PN-AAP-351
ISN 33563

"The Household Demand for Nutrition Inputs in a Developing Country"

by

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NPP No. 20
December 1979

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Section 1. Introduction

At least since the writings of Malthus, economists interested in long-run growth and development have been concerned about the determinants of the consumption of nutrients. In recent years this concern has focused on the inadequacy of present systems for satisfying the basic nutritional needs of literally hundreds of millions of people in the developing world. Malnutrition is posited to have negative short- and long-run effects on physical and intellectual development, which lessen the overall quality and the length of life and reduce productivity. Recent studies document the importance of many of these effects.[1]

In this paper we contribute to the understanding of nutrition in developing countries by examining the determinants of household nutritional inputs for families in Managua, the major metropolitan area of the Central American developing country of Nicaragua. We focus on the demand for four basic nutrients for that population -- proteins, calories, iron, and vitamin A. We concentrate on these nutrients because deficiencies in their consumption are the major forms that malnutrition takes in Nicaragua.[2] Protein and caloric deficiencies are widespread throughout the developing world, and the consequences are well known. Other nutritional deficiencies depend upon local dietary customs and agricultural supplies. Shortages of iron cause anemia and lower productivities. Shortages of vitamin A cause vision disabilities. Since the total impact of these nutrients may depend upon the combination in which they are consumed, we also consider three aggregates in which the four individual nutrients (normalized by international standards[3]) are combined in a "production function" for overall nutritional intake: the minimum of the four which implies an elasticity of substitution of zero among them, the product of the four which implies an elasticity of substitution of one among them, and

the sum of the four which implies an elasticity of substitution of infinity among them.

We estimate extended demand functions for each of the seven resulting measures of nutrition intake. In Section 2 we discuss the specification of the model and define most of the independent variables. In Section 3 we introduce our data set and define the nutrition-related variables. In Section 4 we present our estimates and comment on their implications. In Section 5 we present our conclusions.

Section 2. Specification of the Demand for Nutrition Intake

We begin with the traditional core determinants in microeconomic demand functions: income or wealth, prices, and family size. We note some special considerations for these factors. We then extend the basic model to incorporate the special role of women in the determination of nutrition intakes and the role of women's nutritional knowledge in particular. We conclude with a few comments about functional forms.

Subsection 2.1. Core Determinants: Income or Wealth, Prices, and Household Size

In the simpl basic framework, nutritional inputs are merely particular examples of consumption goods that enter into the household preference function. Maximization of this preference function for given household income or wealth, household size, and market prices gives microeconomic household demand functions that depend on these variables.[4] This framework

is too simplistic, but does serve as a useful starting point.

We represent household income or wealth by two measures: current potential income and a hedonic housing index. We define current potential income to be the estimated earnings for the woman in the household on the basis of her human capital stock plus other household income. We use estimated rather than actual earnings for the women since about half of the women in our sample were not participating in the labor force at the time of our survey. We include women's estimated earnings as a variable in addition to other income instead of summing the two because of the difference in definitions between these two variables.

Our earlier work on the determination of earnings for women and men in Managua in Behrman, Wolfe and Tunali (1979) suggests two further relevant considerations about our representation of income. First, as we also note above, productivity and thus earnings may depend on nutritional status. If there is such a dependence, single equation estimation of the demand for nutrition inputs is subject to simultaneity bias which results in an overestimate of the impact of income on nutrition demands. We keep this possibility in mind in our interpretation of our results below in Section 4. Second, the labor market in Managua appears to be pluralistic with significant differences among sectors in the nature of employment relations and the form of payment. What is most important from the point of view of the present study is that women who work as domestics receive considerable payment in kind in the form of food for themselves and often for other members of their household. The nutritional composition of this food

often is determined by their generally wealthier and more educated employers, not by the domestics themselves. Therefore we include in our specification a dichotomous variable with a value of one if the woman works as a domestic and a value of zero otherwise to test if this payment in kind affects the average nutritional intake of households of domestics.[5]

We use a hedonic housing index to represent physical wealth because housing often is the most important single physical asset for the households in our sample and because our data do not permit the construction of a more comprehensive measure of physical assets. This index is based on the materials used in the construction of the dwelling, the size, the type of sewage and plumbing, and some neighborhood characteristics. In addition to this overall measure of the quality of housing, we include a dichotomous variable to represent the presence or not of refrigeration since in the tropical climate of Managua refrigeration expands significantly the food and nutrient options for a given frequency of food purchasing. However some households without refrigeration may have low opportunity cost means of substituting labor for this consumer durable by having extended family members or domestics shop for food with greater frequency.

We do not have a direct measure of variations in the prices of nutrition inputs in our cross-section data. However we partially represent price differentials across households by neighborhood population densities. As is generally the case in spatial economics, where these densities are higher, food markets tend to be more frequent, more competitive, and more accessible so that the total costs of purchasing nutrients (including the time and transportation

costs) tend to be lower than in more sparsely settled areas. For most cities such spatial price differences might not be important, but for Managua they are quite significant. This is so because the 1972 earthquake destroyed the commercial center of the town and key elements of the urban transportation network. Reconstruction was not permitted in the area of the earlier commercial center, but was spread out over a wide geographical area.[6] Intra-Managuan transportation is relatively costly in terms of time and direct nominal charges. As a result at the time of our 1977 survey Managua was much more spatially fragmented in regard to food markets than normally would be the case for a central city of about a half million inhabitants in a country with Nicaragua's level of development.

Within the simplest model, the size of the household is inversely related to the per capita availability of income or wealth for expenditure on food or on other items, ceteris paribus. However there are considerations which work in the opposite direction. Larger households may be able to purchase food at lower unit prices if there are quantity discounts. They also may be able to exploit some economies of scale in intra-household food production, given transaction costs associated with marketing. Moreover larger households may have more variety in their diets that leads to better nutritional balance because of economies of scale in food preparation and the need to cater somewhat to the differing tastes of more individuals. Thus the total impact of household size on the demand for nutritional inputs may be positive or negative, depending on which factors dominate.

Our earlier work on fertility determinants in Behrman and

Wolfe (1979b) suggests some possibility of simultaneity bias between household size and nutrition through the feedback of nutrition on fertility. There appears to be a direct positive effect of nutrition on desired family size that is reinforced by the income effect of nutrition on earnings, but offset at least in part by the price or opportunity cost impact of nutrition on women's earnings. The net effects, however, apparently are not very large.

Subsection 2.2. Women's General Characteristics and Nutrition and Health Knowledge

Women tend to play major roles in determining nutrition intakes in Nicaraguan households. Given the cost of obtaining information about nutrition and the relations among various foods and different nutrients, women with greater general capacity for evaluating the available information or with better nutritional habits may provide better nutritional inputs for their households than women with less capacity or worse nutritional habits, given the same income, market prices, and household size.[7] The general capacity for evaluating nutritional information and the existence of good nutritional habits would seem to depend on the woman's age, formal education, and other background characteristics. Among these other background characteristics we are able to represent empirically whether or not both of her parents were present in her childhood, the education of each parent (or of other raisers), the social economic status of each parent, her migratory status, and whether or not she has suffered from parasitic diseases. We

interpret the last variable as representing the nature of important hygenic practices that are associated closely with significant nutrition-related activities.

In addition to these general capabilities, there are questions concerning the nature of the more specific nutrition and health knowledge of the women. We represent this more specific knowledge by variables that are created from the women's responses to questions concerning the causes of diarrhea and which foods are best (see Section 3 below).

The extent to which women may be able to utilize their general cabilities or the more specific health and nutrition knowledge, however, may depend upon the type of household structure. Women in formal marriages, for example, may have different (greater?) power in decision making than women in common law relations either because of differential social status or because of differential expectations regarding the longevity of the relation. Therefore we include in our relations dichotomous variables for the marital status of the woman.

Given the extent of misinformation about nutrition, the extention of the standard model to include proxies for general capabilities for evaluating information, good nutrition habits, and specific nutrition and health knowledge is important for at least two reasons. First, it lessens the probability of omitted variable bias in the coefficient estimates of other variables. The estimate of the coefficient of the woman's expected earnings, for example, otherwise might be biased upwards because of the positive correlation between that variable and omitted variables -- like education -- that pertain to her general capacity for evaluating information about nutrition.

Second, the extention of the model in this direction leads to the possibility of richer and more realistic implications of how policies might improve nutrition inputs, such as education about the characteristics of important foods.

Subsection 2.3. Functional Forms

We could posit a specific explicit functional form for the household preference function and derive explicit demand functions for the nutrition inputs. We do not do so because the specification of the preference function would be fairly arbitrary. Moreover, the incorporation of the proxies for general capabilities and habits and specific nutrition and health knowledge also would be quite arbitrary. Furthermore the data, while rich in many respects, probably are too crude to discriminate with much confidence about higher order properties of functional forms. Therefore we limit our explorations to the simplest linear case.[8]

Section 3. Data and Nutrition Input and Knowledge Variable Definitions

Our original data set is a random sample of 1294 households in Managua in 1977 that was collected as part of a larger survey and study on the socioeconomic role of women in that developing country.[9] For 127 households data on some important variables are missing. Initial explorations convinced us that it is reasonable to assume that the missing values are random.[10] On the basis of Monte Carlo experiments on various procedures for dealing with randomly missing observations that we report in

Wolfe, Behrman, and Flesher (1979), we decided to limit our basic analysis to the 1167 households for which we have complete information on all of the major variables. For 430 of these households, however, secondary -- but still quite interesting -- information on the education of the woman's parents is not available. Therefore we focus on estimates for the 1167 households, but also present identical estimates except that the woman's parents' education is included for the 737 households for which these data are available.[11,12]

In the previous section we have defined most of the relevant variables. However we still need to elaborate on the construction of two critical groups of variables: the measures of the basic nutrients and the measures of nutritional knowledge.

We define the nutrition inputs for the four basic nutrients by multiplying the number of times each of 15 food groups was served per week by the nutritional content per serving for each nutrient as given in Adams and Richardson (1975) and then summing for each nutrient across the food groups. We then normalize by the international minimum standards for each nutrient, as given in NAS (1968) and WHO (1974). We use each of the four normalized nutrition input measures as a dependent variable in one set of estimates of the demand for nutritional inputs. We also use them to construct the three aggregate nutrition input measures that are defined in Section 1: minimum, product, and sum.

In Table 1 we present correlation coefficients across the 1167 households among the seven nutrition input measures that we use as dependent variables in our regression estimates.

All of these correlation coefficients are significantly nonzero. Therefore any one of the nutrition measures could serve as a proxy for the others in a representation of overall nutrition inputs. But in some cases -- in particular those that involve vitamin A -- the proxies often would not be all that good. The variances in calories and proteins, the two most emphasized measures, for example, are consistent with only about a third of the variance in vitamin A.

The correlations among the three aggregate measures are fairly high (0.80 to 0.92). For this sample therefore the variations in the aggregate measures do not seem to be very sensitive to a wide range of assumptions about the elasticity of substitution among the four basic components, since our aggregates span the range from no to complete substitutibility. We also note that minimum is very highly correlated with iron and calories -- the two most highly correlated of the basic four nutrition inputs, one or the other of which often represents the minimum of the four normalized nutritional inputs.

We define nutritional knowledge on the bases of the responses to a question about what are the three best foods. For one set of regressions for all seven nutrition input variables we simply include dichotomous variables for whether or not items in each of 10 food groups are mentioned in response to this question. These food groups are (with the percentage of women who included each one in their responses in parentheses): meat (76%), dairy (73%), eggs (37%), beans (25%), vegetables (19%), fruits (12%), rice (11%), grains (10%), corn (9%), and junk foods (7%).[13]

For the four basic nutrition inputs we also use alternative nutrient-specific measures that we construct from the same

responses. On the bases of the three foods mentioned by a respondent and the nutrient content of those foods, for each of the four basic nutrients we classify the household by whether its best foods response indicates high or low levels of each of the nutrients. We then use a dichotomous variable with a value of one if the household is in the high category for a particular nutrient (and zero otherwise). By this measure of nutrient-specific knowledge, the percentages of households in the high category are 79 for proteins, 49 for calories, 9 for iron and 72 for vitamin A.[14]

Section 4. Estimates of the Household Demands for Nutritional Inputs

Table 2 includes our estimates of the extended nutrition model for 1167 households in Managua for each of the seven nutrition measures. For all seven measures a regression is included with the ten dichotomous food group variables for nutritional knowledge. For the four disaggregate nutrition input indices, there also is presented preferred alternatives that use the nutrition specific knowledge dichotomous variables. Table 3 gives one preferred relation for each of the seven nutrition input variables for the 737 households for which data are available for the woman's parents' education. The independent variables in both tables are grouped into the five categories around which the discussion of the model specification in Section 2 is organized. We follow this same organization in our discussion of the results. As we note above, we focus on the estimates in Table 2 except for the role of the woman's parents' education.

Some of the income or wealth variables have significantly positive coefficient estimates in each of the regressions. The most consistently important of these variables is the dichotomous variable for the women working as domestics. This occupation is estimated to result in an increase equal to about one-third of the international minimum standards for proteins, 16 percent for vitamin A, and 8-9 percent for calories and iron.[15] These are quite substantial increases! The impact of in-kind food provided by employers on the nutritional state of the households of domestics is quite large. The pattern across the nutrients also is interesting, with the greater meat consumption causing a particularly large rise in proteins and the greater green and yellow vegetable consumption also resulting in a relatively large increase for vitamin A.

The second most consistently important of this group of variables is the dichotomous one for the presence of refrigeration in the household. Having such refrigeration results in an estimated increase in 9-10 percent of the international standards for proteins and vitamin A and 1-1.5 percent for calories and iron (although not quite significantly nonzero at standard levels for the latter), as well as significant increases for all three of the aggregate measures. Apparently household refrigeration has a nutritional payoff, particularly regarding meats and yellow and green vegetables, ceteris paribus.[16] Low opportunity cost labor might substitute partially for this durable consumer good by shopping more as is hypothesized above, but apparently not completely.

may be a proxy for other things - can w/ Y, S.E. etc.

Other income has significantly positive coefficient estimates, once again, for proteins and for vitamin A and for the two aggregates that depend substantially on these two

nutrients, product and sum. Increasing income of the poorer members of society, thus, tends to increase their intake of two important nutrients. However the estimated impact is not all that large. To increase the estimated nutritional inputs by as much as switching to a job as a domestic worker, for example, would require an income increase of 13.3 standard deviations of the other income distribution for protein, 2.0 standard deviations for vitamin A, 9.4 standard deviations for product, and 8.0 standard deviations for sum.

Of course it is possible that the coefficients of income are biased towards zero. There certainly may be measurement error in the other income variable that may cause such a bias. Some other variables (or some linear combination thereof) may be representing part of the variation in income, although alternative estimates suggest that the most likely candidates (e.g. the hedonic housing index, the woman's estimated earnings, the presence of refrigeration, the woman's education) are not doing so. The simultaneity bias possibility that we mention above in Section 2 would seem to work in the opposite direction. All in all, although we think that it is possible that the coefficient estimates of the other income variable are biased towards zero, we do not perceive any reason to think that they are biased by a factor of 10 or larger. And unless there are biases of at least such a magnitude, these estimates suggest that raising the income of the poor has some significant, but not very substantial impact on their nutritional intake. Probably more direct measures would be more effective in the pursuit of such a goal. The direct provision of important nutrients at schools, nurseries and day-care centers would be one example.

The general lack of significance of the coefficient estimates for the woman's estimated earnings and for the hedonic housing index reinforces our scepticism about the efficacy of depending on income changes alone to improve the consumption of nutrients. The former approaches significance only for proteins and product, and the latter only for vitamin A.

We interpret the neighborhood population density to be representing differences in food total costs (including time and transportation costs), as we discuss in some detail in Section 2 above. The coefficient estimates in Table 2 indicate that the population density is a significant factor for most of the alternative nutritional input dependent variables, although not quite so for proteins and product. The largest relative estimated impact is for vitamin A. Under our interpretation, these estimates suggest that market integration and transportation improvements would result in significant nutritional improvements.

The number of people in the household may represent conflicting factors, as we discuss above. More people places more demands on given resources. On the other hand, there may be economies of scale in purchasing, producing, or preparing food and more people with varied tastes may result in a more varied and more balanced diet. The estimated relations suggest that the latter group of factors dominate. With the exception of vitamin A, all of the relations have significantly positive coefficient estimates for this variable. They imply increases of from 0.4 to 0.8 percent of the international minimum standards for each additional member of the household.

We include a number of the woman's general characteristics because of her critical role in evaluating conflicting information about nutrition and in forming household nutritional habits.

The woman's education is the most important empirically of these characteristics. It has significantly positive coefficients in every case in Table 2. The estimates imply that an added year of schooling for the woman results in an increase of 0.3 or 0.4 percent of the minimum international standards for iron and calories, 1.3 percent for protein, and 2.4 percent for vitamin A. If there are no omitted variable or other biases, these estimates suggest that there is a significant return to women's education in developing countries that often is not mentioned by economists. This is in addition to the much more commonly emphasized returns in terms of increasing productivity and earnings and in regard to fertility.[17] We qualify the strength of this conclusion, however, because of the possibility that our estimates in Table 2 suffer from inadequate control for ability and motivation and family background, all of which probably are correlated with the woman's education.[18] A comparison between Tables 2 and 3, for example, suggests that the estimated returns to the woman's education are reduced somewhat once her mother's education is included.

The empirically second most important of the woman's general characteristics is whether or not she has had parasitic diseases. The coefficient estimates for this variable are significantly negative for all of the regressions in Table 2. They suggest that following practices that avoid such diseases is associated with an improved nutrition input of a little over 1 percent of the minimum international standards for calories and iron and of 4-6 percent for vitamin A and proteins.

As we discuss in Section 2, we interpret this association to reflect related general household and food preparation activities that are associated with less probability of having parasitic diseases and better nutrition, ceteris paribus. As such, the parasitic disease variable reflects omitted variables pertaining to ability, motivation, and family background. A comparison between Tables 2 and 3 suggests that it is playing such a role.

The status of the woman's parents (or other raisers) also has a significant impact on nutrition in her household. Having both raisers present in her youth has significantly positive coefficients for proteins, calories, product and sum in Table 2 (and almost significant estimates for the other cases), with the largest estimated impact on proteins. The estimates in Table 3 suggest that having both raisers present really is about equivalent to having a male raiser present (since over 96 percent of the women had female raisers present but only 61 percent had male raisers present). The estimates in Table 3 also imply that women with more educated mothers also have significantly better nutritional habits or capabilities for evaluating nutritional information. Every additional year of the woman's mother's education is associated with an additional 1-2 percent of the international minimum standards for proteins and vitamin A, and significant (although smaller) effects in the other cases. Thus women's education may have a striking intergenerational effect that is of the same magnitude as the intragenerational one, although the above caveat about omitted variable bias still should be kept in mind.

Prima facie this pattern of significant coefficient estimates might suggest to some readers that women who had

better childhoods in an economic sense are better at providing nutritious food for their households as adults, ceteris paribus. Having male raisers present and more educated female raisers might seem to be proxies for higher income. Unfortunately, we do not have available data on the woman's parents' income with which to explore this possibility directly. However the evidence that we do have about the insignificance of the coefficient estimates of other variables suggests that the primary underlying factor is not parental income when the woman was a child. We are referring to the lack of significance of the parental socioeconomic variables that we would expect to be correlated with permanent income, of the woman's father's education that we also would expect to be correlated with household income during the woman's youth, and of the regional (or migration) variables that might reflect lower parental income outside of Managua, particularly in rural areas. Therefore we interpret the pattern of estimates not to be reflecting primarily the purely economic circumstances of the household in which the woman was raised. Instead we think that they pertain to household stability, the kind of role models to which the woman was exposed, as a child, and the general capabilities of her mother (or female raiser) -- whether they were due to formal education or only "signalled" by education.

In Section 2 we posit that the extent to which a woman may implement her general or specific nutrition knowledge may depend upon the institutional structure of the household. Women who are formally married by the state, the church, or both may be in a stronger position to utilize their capabilities in the improvement of household nutrition ceteris paribus than

women in possibly more transitory common law arrangements. Among women who currently have a companion, in fact, the estimates suggest some support for this supposition. The coefficient estimates for common law arrangements generally are negative, although significantly so at standard levels only for product in Table 3. The coefficient estimates for formal marriage arrangements are generally positive and signficiantly so for calories and iron in Table 2. In these two cases they imply an improvement of about 1.6-1.8 percent of the international minimum standards in households with formal marriage arrangements. However, the lack of a significantly positive estimate for being unaccompanied causes us to qualify our interpretation since the logic of this reasoning would seem to suggest that unaccompanied women would have even more opportunity to implement their expertise than formally married women.

The only personal characteristic that we have included in the regressions but have not yet discussed is the woman's age. A priori we would expect that older women might be less informed about current nutritional knowledge given that much of that information seems to come from the household in which they were children and there have been changes over time in nutritional knowledge. On the other hand we would expect some learning by doing and thus expect the coefficient to be positive. In fact in every regression in Tables 2 and 3 the estimated coefficient of the woman's age is negative. The consistency of this pattern suggests that there may be some systematic inverse relation between the woman's age and household nutritional inputs even though none of the individual coefficient estimates is significantly nonzero at standard levels. However the magnitudes are so small that a

difference in the age cohorts of a decade would imply only a change in nutritional inputs of a few percentage points or less of the international minimum standards.

We turn now to the woman's nutrition and health knowledge. We find no significantly nonzero coefficient estimates for the variable regarding knowledge of prevention of diarrhea. Therefore there is not support for our hypothesis that knowledge of good practices regarding diarrhea prevention is associated with knowledge regarding good nutrition practices. In fact that all of the estimated coefficients are negative, even if each is insignificantly different from zero, may suggest an underlying systematic inverse association.

The estimated coefficients of the food groups that are mentioned by the woman in response to the question concerning the best foods have some interesting patterns. The estimates suggest that a response of meat is associated with a significant increase of 6.5 and 1.7 percentage points of the international minimum standards for proteins and iron, respectively, as well as an almost significant 1.7 percent for calories. On the other hand, a response of dairy is associated with significant reductions of -8.4 and -2.1 percent, respectively, of the international minimum standards for protein and calories, and with significant drops in all three aggregate measures. Also a response of vegetables is associated with a significant decline of -6.2 percent for proteins. The other coefficient estimates are not significantly nonzero at standard levels, although positive ones for fruits and negative ones for beans and vegetables are nearly so.

For the four basic nutrients, we also include as an alternative the dichotomous variables that indicate whether or not the respondent ranked highly in regard to the nutrient specific content of her three "best foods". The estimated

coefficients of these variables indicate a definite association between the woman's nutrient specific knowledge and household nutrient inputs. Each of the coefficient estimates is significantly positive at standard levels. They imply input increases in terms of percentages of the international minimum standards of 8.8 for proteins, 1.6 for calories, 2.9 for iron, and 8.7 for vitamin A. These results reinforce our conclusion that general and specific nutritional knowledge plays an important role in the determination of household nutrition inputs, and the simple demand model that ignores differential capabilities and knowledge may be misleading.

Section 5. Conclusions

Malnutrition is a wide-spread problem in the developing world. We contribute to understanding the problem and possible solutions to it by estimating extended demand relations for four basic nutrients and for three aggregates thereof.

We find that the traditional economic income or asset and price variables have significant effects, indicating that increasing the income of the poor and integrating markets will tend to improve their nutritional intakes. While these effects are significant, however, they are not substantial. Relatively much more important for our sample are extentions of the basic demand model to include the receipt of food in kind by domestics, the presence of household refrigeration, the woman's general knowledge and capabilities, and her specific nutritional knowledge. The education of women appears to have a significant return in terms of improving nutrition by

improving the evaluation of nutritional alternatives and the implementation of good nutrition practices on both an intra- and an intergenerational basis.

These results suggest that economic growth and integration will lead to attainment of goals of lessening malnutrition very slowly. Direct food distribution (akin to the food in kind received by domestics) can have a much more immediate effect, but possibly at high costs in terms of other goals. Perhaps some payoff could be obtained from providing or inducing more local refrigeration. Increasing women's education has a definite payoff in terms of nutrition as well as in terms of other goals, but the gestation period is long. On the demand side, perhaps the highest immediate net returns are from efforts to increase nutrition-specific knowledge.[19]

1

For example, see Behrman, Wolfe and Tunali (1979), Behrman and Wolfe (1979a), Reutlinger and Selowsky (1976), Selowsky (1979), and Selowsky and Taylor (1973).

2

AID (1976) provides a nutritional assessment for Nicaragua and emphasizes the critical role of these nutrients.

3

We use for international standards the nutritional norms in Adams and Richardson (1975).

4

We assume the necessary concavity and regularity conditions for such a maximum to exist. We also assume that household preferences can be defined, without worrying about what this implies for household formation or for aggregation of individual preferences. We further assume that income and household size are determined in a prior recursive manner. We explore some of these assumptions and the determinants of these other variables in other papers: the formation of households in Behrman and Wolfe (1980d); the determinants of fertility in Behrman and Wolfe (1979a,b,c); the determinants of income in Behrman and Wolfe (1980f,g), Behrman, Wolfe and Tunali (1979) and Behrman, Wolfe and Blau (1980); and some dimensions of intrafamilial allocations in Behrman and Wolfe (1980c,e) and Behrman, Wolfe and Tunali (1979).

5

The impact would seem to be most direct on the nutritional input of the domestic worker herself and on that of any of her family who lives with her. However domestic workers often provide food from their employers for other family members who do not actually eat or live in the employers' household.

6

The ostensible motive for a more dispersed post-earthquake population distribution was to lessen the probability of so much destruction from another similar localized earthquake. Apparently a related factor was substantial land speculation in the suburban areas by some government officials.

7

Such women also may tend to be more efficient in household production and may tend to utilize food better, but we are not able to explore such a possibility in this study.

8

For populations that are richer and consume more food such functional forms might be inappropriate representations of the effective nutritional state since malnourishment might take the form of too much of the nutrients as well as too little. For the population under study, however, the nutritional state is poor enough that we think that increases over the relevant ranges in the nutrients improves the nutritional state. For two of the four nutrients (i.e. calories and iron), for example, over half of the households in our sample have average per capita intakes below international minimum standards.

9

The larger survey includes information on over 4100 women from urban areas of various sizes and rural areas and includes sisters of a subset of the original respondents (which permits

better control for family background than heretofore has been possible for broad socioeconomic data from developing countries). For descriptions of the data and various studies, see the various papers that are listed in the bibliography by the present authors (in some cases with additional collaborators), Blau (1977, 1980), and Ybarra (1978).

10
In other explorations with this data set we have investigated the possibility of selectivity bias in regard to reporting data in addition to traditional concerns such as labor force participation and migration. Generally we have not found evidence of a significant selectivity bias in reporting data. For an example see Behrman, Wolfe and Tunali (1979).

11
Generally these estimates do not differ much from the basic set for 1167 households, although some variables tend to be less significantly nonzero. We considered the possibility of testing for selectivity into the smaller subsample, but rejected it because some of the possibly relevant variables for such selection -- such as those pertaining to parental background -- are not available and the few that are available (e.g. the woman's age and education) are likely to lead to a collinearity problem if a Heckman (1976) correction is applied. If such selectivity accounts for the changes in our coefficient estimates between the two samples, moreover, our comments below are not altered substantially because they generally are based on the estimates from the larger sample.

12
A similar problem on a much smaller scale exists because of missing observations for parental socioeconomic status. Of the 1167 generally complete observations, 15 do not have data on this variable. However preliminary estimates indicate that the coefficient estimates of parental socioeconomic status are not near significantly nonzero at standard levels. Therefore we focus on the 1167 households for which information otherwise is complete except for the parental education variable that is discussed in the text.

13
These percentages sum to 279%, which is less than 300% because respondents could identify more than one food in a particular food group.

14
We do not construct cardinal measures of nutritional knowledge that are analogous to the actual nutrition input data because the response to the best foods question does not indicate the frequency that such foods would be consumed. Households in the high categories, if they consumed daily one unit each of their three "most important foods", would satisfy at least 25 percent of their minimum daily calorie and iron requirements and at least 50 percent of their minimum daily protein and vitamin A requirements.

15
The estimates in Table 3 indicate, if anything, even larger nutritional returns to domestics.

16
The estimates in Table 3, however, indicate a more marginal impact of refrigeration except for vitamin A.

17 In Behrman, Wolfe and Tunali (1979) we estimate the private returns to education in terms of earnings to be 14 percent for women in Nicaragua. In Behrman and Wolfe (1979a,b,c) we find evidence of a significant impact of women's education on the total desired number of children and on the timing of births.

18 Behrman, Hrubec, Taubman, and Wales (1980) find evidence of a considerable bias in the conventional approach to estimating the returns to education in terms of earnings in developed economies. In Behrman and Wolfe (1980f) we are making similar estimates for our sample of women from Nicaragua.

19 In many cases supply-oriented policies (e.g. removing disincentives for agriculture, providing critical technological and infrastructural inputs with large externalities or public good characteristics or increasing returns to scale) may have higher returns, but these are beyond the scope of the present paper.

TABLE 1: Correlation Coefficients Among Alternative Measures of Normalized Household Nutrition Inputs for 1167 Households in Managua, 1977

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	Proteins	Calories	Iron	Vitamin A	Minimum	Product	Sum
Proteins	1.00						
Calories	.89	1.00					
Iron	.85	.94	1.00				
Vitamin A	.57	.59	.56	1.00			
Minimum	.85	.95	.98	.60	1.00		
Product	.85	.82	.81	.78	.80	1.00	
Sum	.88	.87	.84	.88	.85	.92	1.00

TABLE 2: Estimated Extended Household Demand for Nutrition Inputs for 1167 Households in Managua, 1977[a]

Variables	Proteins		Calories		Iron		Vitamin A		Minimum	Product	Sum
. Income or Wealth											
1.1 Woman's Estimated Earnings	.041 (1.3)	.050 (1.6)	.009 (1.1)	.010 (1.1)	.008 (0.9)	.008 (0.9)	.003 (0.1)	.007 (0.1)	.007 (0.8)	.059 (1.3)	.07 (1.0
1.2 Work as Domestic	.34 (6.2)	.33 (6.1)	.082 (5.5)	.079 (5.3)	.089 (6.1)	.089 (6.0)	.164 (2.2)	.164 (2.2)	.089 (5.6)	.397 (4.9)	.67 (4.8
1.3 Other Income	.032 (2.0)	.032 (2.0)	.003 (0.7)	.003 (0.7)	.004 (1.0)	.004 (0.9)	.063 (2.8)	.064 (2.8)	.006 (1.2)	.053 (2.2)	.10 (2.5
1.4 Hedonic Housing Index	.015 (0.8)	.014 (0.8)	-.000 (0.1)	-.000 (0.1)	-.000 (0.0)	-.000 (0.0)	.040 (1.6)	.039 (1.5)	-.002 (0.4)	.001 (0.0)	.04 (1.0
1.5 Refrigeration	.085 (3.2)	.088 (3.3)	.015 (2.1)	.016 (2.3)	.011 (1.6)	.011 (1.5)	.097 (2.6)	.097 (2.6)	.015 (1.9)	.113 (2.9)	.21 (3.2
2. Neighborhood Population Density	.35 (1.3)	.37 (1.4)	.15 (2.1)	.15 (2.1)	.15 (2.2)	.14 (2.0)	.58 (2.5)	.61 (1.7)	.15 (1.9)	.64 (1.6)	1.3 (1.9
3. Number in Household	.008 (2.0)	.008 (2.2)	.004 (3.4)	.004 (3.5)	.004 (4.3)	.004 (4.2)	.006 (1.2)	.006 (1.2)	.004 (4.0)	.013 (2.3)	.02 (2.5
4. Woman's General Characteristics											
4.1 Age	-.002 (0.7)	-.001 (0.9)	-.000 (0.6)	-.000 (0.3)	-.000 (0.5)	-.000 (0.6)	-.002 (1.1)	-.003 (1.1)	-.000 (0.4)	-.003 (1.2)	-.00 (1.1
4.2 Education	.013 (3.1)	.015 (3.4)	.004 (3.1)	.004 (3.2)	.003 (2.8)	.003 (2.2)	.024 (4.1)	.024 (4.0)	.004 (2.8)	.021 (3.2)	.04 (4.1
4.3 Both Raisers	.051 (2.3)	.052 (2.4)	.012 (2.0)	.012 (2.0)	.009 (1.6)	.009 (1.6)	.045 (1.5)	.045 (1.5)	.010 (1.6)	.078 (2.4)	.12 (2.2
4.4 Migratory Status											
Rural Childhood	-.009 (0.2)	-.008 (0.2)	-.001 (0.1)	-.001 (0.1)	.003 (0.3)	.003 (0.3)	-.012 (0.2)	-.013 (0.2)	.004 (0.4)	-.019 (0.3)	-.01 (0.1

TABLE 2 CONT'D.

Variables	Proteins		Calories		Iron		Vitamin A		Minimum	Product	Sum
Always in Managua	-.107	-.042	-.005	-.006	-.003	-.004	.008	.005	-.003	-.034	-.041
	(0.9)	(1.5)	(0.6)	(0.8)	(0.4)	(0.5)	(0.2)	(0.1)	(0.4)	(0.8)	(0.6)
Mostly in Managua	.050	.019	-.002	.000	-.002	-.002	-.028	-.024	-.000	-.004	.001
	(0.4)	(0.7)	(0.3)	(0.0)	(0.2)	(0.2)	(0.7)	(0.6)	(0.2)	(0.1)	(0.0)
4.5 Had Parasitic Diseases	-.045	-.046	-.013	-.011	-.011	-.012	-.063	-.063	-.012	-.090	-.128
	(2.1)	(2.1)	(2.2)	(1.8)	(1.9)	(2.0)	(2.1)	(2.1)	(1.9)	(2.8)	(2.3)
4.6 Marital Status											
Single	-.030	-.024	-.011	-.012	-.010	-.011	.049	.049	-.010	.013	.006
	(0.6)	(0.5)	(0.8)	(0.9)	(0.8)	(0.9)	(0.8)	(0.7)	(0.7)	(0.2)	(0.1)
Common Law	-.028	-.034	.005	.002	.001	.001	-.034	-.032	-.002	-.041	-.074
	(0.8)	(1.0)	(0.5)	(0.2)	(0.2)	(0.1)	(0.7)	(0.7)	(0.2)	(0.8)	(0.9)
Married	.022	.016	.018	.014	.017	.016	.034	.037	.016	.013	.073
	(0.6)	(0.5)	(1.9)	(1.5)	(1.9)	(1.8)	(0.7)	(0.8)	(1.7)	(0.3)	(0.9)
Nutrition and Health Knowledge											
5.1 Causes of Diarrhea	-.021	-.032	-.002	-.005	-.001	-.000	-.049	-.047	-.002	-.084	-.103
	(0.5)	(0.7)	(0.2)	(0.4)	(0.1)	(0.0)	(0.8)	(0.8)	(0.2)	(1.3)	(0.9)
5.2 High Nutrient Specific "Best" Foods	.088		.016		.029		.087				
	(3.3)		(2.8)		(3.0)		(2.6)				
5.3 "Best" Foods Include:											
Meat		.065		.017		.017			.016	.042	.105
		(1.8)		(1.7)		(2.5)			(1.5)	(0.8)	(1.1)
Eggs		-.003		.008		.006		.032	.009	-.000	.039
		(0.1)		(0.9)		(0.9)		(1.0)	(1.0)	(0.0)	(0.5)
Dairy		-.084		-.021					-.018	-.137	-.207
		(2.8)		(2.5)					(2.1)	(3.1)	(2.7)

TABLE 2 CONT'D.

Variables	Proteins		Calories		Iron		Vitamin A		Minimum	Product	Sum
Vegetables		-.062 (1.8)		-.012 (1.3)				.032 (0.8)	-.014 (1.4)	-.072 (1.4)	-.08 (1.0
Fruits		.056 (1.4)		.015 (1.4)					.013 (1.2)	.020 (0.3)	.16 (1.6
Beans		-.037 (1.1)		-.006 (0.6)		.005 (0.8)			-.002 (0.2)	-.085 (1.7)	-.11 (1.4
Rice		-.021 (0.5)		-.000 (0.0)					-.003 (0.3)	-.048 (0.8)	-.11 (1.1
Grain		-.022 (0.5)		.001 (0.1)					.003 (0.3)	.015 (0.2)	.03 (0.3
Corn		-.022 (0.5)		.001 (0.1)					.004 (0.3)	.021 (0.3)	.02 (0.2
Junk		-.022 (0.5)		.002 (0.2)					-.003 (0.2)	-.082 (1.2)	-.10 (0.9
onstant	1.2 (10.5)	1.3 (9.7)	.51 (15.8)	.50 (13.9)	.48 (14.8)	.44 (14.0)	.82 (5.1)	.87 (5.3)	.45 (11.9)	.62 (3.2)	3.2 (9.6
?	.126	.137	.072	.075	.068	.065	.103	.098	.071	.104	.13
tandard Error	.360	.358	.098	.098	.096	.096	.499	.501	.103	.528	.90

[a] All variables are defined in the text. Beneath the point estimates in parentheses are given the absolute value of t statistics.

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TABLE 3: Estimated Extended Household Demand for Nutrition Inputs for 737 Households in Managua for Which Information on Women's Parents' Education is Available

Variables	Proteins	Calories	Iron	Vitamin A	Minimum	Product	Sum
Income							
1.1 Woman's Estimated Earnings	.049 (1.4)	.012 (1.3)	.012 (1.2)	.016 (0.3)	.010 (0.9)	.066 (1.3)	.09 (1.1
1.2 Work as Domestic	.408 (5.8)	.096 (5.0)	.101 (5.4)	.179 (1.8)	.096 (4.7)	.559 (5.3)	.77 (4.3
1.3 Other Income	.026 (1.3)	.005 (0.9)	.007 (1.3)	.066 (2.4)	.008 (1.4)	.064 (2.1)	.10 (2.0
1.4 Hedonic Housing Index	.021 (0.9)	.001 (0.1)	.002 (0.3)	.048 (1.5)	.000 (0.0)	.003 (0.1)	.06 (1.1
1.5 Refrigeration	.047 (1.4)	.008 (0.9)	.001 (0.1)	.089 (1.9)	.006 (0.7)	.060 (1.2)	.14 (1.8
Neighborhood Population Density	.250 (0.7)	.135 (1.5)	.142 (1.6)	.910 (1.9)	.114 (1.2)	.780 (1.6)	1.4 (1.6
Number in Household	.004 (0.8)	.003 (2.0)	.003 (2.7)	.003 (0.5)	.003 (2.2)	.010 (1.5)	.01 (1.2
Woman's General Characteristics							
4.1 Age	-.001 (0.4)	-.000 (0.7)	-.000 (0.4)	-.002 (0.6)	-.000 (0.2)	-.003 (0.8)	-.00 (0.5
4.2 Education	.013 (2.3)	.003 (1.9)	.003 (1.9)	.010 (1.4)	.003 (1.8)	.015 (1.9)	.03 (2.3
4.3 Status of Raisers							
Male Present	.088 (2.6)	.023 (2.5)	.019 (2.1)	.067 (1.4)	.022 (2.2)	.080 (1.6)	.18 (2.1
Female Present	-.015 (0.2)	-.009 (0.4)	-.002 (0.1)	.074 (0.7)	-.005 (0.2)	.014 (0.1)	-.00 (0.0

TABLE 3 CONT'D.

Variables	Proteins	Calories	Iron	Vitamin A	Minimum	Product	Sum
Male's Education	-.008 (1.3)	-.002 (1.3)	-.002 (1.3)	.001 (0.1)	-.002 (1.4)	-.005 (0.6)	-.00 (0.6)
Female's Education	.013 (2.3)	.003 (2.0)	.003 (2.3)	.017 (2.1)	.004 (2.2)	.016 (1.9)	.03 (2.6)
4.4 Migratory Status							
Rural Childhood	.005 (0.1)	-.001 (0.1)	.002 (0.1)	.014 (0.2)	.003 (0.2)	.006 (0.1)	.10 (0.1)
Always in Managua	-.031 (0.9)	-.005 (0.5)	-.004 (0.4)	.005 (0.1)	-.002 (0.2)	-.028 (0.5)	-.02 (0.3)
Mostly in Managua	.002 (0.1)	-.006 (0.5)	-.008 (0.8)	-.045 (0.9)	-.006 (0.6)	.015 (0.3)	.03 (0.4)
4.5 Had Parasitic Diseases	-.049 (1.8)	-.012 (1.6)	-.012 (1.7)	-.059 (1.5)	-.011 (1.3)	-.087 (2.1)	-.12 (1.7)
4.6 Marital Status							
Single	-.076 (1.3)	-.019 (1.2)	-.014 (0.9)	.034 (0.4)	-.015 (0.9)	-.054 (0.6)	-.06 (0.4)
Common Law	-.044 (1.0)	-.003 (0.2)	-.003 (0.3)	-.082 (1.4)	-.007 (0.6)	-.112 (1.8)	-.15 (1.4)
Married	.010 (0.2)	.015 (1.4)	.016 (1.5)	.020 (0.4)	.016 (1.4)	-.016 (0.3)	.05 (0.5)
Nutrition and Health Knowledge							
5.1 Causes of Diarrhea	-.037 (0.7)	-.007 (0.4)	-.002 (0.1)	-.007 (0.1)	-.005 (0.3)	-.054 (0.7)	-.08 (0.6
5.2 High Nutrient Specific "Best" Foods	.126 (3.7)	.022 (3.1)	.040 (3.3)	.073 (1.7)			

TABLE 3 CONT'D.

Variables	Proteins	Calories	Iron	Vitamin A	Minimum	Product	Sum
5.3 "Best" Foods Include:							
Meat					.021 (1.6)	.079 (1.1)	.13 (1.1
Eggs					.015 (1.3)	-.000 (0.0)	.09 (0.9
Dairy					-.020 (1.8)	-.124 (2.2)	-.20 (2.1
Vegetables					-.019 (1.6)	-.112 (1.8)	-.14 (1.3
Fruits					.006 (0.4)	.029 (0.4)	.11 (0.9
Beans					-.002 (0.2)	-.087 (1.4)	-.10 (1.0
Rice					.007 (0.4)	-.012 (0.2)	.05 (0.4
Grain					-.001 (0.1)	-.021 (0.2)	-.01 (0.1
Corn					.027 (1.6)	.104 (1.2)	.19 (1.3
Junk					-.008 (0.5)	-.047 (0.5)	-.03 (0.2
onstant	1.13 (6.8)	.53 (11.6)	.49 (10.9)	.69 (3.0)	.45 (8.7)	.53 (2.0)	3.0 (6.7
2	.145	.083	.079	.106	.079	.112	.14
andard Error	.356	.098	.095	.364	.343	.525	.42

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