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INVESTMENTS IN CHILD NUTRITION AND WOMEN'S ALLOCATION OF TIME IN DEVELOPING COUNTRIES

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I. Introduction

One important difference between labor markets for women in developed and developing countries is the existence in the latter of a large so-called informal sector. This sector is characterized by jobs which can be carried out at or near the home, or are otherwise compatible with simultaneous child care. Examples of informal sector occupations include home crafts such as needlework and weaving, various services such as cleaning and laundry, running small retail stores or market stands, street vending, and even some forms of light manufacturing. Twenty years ago Jaffe and Azumi (1960) noted that women employed in informal sector jobs (or cottage industry, as they called it) could work during pregnancy without difficulty, and could intersperse work with taking care of young children. They hypothesized that the commonly observed lower fertility of working women compared to non-working women should not hold for women in informal sector jobs. This hypothesis was confirmed by their examination of data from Puerto Rico and Japan: women who worked for pay in the home had fertility similar to women who did not work; women who worked outside the home had lower fertility. Similar conclusions were reached by Weller (1968) in a further study of the Puerto Rican data, and Hass (1972) in a study of seven major Latin American cities.

These studies based their empirical conclusions on simple correlation or tabular analysis of two variables, fertility and female employment status, which are both more appropriately viewed as choice variables influenced by a common set of exogenous factors. McCabe and Rosenzweig (1976) built an explicit economic model of the factors affecting a household's choices concerning fertility, female labor force participation, and sector of work. Their regression analysis of the ubiquitous Puerto Rican data revealed a result not usually found in studies of developed countries: a positive effect of the market wage rate for women on fertility, as well as the usual positive effect on labor force participation. This result is consistent with the existence of informal sector jobs in which women may work without sacrificing their child care time. A study by Smith (1978) using a similar economic framework applied to data from Mexico City found that unanticipated increases in fertility (unplanned births) caused women to increase their labor supply if they worked in informal sector jobs but not if they worked in formal sector jobs, a finding also consistent with the child care compatibility of informal sector jobs.

Jaffe and Azumi drew a logical conclusion from their study: "From the population viewpoint, perhaps the most desirable industries to be introduced into an underdeveloped country would be those using large quantities of female labor away from home, in modern factories, stores, offices, etc." [Jaffe and Azumi 1960, p. 62]. Rosenzweig and McCabe [1976, p. 347] discuss a similar policy prescription for reducing fertility in developing countries, although they are careful to point out some of its potential drawbacks. One issue not considered in these studies concerns the effect of women switching from informal to formal sector occupations on the human capital of their children. Women in informal sector jobs may be able while working to engage in home production of "child quality" or investments in the human capital of their children such as nutrition. Providing incentives for a woman to switch from informal to formal sector jobs may induce a decline in fertility but also implies a withdrawal of part of her time input to the production of investments in her children's human capital. If enough of the increased income earned by a woman in a formal sector job is allocated to purchasing substitutes for the reduced time input by the woman in home production then the level of child human capital could be maintained or even increased. The effect on children's human capital depends upon the substitutability of other inputs for the woman's time, and the subjective substitutability of child quality and other home goods for child quantity in parents preference functions.

The purpose of this study is to investigate the determinants of fertility and home investments in the human capital of children in a context in which women have the option of working in the informal sector as well as the formal sector or no market work. The types of issues investigated include: (a) Does a woman who works a given number of hours for pay in the informal sector have children with a higher level of human capital than they would have if she worked in the formal sector, other things equal? (b) How easily are households able to substitute other inputs to replace a woman's time in home production if she moves from the informal to the formal sector? (c) Does the choice of sector of employment respond to changes in the relative wage offers in the two sectors in the manner predicted by economic theory? (d) Does fertility respond differently to changes in informal sector wages than to changes in formal sector wages?

The rest of the paper is organized as follows. In Section II a simple household production model of fertility, child investment, and the informal-formal sector choice is proposed as a useful tool for analyzing these issues. Predictions of the model and its implications for the empirical work are discussed. The empirical analysis presented in Section III uses data from a 1977-78 survey of households in Nicaragua.

The nutritional status of young children is employed as a measure of human capital which is especially relevant given the potentially severe effects of malnutrition and the evidence of widespread child malnutrition in developing countries.[1] The empirical analysis is carried out within the framework of the theoretical model and attempts to test its predictions. Section IV discusses the conclusions of the study and some tentative implications for policy.

II. The Household Production Model

In this section a theoretical household production model of fertility, child nutrition, and the woman's sector of employment is developed.[2] The model is used to predict the effects of changes in key exogenous variables such as income, wages, and prices on these household decisions. To facilitate such predictions the model must of necessity be simple; it does not attempt to incorporate all of the possible channels through which nutrition may interact with fertility and women's work decisions. The realism that is lost through simplification allows development of a relatively tractable model.[3]

The approach embodied in this model is static, with no uncertainty. All choices are assumed to be made at the beginning of the single period in full knowledge of preferences, endowments, home production technology, and market constraints. The woman and her spouse or companion are viewed as a single decision-making unit with the utility of individual family members suppressed and only "family utility" considered. The couple is assumed to have preferences for the number of children surviving to age five, C, the average nutritional status of surviving children, N, which is the child quality or investment variable used here, and a composite market good, Z.

The parents preferences are represented by a utility function

$$U = U(C, N, Z) \tag{1}$$

with positive and decreasing marginal utility for each good. In order to focus the analysis on C and N it is assumed that $U_{CZ} = U_{NZ} = 0$, implying that a change in Z has no effect on the marginal rate of substitution between C and N. It is assumed that $U_{CN} > 0$.

Average child nutritional status is modeled as a good produced in the home with inputs of family members' time and purchased market goods. The home production function for N is

$$N = N (T, J, X, C; R) \tag{2}$$

where T = time spent by the woman in home production; J = time spent by the woman in informal sector work; X = an index of purchases of market goods used in the production of N; and R represents the level of technical efficiency of production, assumed to be exogenous. A number of assumptions are being made in this formulation. First, the time of the husband and family members other than the wife are not inputs into the production of nutrition; their allocation of time is taken as exogenous. Second, it is assumed that the wife's time spent in informal sector work (J) is simultaneously an input to the production of child nutrition. This assumption, which will be tested empirically, is consistent with the notion discussed above that it is generally possible to take care of one's children while engaged in informal sector work. Third, since N represents average child nutritional status C is included in the production function as an input with a negative marginal product. Other things equal, more children mean fewer resources per child, and also lower marginal products for the other inputs (see Gopalan and Naidu 1972 for evidence on this point). The variable X includes food purchases as well as purchases of medical services, child care services, and other market goods relevant to children's nutritional status. It will often be referred to as food for brevity. The variable T represents breastfeeding time, cooking, shopping, and other uses of time which affect nutritional status, and will often be referred to as "home time."

The assumptions regarding signs of derivatives of $N(\cdot)$ are that all first partial derivatives are positive except N_c which is negative; all second own partial derivatives are negative except N_{cc}, which is positive (the effect of an additional child on average nutritional status becomes less deleterious as C increases); and all cross partial derivatives are positive except those involving C, which are negative.

It is assumed for simplicity that there are no biological constraints on fertility, so that desired family size can always be attained. Child mortality is ignored as well (until Section III), so the number of children surviving to age five simply equals the number of live births. It is fairly straightforward to drop these assumptions and expand the model to incorporate a fecundity constraint and a child mortality function (see Blau 1980, Chapter 4), but this is not necessary for the purposes of this paper.

The time constraint faced by the family is

$$T + J + H = \bar{T} \tag{3}$$

where H = time spent by the woman in formal sector work, and $\bar{T}$ is total time available to the woman after subtracting time spent in producing other home goods. The budget constraint is

$$J.w_I + H.w_F + E = P_x.X + P_Z . Z \tag{4}$$

where w_I and w_F are wage rates for informal and formal sector work, respectively; E is family income minus the woman's earnings; and P_x and P_Z are prices of X and Z, respectively. Let X be the numeraire and set $P_x = 1$ so that w_I and w_F are real wages in terms of food. Assume also that $w_F > w_I$; if not, formal sector work would never be chosen as long as $N_J > 0$. Wages, prices, and other income are taken as exogenous. This ignores the possibility that wages depend on accumulated human capital, as in Willis (1974), except in so far as this is captured by the fact that $w_F > w_I$. Children's earnings, if any, are subsumed in E and not explicitly analyzed since the focus here is on young children who do not yet face the work decision. The earnings of the spouse or companion are considered exogenous and the time of the companion is assumed not to contribute directly to production of child nutrition. Home food production is assumed away since the empirical work uses a sample of non-agricultural households.

As formulated in equation (4) the budget constraint allows for the possibility that a woman can work in both the informal and the formal sector simultaneously. However, if there are fixed money or time costs of working in any given job in either sector, then it is unlikely that a woman would find it in her interest to work simultaneously in more than one sector.[4] This possibility is therefore assumed away, implying that either $H = 0$ or $J = 0$ or $H = J = 0$. The model can be analyzed separately for these three cases with the couple assumed to calculate its maximum utility given that the woman will (a) participate in the informal sector, (b) participate in the formal sector, or (c) not participate in market work at all, and then choose the allocation of resources corresponding to the option yielding the highest utility.

In the remainder of this section the necessary conditions for an optimal allocation of household resources are presented for case (a) as an example, and then comparative statics for all three cases are discussed.

In the informal sector case the household maximizes the Lagrangean

$$\begin{aligned} \pounds &= U(C, N\,[T, \bar{T} - T, X, C; R], Z) \\ &+ \lambda \cdot ((\bar{T} - T) \cdot W_I + E - X - P_Z \cdot Z) \end{aligned} \tag{5}$$

where λ is the lagrangean multiplier, $H = 0$, (2) is substituted for N, and $\bar{T} - T$ is substituted for J. Assuming interior solutions, the first order conditions for a maximum of $\pounds$ are

$$\frac{\partial \pounds}{\partial C} = U_N \cdot N_C + U_C = 0 \tag{6}$$

$$\frac{\partial \pounds}{\partial T} = U_N \cdot (N_T - N_J) - \lambda \cdot W_I = 0 \tag{7}$$

$$\frac{\partial \mathcal{L}}{\partial X} = U_N \cdot N_X - \lambda = 0 \tag{8}$$

$$\frac{\partial \mathcal{L}}{\partial Z} = U_Z - \lambda \cdot P_Z = 0 \tag{9}$$

$$\frac{\partial \mathcal{L}}{\partial \lambda} = (\bar{T} - T) \cdot w_I + E - X - P_Z \cdot Z = 0 \tag{10}$$

Equation (6) can be rearranged as $U_c = - U_N \cdot N_c$ and implies that C is chosen so that the utility gained from the last child equals the utility lost from the reduction in N caused by the last child. Rearranging (7) to read $U_N \cdot N_T = U_N \cdot N_J + \lambda . W_I$ leads to the following interpretation: the opportunity cost of a unit of T is the utility value of the foregone N that could have been produced if the unit of time had been allocated to J $(U_N \cdot N_J)$ plus the utility value of the foregone money wage from a unit of J $(\lambda \cdot w_I)$. This is equated on the margin with the benefit from T, which is the value of N produced. For (7) to hold it is required that $N_T > N_J$, which is plausible since T is devoted entirely to producing N while J involves working at the same time as producing N. Equation (8) implies that the utility gained from the last unit of X via the addition to N must equal the utility value of the expenditure on the last unit of X. Equation (9) is the usual first order condition for a purchased good and equation (10) reproduces the combined time and budget constraints.

The first order conditions for the formal sector version of the model are identical to equations (6) - (10) with H and W_F substituted for J and W_I, and $N_J = 0$. In the no-work version of the model the first order conditions are also similar to equations (6) - (10) with (7) eliminated since $T = \bar{T}$ and $J = 0$.

In order to derive testable implications from the model a comparative static analysis of the effects of changes in income, wages, and prices on each of the endogenous variables is carried out. This is done by totally differentiating equations (6)-(10) and solving the resulting system of equations for the expressions of interest. The details of the analysis are contained in Appendix A to which the interested reader is referred for derivation of the results to be discussed here.

The pure income effects on all variables in the model are ambiguous in sign. If inferior goods and factors are ruled out then the income effects on T, C, X and Z would be positive and the income effects on J and H would be negative. If N is a normal good then a positive income effect would be expected. But since $dN/dE = N_C \cdot dC/dE + (N_T - N_J) dT/dE + N_X \cdot dX/dE$, if the income effect on C is large relative to those for T and X then dN/dE could be negative given that $N_C < 0$. The income effects on choice of formal sector, informal sector, or no work depend upon the income effect on the maximum utility attainable under each of the three choices. These effects on utility are all clearly positive but it is not possible to say which is largest, so the income effect on choice of sector is ambiguous. Given that dJ/dE and dH/dE are both negative, however, one would expect this to lead eventually to a positive income effect on the probability of not working at all.

The only unambiguous non-zero effects of an income-compensated increase in the wage offer in either sector are to decrease T in both the formal and informal sector cases, and to raise J in the informal sector case and raise H in the formal sector case. These are analogous to the typical substitution effect on market labor supply of a wage increase derived from the Slutsky equation. The signs of the income-compensated wage effects on X and Z are uncertain although one would expect them to be positive a priori given that an increase in W_I or W_F reduces the prices of X and Z relative to the price of T. The effect on the shadow price of C when the wage increases is uncertain so the signs of the compensated wage effects on fertility are ambiguous, but might be expected to be negative a priori. The compensated wage effects on N are indeterminate because of probable offsetting effects on N of the induced increase in X and decrease in T. However, an increase in N may be more likely when W_I rises because it induces an increase in J which contributes to N, while an increase in W_F raises H which does not contribute to N. An increase in the formal (informal) sector wage raises the probability of choosing the formal (informal) sector and reduces the probability of both other alternatives. This is due to the positive effect of an informal (formal) sector wage increase and the zero effect of a formal (informal) sector wage increase on maximum utility attainable in the informal (formal) sector and the zero effect of a wage increase in either sector on maximum utility in the no work case.

A compensated increase in the price of Z causes a decrease in the value of Z and has uncertain effects on the other choice variables in the model, although under further simplifying assumptions discussed in Appendix A the effects of an increase in P_Z on C, T, and X would all be positive, as seems intuitively plausible. The sign of dN/dP_Z (compensated) is uncertain even with further simplifying assumptions because the increase in C could offset the effects of the increases in T and X.

The model presented here provides few clear testable hypotheses, unfortunately, but this is a common problem in models of this type.[5] The model does provide guidance for organizing and interpreting the empirical work, however. The two main implications of the model are (1) the demand for each of the nutrition inputs is a function of all of the exogenous variables in the model, and (2) nutritional status is itself a function of the inputs, which in turn are functions of the exogenous variables. Thus the income, wage, price, and household technology variables determine the household's decisions concerning time allocation, food purchases, and fertility, and the levels of the latter variables determine nutritional status. The next section discusses the empirical specification of the model and presents estimates of demand equations for the inputs, derived demand equations for nutritional status, and structural estimates of the nutritional status production function.

III. Empirical Analysis

Description of the Data

The data used in the study were collected in a household survey carried out in Nicaragua during 1977 and 1978.[6] The survey took a stratified random sample of Nicaraguan households in which at least one woman between the ages of 15 and 45 years was present. One such woman in each household was selected as the primary respondent and a variety of economic, demographic, health and background information collected from her concerning herself and her family, including anthropometric nutritional status measures of at least one child under five years old if there were any children under five.

This study uses the subsample of spouse or companion present households living in cities or towns with at least one child under five and with complete data on all the variables used in the analysis. Households headed by a single, divorced, or separated woman are excluded because the absence of a spouse or companion (common law marriage is quite common in Nicaragua) probably results in a different structure to the relationships of interest. Agricultural and other rural households are excluded because the distinction between formal and informal sector occupations is probably not as meaningful in rural areas as in urban areas. The equations reported below were also estimated for the rural non-agricultural households in the sample but the results were generally poor and are not reported here. Because nutritional status data were collected only for children under age five the sample in this study is restricted to households with a child under five. Finally, approximately

40 percent of the potential observations were lost due to missing data, mainly for nutritional status.[7]

Table 1 presents means and standard deviations for the empirical counterparts to the variables in the theoretical model for the sub-sample used in this study.[8] Nutritional status is measured for one child under age five in each family by the child's height minus the median height of children of the same age and sex from a well nourished reference population, divided by the standard deviation of height of children of the same age and sex in the reference population. Thus "Standardized Height" is measured in units of reference population standard deviations. This type of anthropometric measure is widely used as an indicator of nutritional status, designed to detect chronic malnutrition, which is known to cause stunting.[9] Other anthropometric nutritional indicators such as standardized weight and bicep circumference were also used in the analysis but the results did not differ substantially from those for height, and they are not presented here. The data in Table 1 indicate that the average child is four fifths of a standard deviation below his or her height norm. Since very poor child nutritional status can lead directly or indirectly to death, a measure of mortality among children born since the 1972 Managua earthquake is also used as an alternative indicator of the "output" of the household production function.[10] About seven percent of families in the sample experienced a death of a child born since 1972.

The variables representing inputs to the production of nutritional status are live births since the earthquake, months of breastfeeding, the woman's hours of work, food expenditure per adult equivalent, the age of

Table 1

Descriptive Statistics for Variables Used in the Analysis

Endogenous Variables	Mean	Standard Deviation
Standardized Height	-.80	1.57
Deaths of Children Born since the 1972 Earthquate	.07	.26
Live Births Since the Earthquake	1.61	.78
Months of breastfeeding	5.4	6.8
Woman's Weekly hours of work	13.0	24.1
Monthly Food Expenditure per Adult Equivalent ÷ 100[a]	1.54	1.11
Age of woman at first birth	20.7	4.4
Dummy-woman works in informal sector[b]	.20	.40
Exogenous Variables		
Woman's years of education	5.0	3.5
Woman's age	28.1	6.5
Dummy-woman raised in urban area	.90	.30
Biweekly family income other than woman's earnings ÷ 100	7.64	7.69
Predicted log of woman's informal sector wage offer[c]	1.01	.35
Predicted log of woman's formal sector wage offer[c]	1.29	.49
Sample size	1,023	

Notes: (a) The Nicaraguan monetary unit, the cordoba, was valued at U.S. $.14 in 1977. All monetary variables are measured in cordobas or hundreds of cordobas, as indicated by the descriptions.
(b) In this study informal sector jobs are most easily described as those not in the formal sector. A woman was classified in the formal sector if she worked as a professional, manager, administrator, foreman, contractor, or technical worker; or if she worked in some other occupation but had ten or more co-workers or received any type of social security benefit from her job (insurance, health, schooling for children etc.). Most of the women classified in the informal sector worked as vendors, home craft workers, sales person operating in own residence, or service workers of various types.
(c) The method used to construct the predicted log wage variables is described in Appendix B.

the woman at her first birth and a dummy equal to one if the woman worked in an informal sector job and zero if she did not work or worked in a formal sector job. Fertility is measured from the time of the 1972 earthquake because it is expected that the more young children present, the lower their average nutritional status, ceteris paribus, while older children might contribute to the care of young children as well as compete with them for nutritional resources. The average woman (about 28 years old at the time of the survey) had one and three fifths live births in the 5-6 years since the earthquake.

It should be noted that this fertility measure may not be closely related to a lifetime measure such as children ever born because birth timing probably has a strong influence on fertility over a five to six year span. It is also a measure of actual rather than desired fertility and may systematically differ from the desired birth pattern. This could affect the interpretation of the coefficients presented below. For example, if couples are unable to achieve as many births as desired due to a fecundity constraint, then the effects of changes in the exogenous variables on fertility reported below could be in part the effects of changes in these variables on the fecundity constraint rather than on desired fertility.

Months of breastfeeding and hours of work measure two aspects of women's time allocation which affect nutritional status, and food expenditure (given constant food prices for a cross-section at a moment of time) is a measure of the purchased inputs to nutrition production. Table 1 reveals an average of about 6 months of breastfeeding per child, 13 hours of work per week and 154 cordobas (about $11) of food expenditure per month per adult equivalent. The age of the woman at the time of her first birth is included as another dimension of fertility for which it is important to control when investigating the impact of fertility on nutritional status. Finally the informal sector dummy is used to test the hypothesis that time spent working in the informal sector can also be used to produce nutrition. Twenty percent of the women in the sample worked in the informal sector, 14% worked in the formal sector and the remaining 66% did not work at all.

The variables shown in the lower panel of Table 1 are intended to represent in so far as possible the exogenous components of prices, income, tastes, and the state of technology faced by households. The woman's formal schooling is expected to affect both tastes and efficiency in home production, as well as her market wage offers. Age of the woman is included as a control for stage of the life cycle. A dummy variable for whether the woman was raised in an urban area may capture the effects of differences in prices and work opportunities between urban and rural areas and may also proxy for differences in tastes between urban and rural areas. Family income other than the woman's earnings includes earnings of the spouse or companion, earnings of older children and other adults, and transfers and asset income. These are all treated as exogenous with respect to the decisions under investigation here, although it is recognized that for the non-asset components of income this assumption may be questionable. The last two variables shown in Table 1 are estimated logs of the wage offers faced by the woman in the informal and formal sectors, respectively. These are imputed from regressions of the log wage on a small set of exogenous variables (education and potential experience) using the samples of women who reported a wage in the informal and formal sectors, respectively. The potential selection bias inherent in such a procedure is controlled for using a method developed by Hay (1980). The estimation method is discussed in detail and the results reported in Appendix B. As expected, the average estimated formal sector wage is greater than the average estimated informal sector wage.

Results

Before discussing the empirical results several specification and estimation issues will be briefly mentioned. The theoretical model gave no reason to expect linear input demand and structural equations so some squared terms and interaction terms were tested. Some of these terms were individually significant but it was never possible to reject the hypothesis that as a group they were insignificant, so only the linear specifications are reported here. In order to estimate the woman's choice of sector equation the work decision is put in the form of a trichotomous variable indicating whether she worked in the informal sector, the formal sector, or did not work. Maximum likelihood trichotomous logit is used to estimate the equation for this variable. Maximum likelihood tobit is used to estimate the length of breastfeeding and hours of work equations since both are limited dependent variables in the sense that substantial portions of the sample did not breastfeed (30%) or work (66%). All input demand equations were estimated with single equation techniques because they share common sets of right hand side variables so even if the disturbances are correlated across equations no efficiency gain would result from joint estimation.[11] However, if the disturbances of the input demand equations were correlated with the disturbances of the structural nutrition or mortality equations then the disturbances of the latter would be correlated with right hand side variables (the inputs) and Ordinary Least Squares (OLS) would give biased parameter estimates for the production functions. A more appropriate approach would be to use an instrumental variables procedure with the input demand equations providing the first stage estimates for the inputs, and the fitted values of the inputs used in the production function. However there are not enough exogenous variables in the model excluded from the production function to permit identification of the production function so this is not feasible and only OLS estimates are possible. A check of correlations among residuals of the input demand and production function equations estimated by OLS revealed correlation coefficients of .02 or less for the nutrition equation and .17 or less for the child mortality equation, so OLS estimates of the parameters of the nutritional status production function will probably not be subject to simultaneous equations bias.

The estimation results are presented in Tables 2-4, with t-ratios reported in parentheses next to the coefficients. The input demand equations are discussed first followed by the reduced form demand and structural nutritional status and child mortality equations.

Input Demand Equations

Table 2 contains the maximum likelihood trichotomous logit results for choice of sector and the maximum likelihood tobit results for months of breastfeeding and weekly hours of work. Women's education appears to be the key determinant of choice of sector, with more educated women more likely to be in the formal sector and less likely to be in the informal sector. This is a plausible result given that the returns to education are probably higher in the formal sector, but it is surprising that the wage variables do not pick this up as well. The formal sector wage in particular appears to matter very little in determining choice of sector. This could be due in part to the high correlation between the wage variables (.85) due to the procedure used to estimate them (see Appendix B). Higher income reduces the probability of working in either sector, consistent with the theoretical model, though the coefficient estimates are insignificant. Older women are more likely to work in either sector and so are women who grew up in urban areas.

Education has a significant negative impact on the length of breastfeeding, which may indicate that more educated women are able to breastfeed less without harming the nutritional status of their children, perhaps because education improves their knowledge of sound infant feeding practices. Butz and DaVanzo (1978) and Heller and Drake (1979) also report negative effects of the mother's education on breastfeeding for Malaysia and Colombia, respectively. The estimated income effect on breastfeeding is

Table 2

Maximum Likelihood Logit and Tobit Estimation of Woman's Choice of Sector, Months of Breastfeeding and Hours of Work

	Trichotomous Logit Estimates of Choice of Informal Sector, Formal Sector or No Work[a]				Tobit Estimates of			
					Months of Breastfeeding		Hours of Work	
	Informal Sector		Formal Sector					
Intercept	-.27	(0.7)	-2.52	(5.6)	.63	(0.4)	-111	(5.3)
Education	-.16	(3.0)	.19	(2.8)	-.86	(3.7)	0.9	(0.4)
Age	.015	(1.1)	.020	(1.1)	.21	(3.2)	2.2	(3.5)
Urban Origin	.21	(1.0)	.02	(0.1)	-1.04	(1.1)	13.7	(1.6)
Other Income	-.02	(1.3)	-.02	(1.2)	-.08	(1.8)	-0.75	(1.6)
Predicted Log of Informal Sector Wage Offer	.33	(0.9)	.28	(0.7)	1.65	(1.1)	24.4	(1.8)
Predicted Log of Formal Sector Wage Offer	-.001	(0.0)	.03	(0.1)	1.06	(0.6)	-14.4	(0.9)
χ^{2}[b]	180				134		42	

Notes: (a) The coefficients for the third choice, no work, are not reported here. The normalization procedure used forced the three coefficient vectors to sum to a zero vector across the three alternatives, so the coefficient vector for the no work alternative equals minus the sum of the coefficient vectors for the two reported alternatives.

(b) The χ^2 statistic reported is for a likelihood ratio test of the null hypothesis that all coefficients other than the intercepts are equal to zero for all three alternatives. The critical values for the χ^2 (12) distribution are 21, at the 5% level and 26 at the 1% level, and for the χ^2 (6) distribution, 13 and 17 respectively.

Asymptotic t values are reported in parentheses.

negative and marginally significant, indicating that breastfeeding is viewed as an "inferior factor." Both wage effects are positive, though insignificant, a surprising result which is inconsistent with the predictions of the theoretical model. Older women breastfeed longer and women raised in urban areas breastfeed about one month less, other things equal, than women raised in rural areas.

In the weekly hours of work equation the informal sector wage has the expected positive effect, marginally significant, but the formal sector wage again performs poorly, with an unexpected negative insignificant coefficient. Income has a negative effect on hours of work, as expected, and older age and urban origin both have positive effects, highly significant in the case of age. The education effect is positive but insignificant, indicating no marked effect of education on the relative productivity of time at home versus market time.

The estimation results for the three remaining input demand equations are presented in Table 3. The fertility equation shows an unexpected positive and significant effect of education on live births since the earthquake. This is an unusual finding but may be due to the relatively short period over which fertility is being measured. More educated women may bunch births more closely together in order to reduce time lost from market work, but still have lower completed fertility. Also, when the effect of education on the wage offers is taken into account the total effect of education

Table 3

Linear Regression Estimates of Equations for Live Births Since the Earthquake, Woman's Age at First Birth, and Food Expenditures per Adult Equivalent

	Live Births		Age at First Birth		Food Expenditures	
Intercept	2.1	(14.8)	8.3	(12.4)	.78	(3.9)
Education	.07	(3.6)	.04	(0.4)	.06	(2.0)
Age	.01	(1.1)	.35	(13.4)	-.002	(0.3)
Urban Origin	.02	(0.2)	-.33	(0.9)	.05	(0.5)
Other Income	.005	(1.3)	-.04	(2.3)	.02	(3.0)
Predicted log of Informal Sector Wage Offer	-.03	(0.2)	.44	(0.8)	.47	(2.8)
Predicted Log of Formal Sector Wage Offer	-.85	(5.8)	1.94	(2.9)	-.08	(0.4)
R^2 (F)	.07	(12.7)	.36	(96.9)	.11	(21.2)

T statistics are in parentheses.

on fertility becomes negative (see Table 5). The formal sector wage offer has a significant negative coefficient in the fertility equation, which is consistent with, though not predicted by, the theoretical model. Income has a small positive effect but the coefficient estimate is insignificant, as are the remaining coefficient estimates in the fertility equation.

The coefficient estimates in the age at first birth equation show that higher wage offers, particularly in the formal sector cause women to have their first birth at a later age, while higher other income tends to lower the age at first birth. The strong age effect simply indicates that current age is a ceiling on age at first birth. The positive education and negative urban origin coefficients are both insignificant.

Education, income and informal sector wages all have positive significant coefficient estimates in the food expenditure per adult equivalent equation, while the age, urban origin, and formal sector wage coefficients are insignificant.

Nutritional Status and Child Mortality Equations

Table 4 presents coefficient estimates of both reduced form demand and structural equations for nutritional status and child mortality since the earthquake. The most striking results in the nutritional status demand equation are the positive significant wage coefficients, particularly strong for the formal sector wage.

Table 4

Linear Regression Estimates of Reduced Form and Structural Nutritional Status and Child Mortility Equations

A. Reduced Form Equations

	Standardized Height		Child Mortality	
Intercept	-1.14	(3.9)	.22	(4.1)
Education	- .05	(1.3)	.008	(1.0)
Age	- .04	(3.4)	.0004	(.18)
Urban Origin	.12	(0.7)	-.04	(1.2)
Other Income	-.006	(0.8)	.0009	(0.6)
Predicted Log of Informal Sector Wage Offer	.43	(1.7)	-.001	(0.0)
Predicted Log of Formal Sector Wage Offer	.92	(3.1)	-.13	(2.4)
R^2 (F)	.07	(12.0)	.02	(3.7)

B. Production Function Estimates

	Standardized Height		Child Mortality	
Intercept	-1.02	(3.6)	-.09	(1.8)
Education	.09	(5.7)	-.003	(1.1)
Months of Breastfeeding	-.02	(2.3)	-.00005	(0.0)
Hours of Work	-.002	(0.9)	.00005	(1.1)
Live Births Since Eq.	-.22	(3.6)	.12	(11.6)
Food Expenditure per A.E.	-.03	(0.7)	-.006	(0.7)
Age at First Birth	.01	(1.3)	.001	(0.7)
Informal Sector[a]	.03	(0.2)	.01	(0.6)
R^2 (F)	.07	(10.9)	.13	(21.9)

Notes: (a) The informal sector is a dichotomous variable here, rather than the trichotomous variable used in Table 2.

An increase in the woman's value of time reduces the relative price of purchased market inputs and raises the price of home time, and if market inputs are substantially more productive than home time this could explain why wage increases lend to nutritional status improvements. The wage increase also tends to reduce fertility and given the hypothesized negative fertility effect on nutrition this is another channel through which the positive wage effect on nutrition could arise. Education and income both have unexpected negative insignificant effects on nutritional status, and age of the woman has a negative significant coefficient estimate. The signs of the coefficients in the child mortality equation are all opposite of the corresponding signs in the nutrition equation, as expected, but only the formal sector wage coefficient is significant.

The nutritional status production function estimates reveal some interesting and in some cases surprising results. Fertility has its hypothesized negative effect on nutritional status and the coefficient estimate is highly significant. Education has a highly significant positive coefficient estimate indicating that the effect of education on the woman's home productivity is positive, so the negative education coefficient in the upper panel of Table 4 must arise from some other source. Months of breastfeeding has an unexpected negative and significant effect on nutritional status and the food expenditure effect is also unexpectedly negative, though insignificant. A possible explanation for the breastfeeding result is that women who breastfeed longer than average may also not provide supplementary food to their infants as early as necessary

(4-6 months after birth). The breastfeeding coefficient would then pick up the harmful effect on nutritional status of lack of supplementary feeding even though breastfeeding itself is not harmful. The lack of a significant effect of food expenditures may indicate that this variable is not a good proxy for a child-specific food consumption variable, which is not available in this data. Hours of work has only a small negative effect on child nutrition and age at first birth has a small positive effect. The coefficient on the informal sector dummy does not reveal a strong effect on nutritional status of being in the informal sector. In the child mortality equation the only significant coefficient estimate is for fertility and this is due in large part to the fact that women with more births have more children at risk of mortality.

IV. Conclusions

The key results are summarized in Table 5 in elasticity form (except for nutritional status--see note (e) in Table 5). With the exceptions noted above, most of the empirical results are consistent with the predictions and assumptions of the theoretical model discussed in Section II.

The results in Table 5 suggest that increasing levels of women's education will draw women in developing countries out of the informal sector and into the formal sector, and will cause declines in both fertility and mortality and improvements in child

Table 5

Elasticities of the Endogenous Variables with Respect to Four of the Exogenous Variables[a]

	Education	Education[b]	Income	Informal Sector Wage	Formal Sector Wage
Probability of Informal Sector Participation[c]	-.65**	-.07	-.38	.79	.02
Probability of Formal Sector Participation	1.10*	1.66	-.38	.74	.05
Months of Breastfeeding[d]	-.53**	-.31	-.08*	.20	.13
Hours of Work	.10	.30	.13	.56*	-.33
Live Births Since EQ.	.22**	-.12**	.02	-.02	-.53**
Age at First Birth	.01	.08	-.01**	.02	.09**
Food Expenditure per A.E.	.19**	.37**	.10**	.30**	-.05
Nutritional Status[e]	-.02	.42	-.00	.21*	.46**
Child Mortality	.57	-.59	.10	-.01	-1.86**

Notes: *: Coefficient estimate significant at the 10% level.
**: Coefficient estimate significant at the 5% level.

(a): The elasticities are calculated at the means of the variables.

(b): The elasticities in this column incorporate the effect of education on wages. From Table B-2 in the Appendix the elasticities of the informal and formal sector wages with respect to education are .72 and .62, respectively, as weighted averages of the Managua and other urban elasticities.

(c) The elasticities from the logit equations use the following formula for the partial derivative of the predicted probability of alternative j with respect to variable i:

$$P(j) \cdot [b_{ji} - \sum_{j=1}^{3} P(j) \cdot b_{ji}]$$

where b_{ji} = estimated coefficient on variable i for alternative j, and the P(j) are calculated at the means.

(d) The elasticities for the tobit equations use the following formula for the partial derivative of the endogenous variable with respect to variable i:

$$b_i \cdot F(Z)$$

where b_i is the coefficient on variable i, $Z = \frac{1}{\hat{\sigma}} \sum_{j=1}^{3} P(j) . b_{ji}]$, $\hat{\sigma}$ = estimated standar error of the residuals, X_j = the jth exogenous variable, and F(.) is the cumulative distribution function of the standard normal variate.

(e) Elasticities for nutritional status could not be calculated because of the nature of the standardized height variable, which could have a mean of zero. The numbers reported here are the effects of 10% increases in the exogenous variables on standardized height, so they are measured in units of standard deviations of height.

nutritional status. Increases in formal sector wages will have similar effects on fertility, mortality, and nutrition, but apparently will not draw women into the formal sector. These results tend to substantiate the views of those who advocate promoting the expansion of formal sector jobs for women as a means of hastening the decline of fertility rates in developing countries. The improvement in nutrition and decrease in mortality of children which would apparently accompany the fertility decline provide an even stronger rational for such a policy.

Appendix A

Comparative Static Results

This Appendix presents a comparative static analysis of the model presented in the text. The analysis is carried out for the informal sector version of the model and it is then shown how the results are modified for the formal sector version and the no work version. The separability assumption regarding the utility function made in the text is maintained here, so it is assumed that $U_{CZ} = U_{NZ} = 0$. Interior solutions are assumed throughout the analysis.

In the informal sector version of the model the household maximizes the Lagrangean

$$\pounds = U(N[T, \bar{T} - T, X, C], C, Z)$$

$$+ \lambda(W_I(\bar{T} - T) + E - X - P_Z.Z)$$

The first order conditions for a maximum given in the text are repeated here:

$$\frac{\partial \pounds}{\partial C} = U_N.N_C + U_C = 0 \qquad \text{(A1)}$$

$$\frac{\partial \pounds}{\partial T} = U_N.(N_T - N_J) - \lambda \cdot W_I = 0 \qquad \text{(A2)}$$

$$\frac{\partial \pounds}{\partial X} = U_N.N_X - \lambda = 0 \qquad \text{(A3)}$$

$$\frac{\partial \pounds}{\partial Z} = U_Z - \lambda \cdot P_Z = 0 \qquad \text{(A4)}$$

$$\frac{\partial \pounds}{\partial \lambda} = J.W_I + E - X - P_Z.Z = 0 \qquad \text{(A5)}$$

Totally differentiating these five equations and rearranging the results leads to the following matrix equation:

$$\begin{bmatrix} a & b & c & 0 & 0 \\ b & d & e & 0 & -W_I \\ c & e & f & 0 & -1 \\ 0 & 0 & 0 & U_{ZZ} & -P_Z \\ 0 & -W_I & -1 & -P_Z & 0 \end{bmatrix} \cdot \begin{bmatrix} dC \\ dT \\ dX \\ dZ \\ d\lambda \end{bmatrix} = \begin{bmatrix} 0 \\ \lambda \cdot dw_I \\ 0 \\ \lambda \cdot dP_Z \\ -dE - J \cdot dW_I + Z \cdot dP_Z \end{bmatrix} \qquad \text{(A6)}$$

where

$$a = U_N \cdot N_{CC} + U_{CC} + U_{NC} \cdot N_C + N_C\,(U_{NN} \cdot N_C + U_{CN}) \gtrless 0$$

$$b = U_N(N_{TC} - N_{JC}) + (N_T - N_J)\,(U_{NN}N_C + U_{CN}) \gtrless 0$$

$$c = U_N N_{CX} + N_X(U_{NN}N_C + U_{CN}) \gtrless 0$$

$$d = U_N \cdot (N_{TT} + N_{JJ}) + U_{NN}(N_T - N_J)^2 < 0$$

$$e = U_N \cdot (N_{TX} - N_{JX}) + U_{NN} \cdot N_X(N_T - N_J) \gtrless 0$$

$$f = U_N \cdot N_{XX} + U_{NN} \cdot N_X^2 < 0$$

The second order conditions for a maximum require that $a < 0$, $a(w_I \cdot f - d) < (b - c \cdot w_I)^2$, and $D > 0$, where D is the determinant of the bordered Hessian matrix in A6. These conditions will be assumed to hold. By using Cramer's rule to solve equation A6 and allowing one exogenous variable at a time to vary the following comparative static derivatives can be derived:

$$dC/dE = -\frac{1}{D} \cdot U_{ZZ} \cdot (-b\cdot(f.w_I - e) + c(e.w_I - d)) \gtrless 0$$

$$dC/dw_I\Big|_{U=\bar{U}} = -\frac{1}{D} \cdot \lambda \cdot (P_Z^2\,(c\cdot e - b\cdot f) + U_{ZZ}\cdot(b - c\cdot w_I)) \gtrless 0$$

$$dC/dP_Z\Big|_{U=\bar{U}} = \frac{1}{D} \cdot \lambda \cdot P_Z(-b\cdot(f\cdot w_I - e) - c(d - e\cdot w_I) \gtrless 0$$

$$dT/dE = \frac{1}{D} \cdot U_{ZZ}\,(-a\cdot(f\cdot w_I - e) + c\cdot(c\cdot w_I - b)) \gtrless 0$$

$$dT/dw_I\Big|_{U=\bar{U}} = -\frac{1}{D} \cdot \lambda \cdot(P_Z^2\cdot(a\cdot f - c^2) + a\cdot U_{ZZ}) < 0$$

$$dT/dP_Z\Big|_{U=\bar{U}} = \frac{1}{D} \cdot \lambda . p_Z\cdot(a(f.w_I - e) - c\cdot(c\cdot w_I - b)) \lesseqgtr 0$$

$$dX/dE = -\frac{1}{D} . U_{ZZ}\cdot(a(d - e\cdot w_I) - b\cdot(c\cdot w_I - b) \gtrless 0$$

$$dX/dw_I\Big|_{U=\bar{U}} = -\frac{1}{D} \cdot \lambda \cdot (P_Z^2(-a\cdot e + b\cdot c) - aU_{ZZ}\cdot w_I) \gtrless 0$$

$$dX/dP_Z\Big|_{U=\bar{U}} = \frac{1}{D} \cdot \lambda \cdot P_Z(a(d - e\cdot w_I) - b(c\cdot w_I - b)) \gtrless 0$$

$$dZ/dE = \frac{1}{D} \cdot P_Z\,(a\cdot(e^2 - d\cdot f) - b\cdot(-b.f + e\cdot c) - c\cdot(b\cdot e - c\cdot d)) \gtrless 0$$

$$dZ/dw_I\Big|_{U=\bar{U}} = \frac{1}{D} \cdot \lambda \cdot P_Z\cdot(a\cdot(f\cdot w_I - e) - c\cdot(c\cdot w_I - b)) \gtrless 0$$

$$dZ/dP_Z\Big|_{U=\bar{U}} = \frac{1}{D} \cdot \lambda \cdot (-(c\cdot w_I - b)^2 + a\cdot(2\cdot e\cdot w_I - d - w_I^2.f) < 0$$

None of the income effects can be signed with certainty but in the absence of any inferior goods or factors they would all be presumed positive. The signs of the compensated wage and price effects are uncertain with the exception of the own price effects

(dT/dw_I $U=\bar{U}$ and dZ/dP_Z $U=\bar{U}$) which are both negative. In order to derive stronger predictions one must impose more structure on the model. For example, one strong assumption would be that the production function is strongly separable, i.e. all cross partial derivatives of $N(\cdot)$ with respect to the inputs are equal to zero. Under this assumption the terms a,..., f become simpler and one can show that b>0, c>0, e<0, and the first order conditions imply that $b - c \cdot w_I = 0$. This would lead to the following predictions: $dC/dP_Z| U=\bar{U}>0$, $dT/dP_Z| U=\bar{U}>0$, $dX/dP_Z| U=\bar{U}>0$, and $dZ/dw_I| U=\bar{U}>0$, with the other two wage effects still uncertain.

To find the effects of changes in E, w_I, and P_Z on N, the production function is differentiated with respect to these variables. Thus $dN/dE = (N_T - N_J) \cdot dT/dE + N_X \cdot dX/dE + N_C \cdot dC/dE$ cannot be signed even if all income effects were positive since $N_C < 0$.

The signs of $dN/dw_I| U=\bar{U}$ and $dN/dP_Z| U=\bar{U}$ are also uncertain even under the strong separability assumption on the production function. This is due to uncertainty about the direction of the effects of w_I on C and X, and to the offsetting effects on N of the increases in T, X, and C induced by a compensated increase in P_Z.

The comparative static results for the formal sector model are identical to those for the informal sector model with w_F and H substituted for w_I and J, and $N_J = N_{JJ} = N_{JC} = N_{JX} = 0$. In the no-work version of the model $T = \bar{T}$ and $H = J = 0$ and the only decisions are how to allocate income between X and Z and where on the N-C tradeoff locus to be. Changes in w_I and w_F have no effect at all in this case, the compensated P_Z effects are all similar to the informal sector case, and the income effects are still uncertain in sign unless inferior goods and factors are ruled out.

Appendix B

Wage Estimation Procedure

In this Appendix the procedure used to obtain estimates of the informal and formal sector market wage offers facing all women in the sample is described. If women who work differ systematically from non-working women in some unmeasured characteristics then selectivity bias could result from imputing wages for all women based on regressions using the working subsample. This problem has a commonly used solution (Heckman 1976) but an added twist is introduced by the need to obtain predictions for all women of separate market wage offers for the two sectors. Separate wage regressions for informal sector workers and formal sector workers are required but rather than the usual dichotomous selection problem (in or out of the labor force) there is a trichotomous selection problem (informal sector, formal sector or out of the labor force).

A selectivity correction procedure developed by Hay (1980) is ideally suited to this problem. The mechanics of the procedure and the results are given below, and the reader is referred to Hay's paper for a detailed derivation of the procedure, and to Heckman (1976) for a general discussion of selectivity bias.

The first step of the procedure involves running maximum likelihood trichotomous logit on the informal-formal-no work trichotomy with a small set of exogenous right hand side variables which enter either a market wage offer function or a home value of time function. The variables used here include the woman's education, potential years of work experience (age minus education minus five), experience squared and family income other than her earnings. The results, shown in Table B-1, are given for Managua and other urban area separately although in the text the two urban areas

Table B-1

Maximum Likelihood Trichotomous Logit Estimation of the Informal Sector, Formal Sector, No Work Choice[a]

	Managua		Other Urban	
Informal Sector				
Intercept	-2.04	(7.78)	-2.46	(7.95)
Education	.25	(12.93)	.21	(10.86)
Experience	.026	(1.15)	.065	(2.49)
Experience Squared	-.017	(.32)	-.083	(1.35)
Biweekly Family Income Other than Woman's Earnings ÷ 100	-.0051	(.70)	-.0076	(.97)
Formal Sector				
Intercept	.78	(3.07)	.68	(2.43)
Education	-.14	(7.96)	-.09	(5.12)
Experience	.015	(.67)	-.024	(.99)
Experience Squared	-.034	(.68)	(.069)	(1.30)
Biweekly Family Income Other than Woman's Earnings ÷ 100	-.0519	(5.54)	-.0257	(2.84)
Sample Size	1,638		1,291	
Log of likelihood Function	-1,528		-1,181	

Notes: (a) The coefficients are normalized such that the coefficient vectors for the three alternatives sum to a zero vector. The coefficient vector for the no work alternative, not shown here, equals minus the sum of the coefficient vectors for the two other alternatives are always run together. The reason for this is to impose as few constraints as possible on the wage prediction procedure. Also note that the samples used here are larger than those used in the text: they include all observations with non-missing values of the few variables used here, rather than only observations with non-missing values for all variables used in the analysis in the text. The reason again is to use the maximum information possible.

The next step is to use the results from Table B-1 to construct variables which are inserted in wage regressions to serve as controls for the selection bias arising from the wage imputation procedure. The formula for the informal sector selection bias control variable which is derived in Hay (1980), is

$$\lambda_I = \frac{6}{\pi^2} \cdot [\frac{1}{3} \cdot (\frac{P_N}{1-P_N} \cdot \text{Log } (P_N)) + \frac{1}{3} \cdot (\frac{P_F'}{1 - P_F} \cdot \text{Log}(P_F)) + \frac{2}{3} \cdot \text{Log } (P_I)]$$

where P_N = predicted probability of not working, P_F = predicted probability of working in the formal sector, and P_I = predicted probability of working in the informal sector. The formula for a typical one of these predicted probabilities, P_i, is given by

$$P_i = \frac{e^{\underline{\beta_i}\underline{X}}}{\sum_{j=1}^{3} e^{\underline{\beta_j}\underline{X}}}$$

where $\underline{\beta_i}$ is the vector of coefficients for alternative i, $\underline{X}$ is the vector of right hand side variables, and $\underline{\beta_j}$ is the coefficient vector for alternative j, j = no work, formal sector, informal sector. The formula for the formal sector selection bias control variable, λ_F , is the same as for λ_I

with the F and I subscripts in the formula switched.

Finally, for each sector and region a regression of the log of the woman's hourly wage was run on education, potential experience, experience squared, and the selection bias control variable λ_I or λ_F. The results are shown in Table B-2 along with similar regressions without the λ's for comparison. These results do not always accord with one's prior notions concerning relative magnitudes of coefficients in different sectors and regions, particularly when the λ terms are included. For example, one would expect a higher rate of return to education in the formal sector and the results generally confirm this except for the case of Managua when the λ terms are included. The λ's are significant at the 5% level in one out of four cases, and in some cases the omission of λ yields drastically different coefficient estimates for the remaining variables, particularly in the informal sector equations. In the absence of any strong indication that selection bias is or is not important in this sample, an arbitrary decision was made to impute log wages based on the equations which include the λ's.

Table B-2

Linear Regression Estimates of the Log of
The Woman's Hourly Wage by Sector and Region

	Managua		Other Urban	
Informal Sector				
Intercept	-3.41 (1.98)	-.79 (1.97)	1.59 (1.18)	-.07 (.18)
Education	.29 (2.42)	.11 (4.59)	.01 (.09)	.09 (3.85)
Experience	.14 (3.88)	.12 (3.55)	.04 (.96)	.06 (1.90)
Experience^2	-.24 (3.23)	-.23 (3.08)	-.11 (1.49)	-.14 (2.02)
λ_I	-1.50 (1.57)		.86 (1.30)	
R^2 (F)	.10 (7.6)	.10 (9.2)	.12 (7.4)	.12 (9.3)
n	267	267	217	217
Formal Sector				
Intercept	.16 (.73)	.17 (.73)	-.38 (1.03)	-.16 (.47)
Education	.10 (5.26)	.15 (10.31)	.16 (6.79)	.18 (9.58)
Experience	.03 (1.46)	.02 (1.36)	.002 (.08)	.008 (.26)
Experience^2	-.01 (.25)	.01 (.13)	.08 (1.15)	.07 (.94)
λ_F	-.42 (3.90)		-.45 (1.48)	
R^2 (F)	.34 (33.5)	.30 (37.6)	.37(25.5)	.37 (33.1)
n	271	271	176	176

Notes

[1]See Blau (1980, Chapter 1) for a review of evidence on the harmful effects of malnutrition on children and the extent of malnutrition in developing countries.

[2]The household production model owes its original formulation to Becker (1965) and was developed more intensively and applied to fertility decisions by Willis (1974). The model has now been used frequantly in developing country contexts; see, for example, Rosenzweig and Wolpin (1980).

[3]See Blau(1980, Chapter 4) for discussion of a more fully specified model.

[4]Cogan (1977) found that fixed money and time costs of working amounted to about one quarter of the average annual earnings of women in a U.S. sample.

[5]See Rosenzweig and Wolpin (1980) for a discussion of the types of restrictions that must be imposed on the household production model in order to derive more testable hypotheses.

[6]The survey was funded by the Population and Development Policy Research Program of the Ford and Rockefeller Foundations and the Agency for International Development. The principal investigators for the overall project of which the survey is a part are Jere R. Behrman (University of Pennsylvania), Barbara L. Wolfe (University of Wisconsin-Madison), Humberto Belli (Centro de Investigaciones Sociales Nicaraguense) and Antonio Ibarra (Banco Central de Nicaragua).

[7]It is unknown to what extent the data are randomly missing. See Behrman, Flesher and Wolfe (1979) and Behrman and Wolfe (1980) for further discussion of this issue as it pertains to the Nicaragua data.

[8]See Behrman, Wolfe and Gustafson (1980) for a description of the characteristics of the whole sample.

[9]The reference population used in this study is that of the United States (see National Center for Health Statistics 1976). Habicht et al. (1974) discuss the appropriateness of using norms from developed countries as a standard for use in developing countries.

[10]See Pan American Health Organization (1973) for evidence on the relationship between malnutrition and infant and child mortality in Latin America. Mortality of children born after the Managua earthquake of 1972 is used because of the unusually high mortality among children living in 1972 caused by the earthquake.

[11]If cross equation restrictions could be derived from analysis of the theoretical model then imposition of these restrictions by using joint estimation techniques could increase efficiency. The theoretical model is so highly simplified, however, that this step is not taken since the validity of the restrictions would be in serious doubt.

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