortality outcomes per pregnancy for each respondent and the sum of the three: abortion per pregnancy, involuntary prenatal mortality per pregnancy, post-natal infant mortality per pregnancy, and total pre- or post-natal infant mortality per pregnancy. Nearly 20 percent of all pregnancies during this period resulted in pre- or post-natal infant mortality. Table 3 gives the percentage distributions. This table states that 6.3% of the respondents had 2 of their pregnancies since the earthquake result in pre- or post-natal deaths, had half, 3.6% had one third, etc. We expect that totals are underreported because

Table 2: Sample Distributions of Pregnancies per Year Since Earthquake

<u>Pregnancies per Year</u> (1)	<u>Percentage of Sample</u> (2)
0	33 %
$0 \leq$ and < 0.4	29
$0.4 \leq$ and < 0.6	20
≥ 0.6	7
<hr/> never accompanied	<hr/> 9

Table 3: Sample Percentage Distributions of Respondents by Mortality Outcomes per Pregnancy ^{a/}

Proportions per Pregnancies	Abortion per Pregnancy	Involuntary Prenatal Infant Mortality per Pregnancy	Postnatal Infant Mortality per Pregnancy	Total Pre- and Post Natal Infant Mortality per Pregnancy
(1)	(2)	(3)	(4)	(5)
0	97.3%	89.9%	92.2%	80.6%
0.20	0.1	0.1	0.0	0.0
0.25	0.0	0.7	0.1	0.6
0.33	1.0	1.8	2.2	3.6
0.40	0.0	0.1	0.1	0.4
0.50	1.1	4.1	2.9	7.1
0.67	0.3	0.1	0.1	1.2
1.00	0.3	3.2	2.3	6.3

^{a/} For the 731 women who had a pregnancy during the period between the earthquake and the survey.

the familiar tendency to underreport infant deaths (especially pre-natal ones) in retrospective surveys and because for births close to the survey the impact of a fairly high infant mortality period after the time of the survey is not included. Note that if the latter bias is not too large, the quite high Nicaraguan infant mortality mentioned in Section 2 is probably accompanied by even higher pre-natal pregnancy termination rates. Because of the limited social acceptance of abortions, they probably are particularly underreported, or perhaps misreported as involuntary mortalities. Because of the last possibility, reinforced by the small number of cases in any of the three categories in comparison to the number of survivors, we combine across categories for the multivariate regression analysis below.

An important determinant of fertility behavior is posited to be the gap between the total desired number of children (taking into account the current number of living children)¹⁰ and the current number of living children. For most purposes of this study, however, it is desirable to adjust this difference for the post-earthquake net addition of surviving children to obtain the difference between the currently stated desired number of children and the number existing 5 years earlier at the time of the earthquake.¹¹ This calculation assumes that the number of desired children remained constant over this quinquennial.¹² Table 4 presents the percentage distributions of the sample respondents for each of these variables and for answers to a question inquiring about the ideal number of children for a Nicaraguan family. These variables imply an average desired family size (given the number of living children at the time of the interviews) of 3.7 children in comparison to an average of 2.8 living children at the time of the interview and an ideal Nicaraguan family size of 3.0 children. The average gap between the desired and actual number of children immediately after the earthquake was 1.6. An average of 0.7 children of this gap was closed between the earthquake and the

13

Table 4: Percentage Distributions of Respondents by Number of Live Children, Desired Own Family Size, Ideal Number of Children per Nicaraguan Family and Related Variables.

Number of Children	Number of Live Children	Desired Number of Children	Gap Between Desired and Live Number of Children	Gap Between Desired and Live Number of Children 5 Years Ago	Ideal Number of Children Nicaraguan Family
(1)	(2)	(3)	(4)	(5)	(6)
0	16%	1%	53%	23%	0.3%
1	17	5	19	24	1
2	20	21	15	27	34
3	16	25	4	14	38
4	10	17	2	5	19
5	8	10	0.4	1	2
6	5	7	0.2	0.4	3
7	3	3	0.1	0.1	1
8	2	2		0.1	
9	1	1			
10-15	1	1			
no answer	0.1	6	6	6	1

14

interviews almost five years later by the pregnancies and pre- and post-natal infant mortalities discussed above. Of course for all of these distributions there is a fair amount of variance around the means, much more so for the number of living children and desired children than for the ideal number of children in a Nicaraguan family.

Contraceptive practices provide a means of regulating the probability of conception and thus the rate at which the gap (if any) between desired and actual number of children is closed or the probability that the desired number of children is overshot. Table 5 summarizes the distributions of the respondent regarding contraceptive knowledge, use (current and past) and attitudes of male companions. About 15 percent of the respondents claim no knowledge of contraceptive methods that involve outside agents, whether purchased or provided through medical organizations or family planning clinics¹³; and 44 percent claim never to have used contraceptives. A possible factor influencing the lack of use of such contraceptive practices for 12 percent of the respondents may be the stated active opposition of male companions. There is some evidence that the impact of opposition from male companions is greater among previous contraceptive users. Among the 56 percent who have used contraceptives (33 percent at the time of the interview), pills dominate, with IUD's, diaphragms and sterilization significantly more important than other alternatives. We originally intended to use contraceptive efficiency estimates as a cardinal measure of contraception. But the distribution of types of contraceptives used is so concentrated on highly efficient methods that the correlation between a 0-1 variable for never used versus have used and the contraceptive efficiency representation is 0.999. Therefore, with this sample, nothing is gained by introducing the notion of contraceptive efficiency.

2) Human Capital Related Variables - Education, Health and Nutrition:

The primary emphasis of this paper is to investigate to what extent the human capital variables in this second group have an impact on the number of surviving children in the first group.

15

Table 5: Percentage Distributions Relating to Contraceptive Knowledge, Use, and Attitudes.

Contraceptive Knowledge		Contraceptive Use		Companion's Attitude About Contraceptive Use		Contraceptive Type Used		Contraceptive Efficiency ^a
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
None	14%	Current	33%	Against	12%	Pill	32%	99.6%
Traditional only	1	Not current, past	21	Not against	86	IUD, Diaphragm	9	96.5
Methods involving outside agents	85	Never	44	No Answer	2	Sterilization	6	100.0
						Shots	3	99.6
						Condoms	2	94.3
						Rhythm	1	84.0
						Foam, Jelly	1	91.9
Other	1	83.2						
						None	44	0
						No Answer	1	

^aContraceptive efficiency based on United States' experience.. See Michael and Willis (1976)

In previous fertility studies the most emphasized human capital related variable has been women's years of schooling. Table 6 gives the percentage distributions of years of schooling for the respondents, companions and parents of both. The mean years of schooling for women is 4.9. While only 11 percent had no education, over 70 percent had less than 7 years of elementary education, and only 8 percent had as much as a high school education. There is no bunching at high school graduation as in the United States. The mean years of schooling for the other columns are 6.3 for male companions, 4.0 for her father, 3.1 for her mother, 4.2 for his father, and 3.4 for his mother (a pattern that merely may reflect selectivity bias). Within couples there is a systematic tendency for the male to have more education than the female. Across generations for both males and females, years of schooling tends to increase substantially. In comparison with the average of her own parents, for example, only 15 percent of the women respondents have less education. Across generations, however, the average gap between male and female members of couples increases from 0.8 or 0.9 to 1.4 years of schooling. Part, but only part of this increase, may reflect the fact that the parents of the male companion tend to have more education than those of the female, which may result in generally higher education (independent of sex) for him and his siblings than for her and her siblings.¹⁴ Nevertheless much of the increasing schooling gap between the sexes seems to reflect larger differentiation by sex even while overall schooling rises.

Although we include years of schooling in our model, in this paper we are more interested in other human capital related variables and, in particular, the impact of health and nutrition status on the number of surviving children. No single satisfactory measure of this status exists. Therefore we work with a number of characteristics that can be divided into three groups: 1) medical attention, 2) nonmedical inputs in the production of good health and nutrition status, and 3) illnesses, deaths and low birthweights as indices of

11

Table 6: Percentage DISTRIBUTIONS OF YEARS OF SCHOOLING

Years of Schooling (1)	Woman (2)	Male Companion (3)	Woman's Parents ^a		Companion's Parents	
			Father (4)	Mother (5)	Father (6)	Mother (7)
None	11%	5%	11%	20%	5%	8%
1st-3rd Grade	23	10	8	16	3	5
4th-6th Grade	37	25	17	25	7	8
Some High School	19	16	3	3	2	1
Completed High School	4	6	2	2	1	1
Started University	3	3	0.1	0.2	0	0.2
Completed University	1	3	2	0.2	1	0.4
Other Post-Elementary Education	1	2	0.3	0.1	1	0.3
No Answer	1	30	57	33	82	77

^aOr male and female guardian or other raiser if not raised by parents.

deficiencies in health and nutrition status.¹⁵

Table 7 summarizes the data that we use for medical attention. For the last successful pregnancy (i.e., that which resulted in a live birth), 55 percent of the women pregnant since the earthquake began to receive medical attention in the first trimester, 9 percent in the second, 5 percent in the third, and 29 percent did not receive pre-partum medical attention. Among the same group of women, 73 percent gave birth with a doctor present or in a hospital, 18 percent with a nurse or midwife present, and less than 9 percent with no medical attention. The average number of vaccinations for the oldest child under five years of age is 2.3 out of a possible set of six (i.e., polio, DPT, measles, typhoid, rubella, and tuberculosis), with three-quarters of these children receiving 1 to 3 such vaccinations.¹⁶

Table 8 presents the distributions that we use for nonmedical inputs in the production of health and nutrition status. The first two distributions refer to breastfeeding which is reputed to provide better nutrition and immunization than bottlefeeding, particularly if water supplies are not safe. Within our sample 63 percent of all women (or 75 percent of those who have living children) breastfed their children. For those who breastfed their children, the average duration was over 8 months.

The next distributions refer to the availability of sewage and bathrooms. Only 4 and 2 percent of the respondents, respectively, do not have sewage or bathrooms, although 29 percent use public sewage systems.

The last group of distributions refers to the percentage satisfaction of food important nutrient requirements in the week before the interview. These requirements are for women in childbearing ages. A number of problems arise in regard to these variables: (i) True nutrient requirements vary depending on weight, age, activity, and health status;¹⁷ (ii) Our estimates assume standard size portions; (iii) Our survey was conducted at a time when food supplies probably were somewhat available because of the seasonal climatic fluctuations; (iv) Alternative sources

19

Table 7: Percentage Distributions of Medical Attention Received.

Trimester Medical Attention Began in Last Pregnancy		Medical Attention at Birth		Number of Vaccination of Oldest Child Under 5 Years of Age	
(1)	(2)	(3)	(4)	(5)	(6)
1st Trimester	31%	Doctor, Hospital	40%	0	4%
2nd Trimester	5	Nurse, Midwife	10	1	13
				2	15
3rd Trimester	3	No Medical Attention	3	3	18
				4	7
No Medical Attention	16	No Answer	2	5	2
No Pregnancy Since Earthquake	45	No Pregnancy Since Earthquake	45	6	1
				No Answer	3
				No Child Under 5	38

Table 8: Percentage Distributions of Non-Medical Health and Nutrition Inputs.

Children Breastfed ^a	Length Breastfed in Months ^a		Sewage and Bathroom	Percentage Attained of Weekly Nutrient Requirements ^b								
	(1)	(2)		(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
			0	20%								
es	63 %	0 to 3	14	Private Sewage	55 %	< 30	2 %	0%	3%	2%		
o	20	3 to 6	18	Public Sewage	29	30 to 40-	6	0	9	3		
o Children	16	6 to 12	17	No Sewage	4	40 to 50-	18	0.2	28	4		
to answer	2	12 to 24	11					50 to 60-	36	1	37	4
		> 24	2	Bathroom	98	60 to 70-	33	1	22	5		
		No children	16	No Bathroom	2	70 to 80-	5	2	1	7		
		No answer	2					80 to 90-	0.4	3	0.1	8
						90 to 100-	0.1	4	0	7		
						≥ 100	0	89	0	60		

Average for all children born since earthquake.

Based on adult women requirements in Adams and Richardson (1975), WHO (1974), and INCAP (1973).

2

- 135 -

widely different nutrient requirements for some nutrients (e.g., vitamin A standards differing by a factor of 5!).¹⁸ Nevertheless, they seem useful to represent, even if somewhat crudely, the relative nutrition status of our respondents. The median respondents satisfies 53 percent of the caloric requirements, 56 percent of the iron requirements, and all of the protein and vitamin A requirements. The basic Nicaraguan diet depends heavily on rice, beans and tortillas. Therefore, the relative satisfaction of protein requirements may not be surprising. The fairly substantial iron deficiency is consistent with another independent assessment of nutrition in Nicaragua.¹⁹ However the extent of the implied caloric deficiency seems surprising given common impressions of there being a fairly satisfactory nutritional situation there in comparison to many other developing areas. We suspect that caloric deficiencies are overstated in absolute terms. But nevertheless they may serve well as relative indices of caloric deficiencies in our regression estimates below. Finally, we should note that these nutritional indices are fairly highly associated. The simple correlation coefficient is 0.89 between the two indices that are used primarily in the model of the next section, that for calories and that for proteins. This multicollinearity causes some problems of interpretation of the multivariate regression estimates.

Table 9 summarizes the percentage distributions of low birthweights, child deaths and women's illnesses that we use as indices of inadequate health and nutritional status. The respondent-characterized low birthweights are few in number, which suggests either that low standards for "normal" are used or that respondents are reluctant to characterize the birthweights of their own children as below normal. Thus, this variable may be of limited use. The percentage of children who subsequently died is nonzero for approximately one quarter of the respondents.²⁰ A priori such deaths may cause replacement pregnancies, but also the costs incurred may reduce the number of desired children.

The remaining variables in this table refer to illnesses of the respondents

Table 9: Percentage Distributions of Low Birthweight, Child Deaths, and of Women's Illnesses

Percentage of Low Birthweight Reported ^a	Percentage of Live Births Subsequently Died ^b	Number of Days Ill that Caused Missed Work or Comparable Activities in past 150 days		Disease Category	Percentage Respondents Reporting		
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
0	91%	0	72.5%	0	67%	Pulmonary Disease	22%
25	0.1	0 to 20-	4.8	1-3	10	Diseases Preventible Outside of Medical System	38
33	1.1	20 to 40-	15.5	4-7	9	Diseases Preventible with Medical Care	42
50	2.9	40 to 60-	4.8	8-14	4	Disease for which Therapeutic Medical Treatment Possible	30
67	0.5	60 to 80-	1.2	15-30	5		
100	4.4	80 to 100-	1.2	31-45	1		
				46-60	1		
				> 60	2		

^aAmong 731 women pregnant since earthquake.

^bAmong 1089 women with live children.

23

In regard to recent experience, about one third of the respondents report having had illnesses in the past 150 days that caused them to miss work or comparable activities. The average number of days missed due to illness by all respondents was almost 6 days. To represent their longer-run health status we have classified the respondents' medical history into four categories: (i) 22 percent report having had pulmonary diseases; (ii) 38 percent report having had diseases preventable by measures (such as sanitation) outside of the medical system (e.g., TB, intestinal parasites); (iii) 42 percent report having had diseases preventable by medical care (e.g., diphtheria, tetanus); and (iv) 30 percent report diseases that can be treated only therapeutically by the medical professional (e.g., typhoid, blood pressure). The use of these categories allows us to summarize the medical histories in a manageable number of categories the primarily treatment of which implies different sets of policies in regard to emphasis on sanitation, medical care and nutrition. The apparently high incidences of these diseases probably is related to the relatively short expected life of Nicaraguans in comparison to residents of other middle-income countries that is noted in the previous section.

3) Economic Dimensions: Although the impact of economic activity on the number of surviving children is not of primary interest in this study, some representation of their possible effects is desirable to lessen missing variable biases in our estimates of the coefficients of other variables and to represent channels through which health and nutrition variables indirectly may affect the number of surviving children. Table 10 summarizes the percentage distribution of respondents by aspects of her (and, in some cases, her companion's) labor force situation and earnings or income. At the time of the survey 47 percent of the respondents were in the labor force²¹, although at some time 79 percent had been. Of those currently in the labor force 38 percent were in the formal sector and 32 percent were self-employed²². For those women currently working the mean income was 374 c\$/2 weeks (~\$27/week), as

24

Table 10: Percentage Distributions of Respondents by Economic Activity and Income

General Current Labor Force Category	C\$/2 weeks	Income or Earnings			Other Income	Total Income	Occupational Prestige ^a			Years of Work Experience		
		Respondent's Earnings	Companion's Earnings				Respondent	Companion	Respondent	Comp.		
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
Informal 29%		0	53%	25%	90%	3%	0-20	12%	6%	0	17%	
Formal 18		0-100	5	3	2	3	21-30	43	19	1-5	16	
Not in Labor Force 53		101-200	15	4	2	10	31-40	26	13	6-10	15	
Self-Employed 16		201-400	12	17	2	16	41-50	11	22	11-15	16	
		401-600	5	16	1	15	51-60	4	7	16-20	11	
		601-1000	4	14	1	17	61-70	1	5	20-30	18	
		1001-1500	2	7	0.2	11	No data	2	29	>30	3	
		1501-2000	0.3	2	0.2	4				No data	4	
		2001-3000	0.3	2	0.0	3						
		> 3001	0.3	2	0.2	4						
		No answer	3	8	1	12						

^a By Treiman (1977) index.

compared with a mean income for male companions of 769 c\$/2 weeks (\$55/week). In part this differential reflects greater education and experience and longer work weeks for males than for females (columns 2 and 3 in Table 7 and columns 12 and 13 in Table 10), but the returns to education and to experience would have to be very high for these to be the only explanations. The distribution of occupational prestige, which often is considered a good proxy for permanent earnings, shows a similar pattern with a median value of 26 for women and of 38 for men. Finally, although men have a higher distribution of years of work experience than do women, that 79 percent of the women do have some work experience and that the median experience for women in the sample is 10 years suggests that Managuan women are fairly active in the labor force.

4) Other Background Variables: Table 11 summarizes the percentage distributions for respondents in regard to other background variables. Women were selected randomly into the sample out of the population of females aged 15-45 years, excluding nonworking students. Because of the shape of the age pyramid in a situation in which population has been growing rapidly, there are fewer women in each older quintile above 20-24. Because of the exclusion of non-working students, however, there are fewer women in the 15-19 year old quintile than in any other except for that for 40-44 years old. The median age at which respondents in the sample had their first male companion was 18. The median age of the women at the time of the survey was 28, 6 years less than the median age of their companions.

At that time 71 percent of the women had male companions: 33 percent in common-law unions, 16 percent in civil marriages, and 22 percent in religious and civil unions. That common-law marriages were almost as common as civil and religious marriages together is somewhat striking for a comparative traditional largely Catholic society. Those without companions included 9 percent who never had one and 19 percent who were widowed, separated or divorced. The median number of years per union is 8 (including current unions).

26

Age	Age When First with a Companion	Current Age		Marital Status at Time of Interview		Years per Union		Religion		Number of Monthly Church Attendance		Number of Siblings	
		Woman	Companion	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
<14	8%	0%	0%									0	9%
15-19	55	11	1	Single	9%	0	9%	None	4%	0	24%	1	9
20-24	21	25	12	Common Law	33	1-5	27	Catholic	84	0.5	31	2	11
25-29	3	21	14	Civil Marriage Only	16	6-10	28	Evangelist, Baptist, Nazarene	10	1 to 2	12	3	12
30-34	0.5	17	13	Religious Marriage	22	11-15	16			4	24	4	13
35-39	0.2	14	12	Separated, Widowed, Divorced	19	16-20	9	Witness, Mormon, Other	1	8	9	5	12
40-44		9	8			≥ 21	8	No answer	0.3	30	0.2	6	8
≥ 45		2	10							No answer	0.5	7	9
No data	11	0	30									8	7
												10	2
												≥ 11	3

Migratory Status

(15)	(16)
Always Lived in Managua	43%
Mostly Lived in Managua	23
Mostly Lived Elsewhere	35-

Three other background characteristics of interest pertain to religious affiliation and intensity, the number of siblings of the women respondents, and their migratory status.

Not surprisingly, most of the respondents (84 percent) are Catholics. Another 10 percent fall into the Evangelic, Baptist and Nazarene fundamentalist protestant groups that have been expanding relatively rapidly recently. Only 4 percent identified themselves as not belonging to an organized religious group. However a quarter state that they normally do not attend church, and over half do not attend more than once every couple of months. If frequent church attendance is a good index of religious intensity, thus, a significant proportion of the sample is only nominally religious.

In regard to the number of siblings, the range is from 0 to 16, with a mean of 4.5. This implies an average number of 5.5 children in the families in which they grew up, in contrast to their average desired number of 3.7 and their average ideal Nicaraguan size of 3.0 (Table 4).²³

Finally, in regard to migratory status, 63 percent of the women have lived in Managua all of their life. This leaves a large migrant group. However much of this migration occurred when the respondents were relatively young, so two-thirds of the sample have lived all or most of their lives in Managua. Nevertheless that leaves a fairly large group, about a third of the sample, which has lived more outside of Managua than in this city.

Missing Values of Variables: As is indicated in the ten tables in this section, for a number of important variables there are missing observations. Within the multivariate regression framework of the next section, this causes a definite estimation problem. The best procedure depends upon the cause of the missing values. If they are missing in a way that is systematically

28

associated with the disturbance term in the relation being estimated, we have a standard selectivity problem.²⁴ In subsequent work we intend to explore this possibility.

If the values are missing randomly with regard to the disturbance term in the relation being estimated, a number of alternative procedures have been followed:²⁵ (i) Estimate the relationships using only those observations for which data are complete; (ii) Substitute the means of variables for their respective missing values; (iii) Use some instrumental variable estimates to replace the missing values; and (iv) Use all available observations for each pair of variables to calculate the cross-product matrix. The first of these may not use a lot of the existing information, may require different subsamples for every alternative specification, and may result in very few observations. Hester (1976) has conducted Monte Carlo experiments and concludes that the last method probably is preferable among the last three alternatives if the constructed cross-products matrix can be inverted. But a critical assumption in his Monte Carlo experiments is that the instruments are not very highly correlated with the variables that have missing values. If they are very highly correlated (in the limit, perfectly so) intuitively it would seem that the instrumental variable approach would dominate.

We are experimenting with alternative approaches to dealing with these missing values of some observations. We intend to summarize these experiments in a subsequent paper. In this paper we present only results that use the first method in the previous paragraph. For the relationships of interest it leaves us a reasonable number of degrees of freedom.

Section 4: Model and Estimates

A priori, human capital investments may have a myriad of effects on the number of surviving children. Some of these may be mutually supporting, other may be partially offsetting. Some of them may be direct, others may work indirectly through changing opportunity costs in terms of women's market wages

etc. Perhaps the most robust result of studies of fertility in developing countries is that human capital investment in women's education reduces fertility by increasing opportunity costs.

As is noted above in this study we explore the impact on fertility in developing countries of human capital related investments in health and nutrition. Although there have been very large increases in such investments in recent years, very little systematic work has been undertaken in analyzing their impact on fertility. We hope to contribute to the understanding of possible mutually supporting and offsetting, direct and indirect effects.

Our empirical work uses the new sample of 1294 Managuan women that was designed partially for this study and that is discussed extensively in the previous section. We concentrate on the fertility history of these women in the 4 1/2 year period between the Manguan earthquake in December 1972 and our survey in April-June 1977. We start with the definition that the number of surviving children in mid 1977 equals the number of live children immediately after the earthquake plus the number of pregnancies since minus the number of pre-natal and post-natal child deaths. In subsection 4.1 we concentrate on the determinants of the variables in this identity and the direct impact of health and nutrition status therein. In subsection 4.2 we explore possible indirect effects of health and nutrition on the number of surviving children through possibly important intermediary variables such as the number of desired children, contraceptive use, women's earnings and other characteristics of women's economic activity.

In this study we do not adopt the strategy of rigidly deriving behavioral relations from maximization of some given utility function subject to time and market constraints. We do not do so for at least four reasons: 1) This is a very exploratory effort regarding the nature of the possible impact of health and nutrition human-capital investments on fertility. 2) The multiple

- 12 -

and complex dimensions of health and nutrition status are not satisfactorily represented by one of a few indices. 3) The rigorous neoclassical utility maximizing approach is most suited for exploring the determinants of lifetime fertility, without much insight into dynamics or timing. But our interest is in the determination of surviving children within a specific interval (late 1972 to mid 1977), that relates to timing decisions in addition to life target levels of children. 4) For the strict utility maximizing approach to lead to much insight regarding specific functional forms much more structure has to be imposed on the underlying relations than we think would be desirable.

For the same reasons we do not rigorously build on the literature concerned with utility maximization given endogenous preferences as in the work of Easterlin, Pollak and Wachter (1976). An additional reason is that, at this point, we can not incorporate many of the intergenerational variables emphasized in this part of the literature because of missing values that may reflect selection bias.²⁶

Instead, we attempt to incorporate the major insights of the previous literature in so-far-as our data and imagination permit us within a simple and eclectic framework. We use simple linear functional forms without interaction terms. In a similar vein and for similar reasons we use ordinary least squares estimation techniques for our multivariate regressions. At this stage the ease and the robustness of such an approach seems to us to outweigh other considerations. Let us now turn to the factors underlying the modeling of the individual relations and to our discussion of our estimates of them.

Subsection 4.1: Variables in Identity for Surviving Children

We now work through the identity for surviving children mentioned above. Table 12 gives estimates of the relations of interest. For clarity of exposition the right-hand side variables in this table are presented in the same order and in the same four major groups (and subgroups) as in Section

Table 12: Multivariate Regression Estimates of Relations Determining Number of Surviving Children, Desired Children, and Contraceptive Use for Women in Managua, 1972-1977

32

Independent Variable	1. Demographic and Contraceptive Behavior			2. Human Capital Related Variables							Birthweight, Low Birthweight ^b	Child Deaths, Proportion of Live Births Later Died	Women Ill, Illness Preventable Outside of Medical System	Illness Preventable with Medical Care
	Desired Live Children (after earthquake)	Contraceptive Use ^h Knowledge ^g Comprehension ^h Against	Education	Health and Nutrition			Non-Medical Inputs							
				Early in Pregnancy ^c	At Birth ^b Doctor	Vaccinations per Child	Months Breast-fed	No Bath ^b	% of Requirements					
(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	
Pregnancies per Year	.09 (16.7)	.04 (3.2)								.05 (1.0)		.13 (3.8)	-.04 (3.4)	.02 (2.0)
	.09 (16.8)	.04 (3.0)								.38 (3.2)	-.10 (3.2)		-.04 (3.5)	.03 (2.3)
	.07 (8.8)	.04 ^f (1.9)	.003 (0.8)							.43 (2.6)	-.11 (2.5)	.06 (1.1)	-.04 (2.1)	.02 (1.1)
Infant Mortality per Pregnancy ⁴	-.03 (3.1)	-.04 (1.9)	-.008 (2.4)	.01 (2.1)					-.07 (1.1)	-.12 (1.3)			-.02 (1.0)	.01 (0.6)
	-.03 (3.1)	-.03 (1.7)	-.006 (1.9)						-.07 (1.1)		-.06 (1.2)			
Mortality per Pregnancy ⁶	-.001 (0.3)	.01 1.3	-.000 (0.2)						-.01 (0.4)	.04 (0.8)	-.02 (1.3)		-.001 (0.2)	.003 (0.5)
Post-Natal Mortality per Pregnancy ⁷	-.03 (4.2)	-.06 (3.5)	-.004 (1.2)	.02 (2.4)	-.04 (1.1)	-.02 (3.1)	-.003 (2.1)	-.06 (1.2)	-.09 (1.0)		-.04 (1.1)		-.01 (0.6)	.001 (0.1)
Desired Number of Children ⁸		.18 ^g (1.1)	-.07 (3.6)							3.00 (2.7)	-1.05 (3.5)	-1.15 (3.7)	-.15 (1.3)	.15 (1.5)
Contraceptive Use ⁹	-.09 ^h (5.0)		.02 (3.7)							.03 (0.2)			.04 (1.1)	.05 (1.7)
	-.03 (2.0)	-.11 ^j (2.4)	.02 (3.3)							.05 (0.3)		-.14 (1.5)	.01 (0.4)	.06 (1.9)
Age & Education here variable described	4-5	5-4	6-2	7-2	7-4	7-6	8-4	8-6	8-8	8-9	9-2	9-4	9-8	9-

25

Linear regression with medical care	3. Economic Dimensions					4. Other Background Variables							Constant	R ² Number of Observations ^a
	Informal ^h Sector	Formal ^b Sector	Earnings ^d	Other Income ^d	Occupational ^g Prestige	Age	Marital Status Common Law ⁱ	Civil ^h Only	Religious ^b	Years per Union	Always lived in Managua	Number of Siblings		
(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)	(25)	(26)	(27)	(28)	(29)	(30)
-.002 (0.1)			-.02 (1.5)		.20 (0.3)	-.001 (0.9)	.04 (2.6)		.02 (1.1)	-.003 (2.0)			.07 (1.4)	.37 993
.001 (0.0)			-.02 (1.4)		.21 (0.4)	-.005 (2.7)	.05 (3.0)		.01 (0.8)				.06 (1.4)	.37 993
.001 (0.0)		-.04 (1.6)			1.0 (1.5)	.001 (0.3)	.11 (5.1)		.05 (2.0)	.002 (1.2)	-.01 (0.3)		-.13	.24 448
.002 (0.1)	.04 (1.5)	.000 (0.0)	.01 (0.3)			-.002 (0.9)	.02 (0.7)	.02 (0.5)	-.01 (0.5)	-.002 (0.9)			.28 (3.1)	.03 602
	.04 (1.5)	-.01 (1.0)	.01 (0.2)			-.002 (0.8)	.02 (0.6)	.02 (0.8)	-.01 (0.3)	-.002 (1.1)			.24 (2.7)	.02 602
-.005 (0.9)		-.01 (0.5)	.03 (3.1)			.001 (0.9)	.002 (0.4)		.001 (0.1)	-.001 (2.1)			.004 (0.2)	.01 602
.002 (0.1)	.03 (1.4)	.02 (0.7)	-.01 (0.5)			-.002 (0.9)	.02 (0.9)	.02 (0.7)	-.01 (0.4)	-.000 (0.0)			.31 (3.9)	.07 551
-.21 (1.8)		-.38 (2.4)				.13 (16.7)	.68 (4.6)	.69 (4.2)	.70 (4.4)		-.08 (0.5)	.02 (1.1)	-.17 (0.4)	.28 1068
.02 (0.6)			.03 (0.7)	-.13 (1.5)		-.01 (2.4)	.24 (5.6)	.26 (5.4)	.28 (6.0)		.06 (1.9)		.46 (3.5)	.09 906
.01 (0.3)			.04 (0.9)	-.14 (1.6)		-.003 (1.2)	.25 (5.8)	.29 (6.3)	.27 (5.4)		.04 (1.4)		.40 (3.0)	.07 993
9-8	10-2	10-2	10-4	10-6	20-9	11-3	11-6	11-6	11-6	11-8	11-16	11-14		

Notes for Table 12

^aThe underlying data are described in Section 3. Underneath the point estimates are given absolute t values. A value of 1.0 is significantly nonzero at the 30 percent level, and 2.0 is significantly nonzero at the 5 percent level. For economy of presentation some variables are excluded from the table if their t values are very close to zero (e.g., medical attention at birth by a nurse from row 7; private and public sewage in relation 4, 5 and 7; no companion present in relations 1 and 2; Catholic in relations 4, 5, 7, 8, 9, 10; frequency of church attendance in relations 9 and 10). The coefficients of determination are corrected for degrees of freedom.

^bDummy variable with value of 1 in indicated state, and otherwise 0.

^cVariable equals 3 if attention began in first trimester of last pregnancy, 2 in the 2nd, 1 in the 3rd, 0 if none.

^dMultiplied by 10^{-3} .

^eThe number of observations varies because of the missing data problem discussed at the end of Section 3. Sample size under 500 refers to working women only, over 900 refers to all non-single women, and between 500 and 700 refers to women with pregnancies since the earthquake.

^fPast contraceptive use only.

^gKnowledge of contraception dummy variable.

^hGap as of time of survey.

^jDummy variable for companion opposed to contraceptive practice.

Pregnancies per Year: The notion underlying our formulation of the determinants of the number of pregnancies per year is that the basic factor is the gap between the number of desired children and the number of live children at the start of the period (i.e., immediately after the earthquake). Other variables affect the capability or the desirability of closing this gap at different rates.²⁷

The first three rows of Table 12 give three different estimates of the relation for the number of pregnancies per year. The first two are alternatives for the subsample of non single (i.e., accompanied at some time) women.²⁸ The third is for currently working women. The coefficients of determination are 0.37 in the first two cases and 0.24 in the third. Thus these relations "explain" a surprising amount of the variation in pregnancies per year, especially given the micro nature of the data.

The most important determinant of pregnancies per year, as anticipated, is the gap between desired children and the number of live children immediately after the earthquake. The results imply that for every additional child that is desired, all nonsingle women average 0.09 more pregnancies per year and working women average 0.07 more pregnancies per year. The substantial response to shortfalls below desired number of children is consistent with a model in which fertility decisions in considerable part reflect rational decisions and preferences, and not purely biological conditions. That the coefficient is smaller for working women than for all nonsingle women also is consistent with such a model of rationality in that the former tend to have higher opportunity costs due to foregone earnings and thus adjust more slowly to fill the shortfall between actual and desired number of children.

The remainder of the variables can be thought of as a linear approximation of explicit variables that affect the rate of adjustment to fill the gap between desired and actual children. A priori the signs of some of these variables are ambiguous. Better health and nutrition states, for example,

increase the energy of a woman. This may mean that she can deal with or physically have children at a faster rate. But it also may imply that the opportunity cost of doing so is greater because the returns to other activities, such as paid labor, are higher. Thus there may be "income" and "substitution" effects of opposing signs. Which dominates a priori is not always obvious.

Taken at their face values, the coefficient estimates of the health and nutrition variables reflect the differential dominance of such opposing effects. Better satisfaction of caloric requirements and less incidence of diseases that are preventable outside of the medical system both result in estimated net faster adjustment. Better satisfaction of protein requirements, and less incidence of diseases that are preventable with medical care, both on net reduce the rate of adjustment, apparently due to the dominance of substitution effects. A smaller proportion of child deaths relative to the total born alive also reduces the rate, presumably in this case because of lessened probabilities of replacement births being needed to attain a given target of desired children over a particular time horizon. All of these effects seem to be about the same for working women as for all nonsingle women, with the qualification that the significance levels are much smaller for working women for the incidence of diseases preventable with medical care and for the proportion of live births that later died.

In regard to the nutrition variables, for all of the subsamples considered one further observation need be made. If the caloric requirements variable alone is included (as in the first row), the coefficient estimate is much smaller and less significantly nonzero than if the protein variable also is included (as in the second row). This pattern may reflect the relatively high correlation between these two variables (a simple correlation coefficient of 0.89) that is mentioned in the previous section. Thus the coefficients of the nutrition variables should be interpreted with some caution.²⁹

The economic activity variables represent one type of opportunity cost

that usually is emphasized in discussions of such substitution effects in fertility relations. Our estimates of the coefficients of such variables suggest some plausible patterns. For all nonsingle women the rate of adjustment is lowered when the opportunity cost pertaining to their earnings is greater. For working women the rate of adjustment is lower for those in the formal sector, where child care simultaneous with paid work usually is not possible, in contrast to the informal sector situation.³⁰ The positive signs of the coefficients of occupational prestige, in contrast, suggest the dominance of income effects (particularly for working women) if occupational prestige is highly correlated with permanent income as many economists have maintained. However for all of the coefficients of the economic activity variables the estimates are significantly nonzero at best at the 10 percent level. Therefore the direct support for strong economic substitution and income effects on the rate of adjustment is limited.³¹

Among the other background variables the most robust estimated impact on the adjustment towards the desired number of children is in regard to marital status. For a given gap between desired and actual number of children, the estimates suggest that the rate of adjustment is highest for those in common-law unions and next so for religious marriages (in both cases the estimated effects are stronger and significantly non zero at higher levels for working women than for all nonsingle women). That adjustment is quicker for women in common-law and religiously sanctioned unions than for women not currently in unions is hardly surprising. But the ordering among types of unions prima facie may be somewhat surprising: common law, religious marriage, and civil marriage, in descending order of rapidity of adjustment. Thus the adjustment is most rapid in the least institutionalized and quite possibly least stable living arrangement. For all nonsingle women (but not for working women alone) the negative estimate for the coefficient of years per union may provide further support for a hypothesis that women in more unstable living arrangements try to

31

fill the gap in the number of desired children more rapidly than those in more stable arrangements. ³² Perhaps there is greater pressure to reach the

target levels quicker if there is more uncertainty about the longevity of the relation. ³³ Another possibility is that usually at least one childbirth result from each union, so that those who tend to have more unions adjust to fill the gap more quickly.

The only other background variable for which there is a significantly nonzero estimate is the negative one for age in the second row. This sign might be interpreted as meaning that older women are not able to move towards their desired targets as quickly as younger women due to greater subfecundity and less energy with age. On the other hand, older women have fewer fecund years remaining to attempt to attain their desired number of children, which would seem to work in the other direction. Moreover any interpretation of the coefficient of age must be tempered because the estimate is significantly nonzero only when years per union is excluded (the correlation is 0.73). In the second relation, age only may be serving as a proxy to represent instability of the union.

The last significantly nonzero coefficient estimate is the positive one for current or past contraceptive use. Of course contraceptive practices can be used to regulate the rate of pregnancies as well as to prevent unwanted pregnancies after the target has been reached. Therefore past or current contraceptive users may have high adjustment rates towards their desired targets. A positive sign might reflect that women who have more control over their destiny, as proxied by using contraceptives currently or previously, move more quickly towards their targeted number of children. However it is not clear that more rapid adjustment is preferable, as would be necessary for this explanation to hold. Even after such reflections we continue to find the sign and significance of this estimate to be puzzling.

Total Pre- and Post-Natal Infant Mortality Per Pregnancy: Given the number of pregnancies per year, the number of incremental surviving children depends 3b

on the number of pre- and post-natal infant deaths per pregnancy (and the number of years). Rows 4 and 5 in Tab13 12 present alternative estimates of the determinants of this total infant mortality per pregnancy. The next two rows present estimates of two of the components of this variable: abortions per pregnancy and post-natal infant mortality per pregnancy. Our efforts to estimate the determinants of the third exhaustive component, involuntary infant pre-natal mortality per pregnancy, proved abortive with a negative coefficient of determination corrected for degrees of freedom. We expect that this failure, as well perhaps as our very limited success with abortions per pregnancy, reflects systematic misreporting as is discussed in the previous section. In any case at this time we focus our attention on the total mortality variable, with some references to the estimates of the other components.³⁴

The most important single variable in explaining total and post-natal infant mortality per pregnancy is the gap between desired and actual number of children. With every increase in this gap of one child, the total and post-natal mortality rates per pregnancy drop 3 percent. The more additional children are wanted, thus, the less are the infant mortality rates. This does not necessarily mean that unwanted pregnancies are aborted, nor that unwanted infants are allowed to die. In fact this variable is not significantly nonzero in the relation for abortions per pregnancy.³⁵ The inverse relation between the gap of desired children and infant mortality may be purely involuntary. It may reflect correct appraisals about the extent to which limited family resources cause additional children to be a real strain and have a higher probability of dying, for which reason there is a low desired number of additional children.

There is an additional drop of another 3 or 4 percent for total mortality per pregnancy (and of 6 percent for post-natal mortality per pregnancy) for current and past contraceptive users, as well as an increase in abortions per