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An analysis of the impacts of household size and composition on food expenditure in Haiti

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TABLE OF CONTENTS

LIST OF TABLES

Page

LIST OF FIGURES

1. PROBLEM FORMULATION

1.1 Introduction

Haiti is known in the western hemisphere for its unique level of poverty. Among the several development issues in Haiti today, one that is well documented is the problem of malnutrition. According to the World Bank, the vast majority of illnesses in Haiti are related to undernutrition. It is estimated that 95 percent of deaths among children aged one to four years are caused by malnutrition (World Bank, 1985).

The problem of malnutrition, has been studied in Haiti mainly using anthropometric indicators of nutritional status. The dietary aspects of malnutrition have received relatively less attention. Furthermore, the dietary aspect of malnutrition has been studied only descriptively, identifying important foods, meal types, dietary deficiencies, and household characteristics etiological to the problem of unsatisfactory diets.

These descriptive statistics have reconfirmed the severity of the problem of malnutrition in Haiti. The consumption patterns of preschool children in Haiti have been found to be deficient in calories, protein, vitamin A and iron. Few children have been found to consume fruits and vegetables daily. Consumption of animal products has been found to be low. Children have been found to receive one or no meal of relatively good quality per day. And in all these aspects, rural children have been found to fare worse than urban children (Bureau of Nutrition, 1978).

These descriptions have behavioral implications only to the extent that by identifying certain food consumption patterns, they reveal implications about food choice and nutrient acquirement behavior in Haiti. A more structured behavioral analysis is required, however, to model food demand behavior, to quantify the impacts of etiological variables on food demand, and to predict food consumption patterns and dietary status. One reason for the absence of structured behavioral analyses of food consumption in Haiti, is that it was only in 1986 that a household consumer expenditure survey of Haiti was conducted (Deaton and Siaway, 1988). Unlike the descriptive analyses for Haiti in the past studies, more structured behavioral analyses are developed in the present study.

Food consumption behavior in Haiti is studied reflecting the impacts of particular etiological household characteristic variables, explicitly incorporating a household decision framework, and using the models and methods suggested by microeconomic theory. The analysis assumes a particular decision model, conceptualizes how the etiological variables affect food consumption behavior, and predicts how behavior will change as the etiological variables change.

The household characteristics variables studied for their effects on food consumption are household size and composition, and total expenditure (as a proxy for household income). Data are used from the 1986-87 Household Consumer Expenditure Survey for Haiti (HECS). The impacts of household size, composition, and total expenditure on food consumption patterns are studied by estimating Engel curves for foods.

1.2 Engel Curves for Food

To study the impacts of household size and composition, and total expenditure on food demand in Haiti, the conceptual framework of traditional consumer theory is used to estimate Engel curves. Equivalent scales are specified to adjust for household composition. However, some departures are made from traditional demand theory. First, the decision unit is assumed to be the household instead of the individual as used in neoclassical demand theory. This is because the unit of observation in the survey was the household, and because for Haiti, assuming the household to be the decision unit, is sociologically more realistic than assuming that household members are independent decision makers. Second, while traditional theory allows only the effects of income and prices to affect consumption, taking tastes as given, in the present study, in addition to these variables, are included household size and composition, following Barten (1964).

In the present study Engel curves are estimated using data from the HECS, which is a cross section survey, supporting the assumption of constant prices. Engel curves relate household income or proxies of income to quantities demanded, or proxies thereof. Equivalent scales are factors defining a weighted household size. It is through equivalent scales that household size and composition are introduced into the analysis. The different kinds of equivalent scales models estimated are general scales, specific scales, and economies of size models. These models differ in the assumptions about weightings of different household members.

Following Barten (1964), the weights for the household members are assumed to be behavioral rather than nutritional. Therefore the Engel curves are estimated to obtain weights, determining the scales, and the elasticities. Using the estimated Engel curves, predictions are made for changes in food consumption patterns when total expenditure, household size or household composition change.

There are two reasons for the choice of household size and composition, and income as explanatory variables in models designed to explain consumption and dietary status. First, economic theory offers a general conceptual framework for studying the impacts of these variables on demand. Second, evidence from studies on food demand suggests that these are important explanatory variables for food consumption.

1.3 Previous Studies

In studies of food demand in the United States, household income was found to be a major determinant of household food expenditures and household size variables were also found to have significant effects on food expenditures (Morgan, 1986). Money income was found to have a positive and significant impact on food expenditure in several studies (Basiotis et al., 1983, 1987; Davis et al., 1982; Johnson, Burt and Morgan, 1981; Morgan et al., 1985; Neenan and Davis, 1979; Sanderson, 1982; Smallwood and Blaylock, 1979). However, other studies (Gallo, Salathe and Boehm, 1979; Salathe and Buse, 1979) found that money income has a significant positive or negative impact depending on household characteristics.

Household size was found to have a significant and positive impact total food expenditure (Davis et al., 1982; Neenan and Davis, 1979; and Smallwood and Blaylock, 1979). Furthermore, there was also evidence of economies of size for food expenditure (Davis et al., 1982). Finally, a significant relationship was also found among life cycle stage, food expenditure, and dietary status (Blanciforti et al., 1981; Adrian and Daniel, 1976; and Allen and Gadson, 1982).

1.4 Conclusion

The present study differs from previous studies of food consumption in Haiti in that it contains a structured analysis of food consumption patterns, and it focuses on household size and composition and total expenditure as variables etiological to food expenditure behavior. From a theoretical perspective, the present study differs from other food consumption studies in its inclusion of scaling, and the association of scaling with specific foods.

Using data from the HECS, the analysis in the present study was undertaken in three stages. First, descriptive statistics were presented for food expenditure patterns in Haiti based on tabular analysis of the data by geographical region and rural and urban areas.

Second, using Barten's approach (Barten, 1964), per capita models of Engel curves were specified for 15 food groups and total food expenditure. The per capita Engel curves were estimated using both ordinary least squares and tobit models since participation rates for all food groups were less than 100 percent. From these Engel curve estimates, income elasticities were obtained to study the effect of total expenditure on food expenditures, and to describe further the food expenditure patterns in Haiti. In order to indicate the direction of the effects of total expenditure and unweighted household size on the probability of participation in food expenditures, logit models were also estimated.

Third, effects of household composition on food expenditures and economies of scale with respect to the sizes of the household age-sex categories were examined by using Barten's approach (Barten, 1964), to specify the general and specific scales, and household size effects models. From the general scales model, parameter estimates were obtained and weights calculated for total food expenditure with respect to six age-sex categories. From the specific scales model parameter estimates were obtained and weights calculated for 15 food groups with respect to six age-sex categories. The presence of economies of scale with respect to the age-sex categories was identified for five food groups by estimating the household size effects models. Nonnlinear estimation methods were used for the specific scales and economies of scale models.

The present study is organized into six chapters. First, the survey design of the HECS, the variables used in the analysis, and the empirical findings from the preliminary tabular analysis of the data are described in Chapter 2. Then, alternative conceptual frameworks from microeconomic theory are discussed in Chapter 3, including applications of these approaches in previous studies. The model specifications, and results of the estimations of Engel curves using ordinary least squares, tobit and logit models are described in Chapter 4. The model specifications, and results of estimations of the general scales, specific scales, and economies of size models are described in Chapter 5. Finally, a summary of the results, and conclusions are presented in Chapter 6.

2. DATA DESCRIPTION

2.1 Introduction

Data for the present study are obtained from the 1986-87 Haiti Household Expenditure and Consumption Survey (HECS). The HECS was a national survey conducted by the Institut Haitien de Statistique et d'Informatique (IHSI) to develop a socio-economic data base for Haiti. The HECS was designed as a two stage, stratified, national survey to be conducted over a 13-month period. Each monthly subsample was a national probability subsample.

The universe was all households in the Republic of Haiti, excluding populations in some special institutions such as hospitals and prisons. The sampling frame for the first stage was the 1982 Census of Population and Housing for a listing of primary sampling units for stage one. For the second stage, a sampling frame was created by listing all the housing units in the primary sampling units selected in stage one.

The survey instrument used was a questionnaire. Data were collected on household characteristics, food and non food expenditures, expenditures on items purchased on credit, income, health (including anthropometric measures), and agricultural production.

Although designed for 13 months, the survey was conducted for only 11 months: November 1986 through September 1987. And, at the time of the present study, data were available only for nine months. Furthermore, final weights were not available at the time of the present study. Unweighted data were used in the analysis. As a result, biases can be expected in the estimates of means. However, since the analysis in the present study is for subsamples partitioned by location, major features of the population are likely, when not geographical, to be evenly distributed, so that biases are expected to be small.

Using the nine-months sample, a tabular analysis is undertaken to describe basic food expenditure patterns in Haiti. Average food budget shares and participation rates were used to identify the major food groups and food sources. Participation is defined as the purchase, use from home production, or use of gift during the weekly observation period.

This chapter includes a description of the survey design (section 2.2), a description of the variables to be used in the subsequent analysis (section 2.3), a presentation of summary statistics on demographic and food expenditure variables in Haiti (section 2.4), and conclusions (section 2.5).

2.2 Survey Description

2.2.1 Stratification

The Republic of Haiti was first stratified into five major geographical areas. These were North, Transversale, West (excluding Port-au-Prince), South, and Metropolitan Port-au-Prince (see figure 2.1). Since separate analyses of the data were expected to be made for urban, and rural areas, each area was further stratified into urban and rural components. The exception was Metropolitan Port-au-Prince, which was only urban. There were therefore nine sample strata altogether.

These nine geographic strata were further substratified for

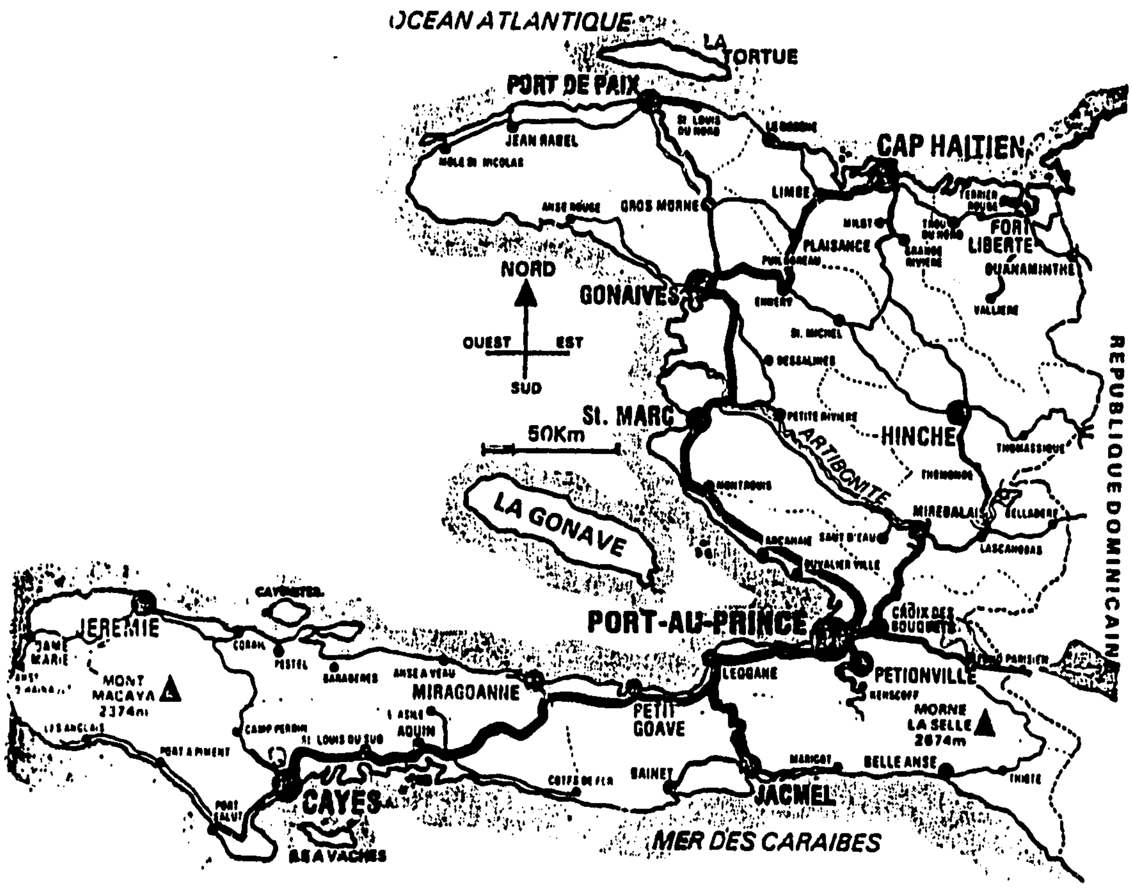

Figure 2.1 Map of The Republic of Haiti

socio-economic homogeneity. Urban strata were substratified by economic criteria (for example, income or housing). Metropolitan Port-au-Prince was divided into three economic substrata: high, middle, and low, and other urban strata were divided into two economic substrata: high or middle, and low. In rural areas, a greater socio-economic homogeneity was found among households. But the socio-economic variables were found to be correlated with major ecological zones. Therefore, the rural strata were divided into two ecological substrata: plains and mountains. There were then 19 substrata altogether (see Figure 2.2).

2.2.2 Stages

The sample was selected in two stages. In the first stage, the primary sampling units selected were the "Sections d'Enumeration" (SDE's). The sampling frame consisted of a list of 4,730 SDE's defined for the 1982 census of Haiti (Meghill and Dauphin, 1985). The SDE's were selected within each substratum with probability proportional to the size of the substratum.

The sampling units selected in the second stage were housing units, or "Logements" (see Figure 2.3). A housing unit was defined as the space occupied by a single household, which implied a one-to-one correspondence between housing units and households at the listing stage of the survey. The sampling frame for the second stage of the survey consisted of a listing of the housing units in the selected SDE's. A fixed number of housing units (15) were selected within each sample SDE. A random sub-sample of ten housing units was then selected from the fifteen and

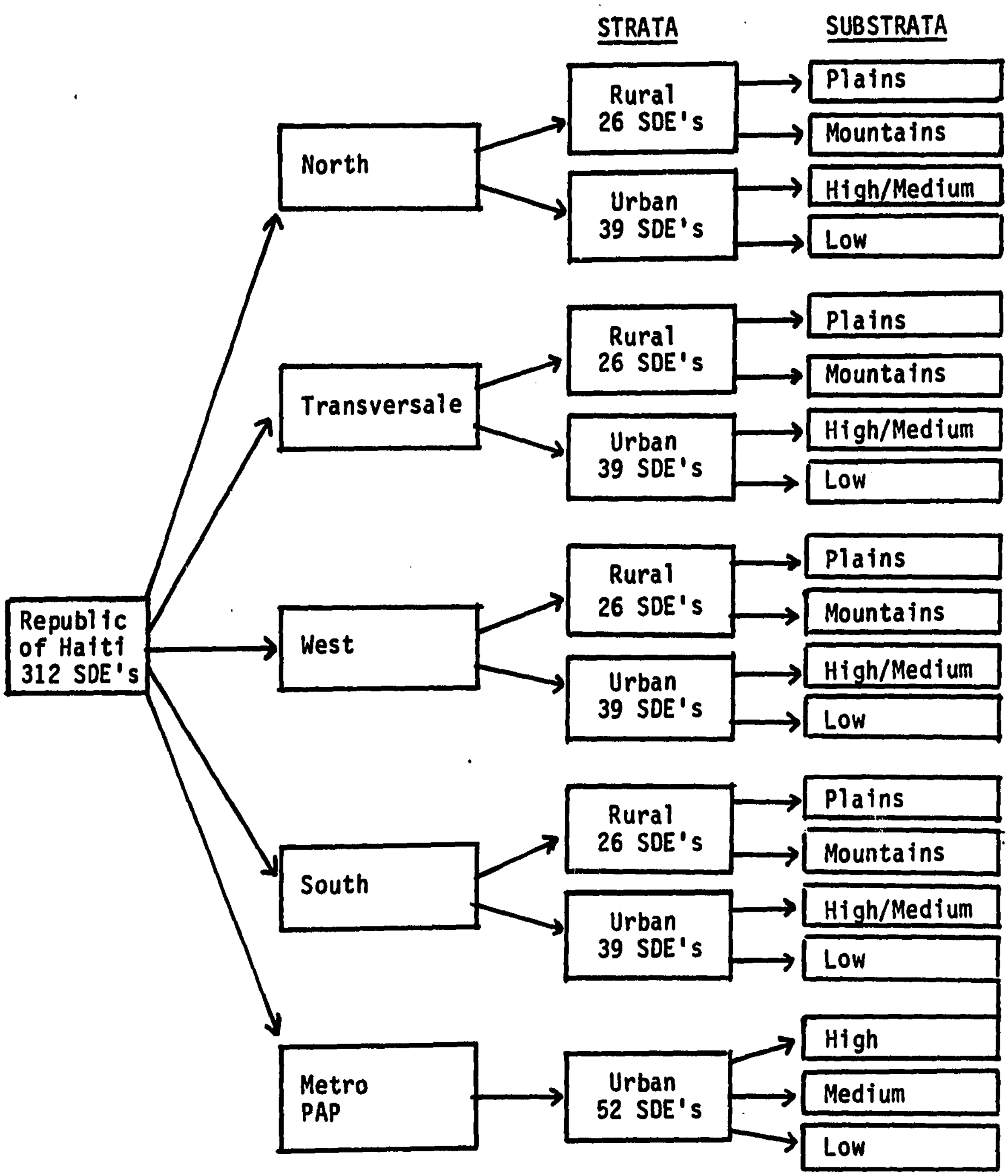

Figure 2.2. Stratification and Allocation of Primary Sampling Units (SDE's) in HECS, 1986-87

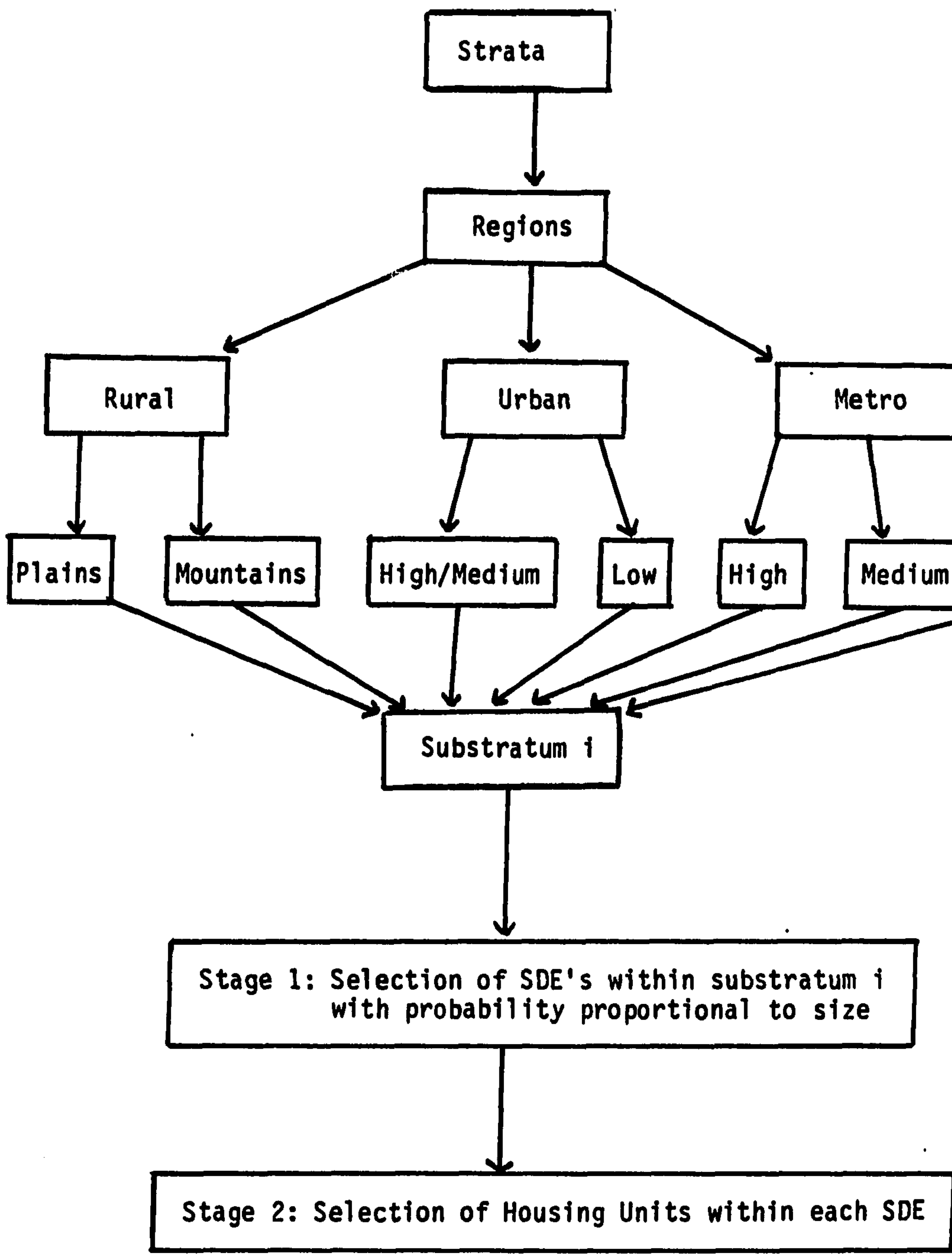

Figure 2.3. Stages of Selection in HECS, 1986-87.

designated as the set of households to be interviewed. The remaining five housing units were kept as possible substitute units, in case some of the 10 selected housing units were nonrespondents.

2.2.3 Sample size and allocation

Owing to the variety of characteristics measured by HECS, it was considered ideal to have as large a sample as possible, constrained however by the survey budget It was decided to sample 3120 households. This number of households is similar to that sampled in most countries for household expenditure surveys (Meghill and Dauphin, 1985).

For a self weighting sample at the national level the allocation of the sample to the strata and substrata would have to be proportional to their respective sizes. However, the areas varied considerably in size, so that, allocating the sample to the areas proportionally would mean that some areas would not have had sufficient numbers of observations to ensure reliable regional estimates. Since the same precision of estimates was wanted from each region, similar sample sizes were allocated to each region and a weighting was developed.

Owing to differences in the costs of field work in urban and rural areas, and because urban areas were expected to have greater variability in socio-economic characteristics compared to rural areas, larger samples were allocated to urban than to rural areas. The variability in socio-economic characteristics was expected to be the highest in Metropolitan Port-au-Prince. And an even greater proportion sample was allocated to this stratum.

The sampling allocation required by the design resulted in each stratum having a different sampling fraction. The national sample, therefore, was not an equal probability sample. However, each stratum sample was designed to be an equal probability sample. Therefore, the sample within each stratum was allocated to the substrata proportionally to size. The substratum size was defined according to the 1982 census.

The sample in each substratum was then allocated to the SDE. Based on studies of intra-class correlation made for similar surveys in other countries, it was decided to allocate 10 housing units to each SDE (Meghill and Dauphin, 1985). Given the sample size allocated to each stratum (n_i), the number of SDE's in each stratum was $n_i/10$.

The sample size was designed to include 312 SDE's, where each SDE contained 10 housing units resulting in a total sample size of 3120 housing units. The allocation of SDE's and housing units by stratum is shown in Table 2.1.

The HECS design also allowed for allocation of the sample by month. The survey was designed for a 13 month period in order to obtain possible seasonal variations in the expenditure patterns. Each monthly subsample was designed to be a national subsample, so that even if the full survey were not completed, parts of it available would be representative of the nation. That is, the national sample of 312 SDE's was divided into monthly national subsamples of 24 SDE's each, such that each region contained three urban and two rural SDE's, and Metropolitan Port-au-Prince contained four SDE's. This monthly allocation of the total sample is described in Figure 2.4.

Table 2.1 Sample size and allocation by stratum (U.S. Bureau of Census, 1986-87)

Region	Total		Urban		Rural	
	SDE's[a]	HU's[b]	SDE's	HU's	SDE's	HU's
North	65	650	39	390	26	260
Transversale	65	650	39	390	26	260
West [without PAP][c]	65	650	39	390	26	260
South	65	650	39	390	26	260
Metro PAP[c]	52	520	52	520	0	0
Haiti	312	3120	208	2080	104	1040

[a]Sections d'Enumeration.

[b]Housing Units.

[c]Port-au-Prince.

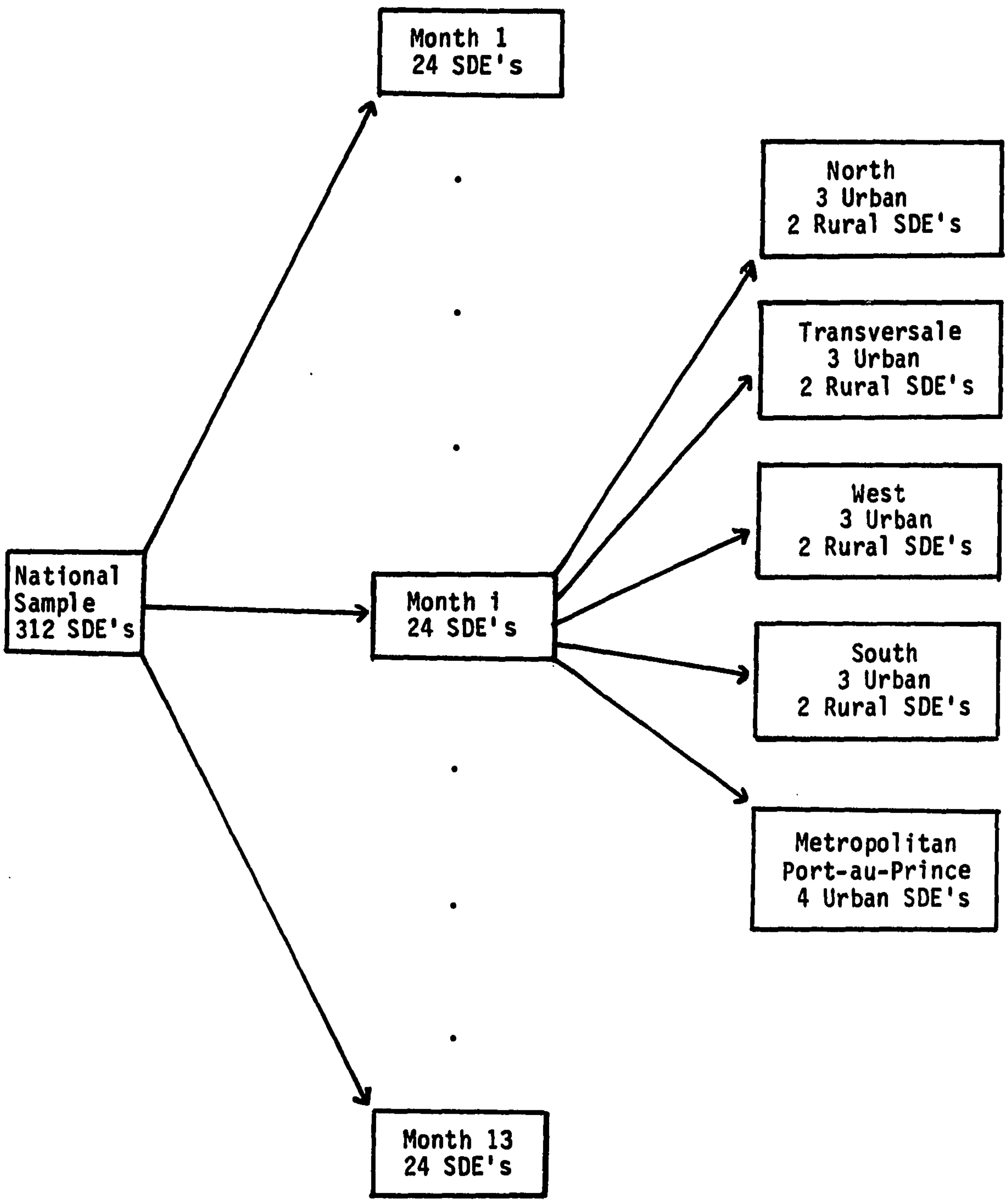

Figure 2.4. Allocation of SDE's into 13 Monthly Systematic National Probability Sub-Samples for HECS, 1986-87

2.2.4 Weights

Weights were designed to be applied to each sample household to insure the representativeness of the sample, and to obtain unbiased sample population parameter estimates. For each sample household, the final weight consisted of the product of the basic sampling weight, and an adjustment factor, to reflect changes in the status of the sample household between the stages of listing the household and the interview.

The basic sampling weight for each sample household was defined as the inverse of the final probability of selection of the household, which was the product of probabilities of selection at each stage. The final probability of selection of a household (p_{hi}) was the product of the probability of selection of the SDE, and the probability of selection of the household within the SDE.

i.e. $$p_{hi}=(n_h M_{hi}/M_h).(15/M'_{hi}).(10/15) \qquad 2.1$$

where p_{hi} is the probability of selection of sample households in the ith sample SDE in substratum h, n_h is the number of SDE's selected in substratum h, M_h is the total number of housing units in substratum h estimated from the 1982 census (cumulated measure of size), M_{hi} is the total number of housing units in the ith sample SDE of substratum h from the 1982 census (measure of size), and M'_{hi} is the total number of housing units listed in the ith sample SDE in substratum h.

Therefore, the basic sampling weight for each sample housing unit (W_{hi}) was,

$$W_{hi}=1/p_{hi}=(M_h M'_{hi})/(10 n_h M_{hi}). \qquad 2.2$$

The sample within each substratum was approximately self weighting.

The weights within each substratum varied only by a factor M'_{hi}/M_{hi}. The variability of the weights within the substratum therefore depended on how well the measure of size within each SDE approximated the actual number of housing units listed in the sample frame.

The sample within each stratum was also approximately self weighting. That is, the sample within each stratum was allocated proportionally among the substrata. But the weights varied significantly among the strata, since the sample was allocated almost equally among the strata. And the strata differed considerably in size.

Adjustments to the basic sampling weight were expected depending on events such as the housing unit being occupied by more than one household, or the housing unit being unoccupied. In addition, adjustments to the basic sampling weights were required because data finally collected were for the first eleven months. For the present study, data were available only for the first nine months of the survey.

If a sample housing unit was found occupied by more than one household, one of the households was randomly selected to be interviewed, and the weight adjustment factor (F_{1hij}) was

$$F_{1hij}=m_{hij} \qquad 2.3$$

where m_{hij} is the number of households in the jth sample housing unit, in the ith sample SDE of substratum h.

If a housing unit was unoccupied at the time of the survey even though occupied at the time of the listing, it was considered ineligible for inclusion in the sample for the survey. A substitute housing unit was designated to be interviewed, and the weight adjustment factor (F_{2hi})

was

$$F_{2hi}=(10-d_{hi})/10 \qquad 2.4$$

where d_{hi} is the number of unoccupied sample housing units in the ith SDE of substratum h.

Since data were collected only for the first eleven months of the survey, and were available for this study only for the first nine months of the survey, at the time of the present study, the weight adjustment factor (F_3) would be a constant factor applied to the weights of all records.

$$F_3=(13/11).(11/9) \qquad 2.5$$

Data used in the present study are unweighted because final weights were unavailable at the time of the study. Since according to the sample design each stratum sample is an equal probability sample, using unweighted data for analysis by stratum would result in unbiased estimates of means if the response rate were 100 percent. However, given that response rates within the strata were less than 100 percent, comparing two SDE's of equal size from the same stratum, the one with the lower response rate would be underrepresented if unweighted data were used. According to the sample design, the national sample is not an equal probability sample since the sample is allocated almost equally among the regions, even though they vary a great deal in size, and unequally among rural and urban areas regardless of size. Using unweighted data for the national sample would therefore result in biased estimates of means. There would be an overrepresentation of strata with relatively small populations, and an underrepresentation of strata with relatively large populations. Furthermore, given that response rates were less than 100 percent, comparing two strata of equal sizes, the one with the lower response rate would be underrepresented.

However, the biases expected because of using unweighted data were small because both the tabular and the regression analysis were for major geographical areas and major features of households. If more refined partitioning by household characteristics had been used, the distribution of households in the sample would have had to be more representative, if major problems of bias were not to have been incurred.

2.2.5 Survey instrument

The survey instrument was a questionnaire. Trained enumerators interviewed household heads. The questionnaire was divided into 14 sections, which contained questions on household socio-economic and demographic characteristics, food and nonfood expenditures, expenditures on items bought on credit, income, health (expenditures and anthropometric measures), and agricultural production variables.

According to the design of the questionnaire, the interview period was one week divided into four visits, during which, trained enumerators filled out a separate questionniare for each household. Questions were answered by the household head. The number of visits, and the recall period varied for different groups of variables on which information was requested (see Figure 2.5). For example, for the food expenditures from purchases, gifts, and harvests, the enumerator made four visits over the interview period. On each visit, the household head was asked

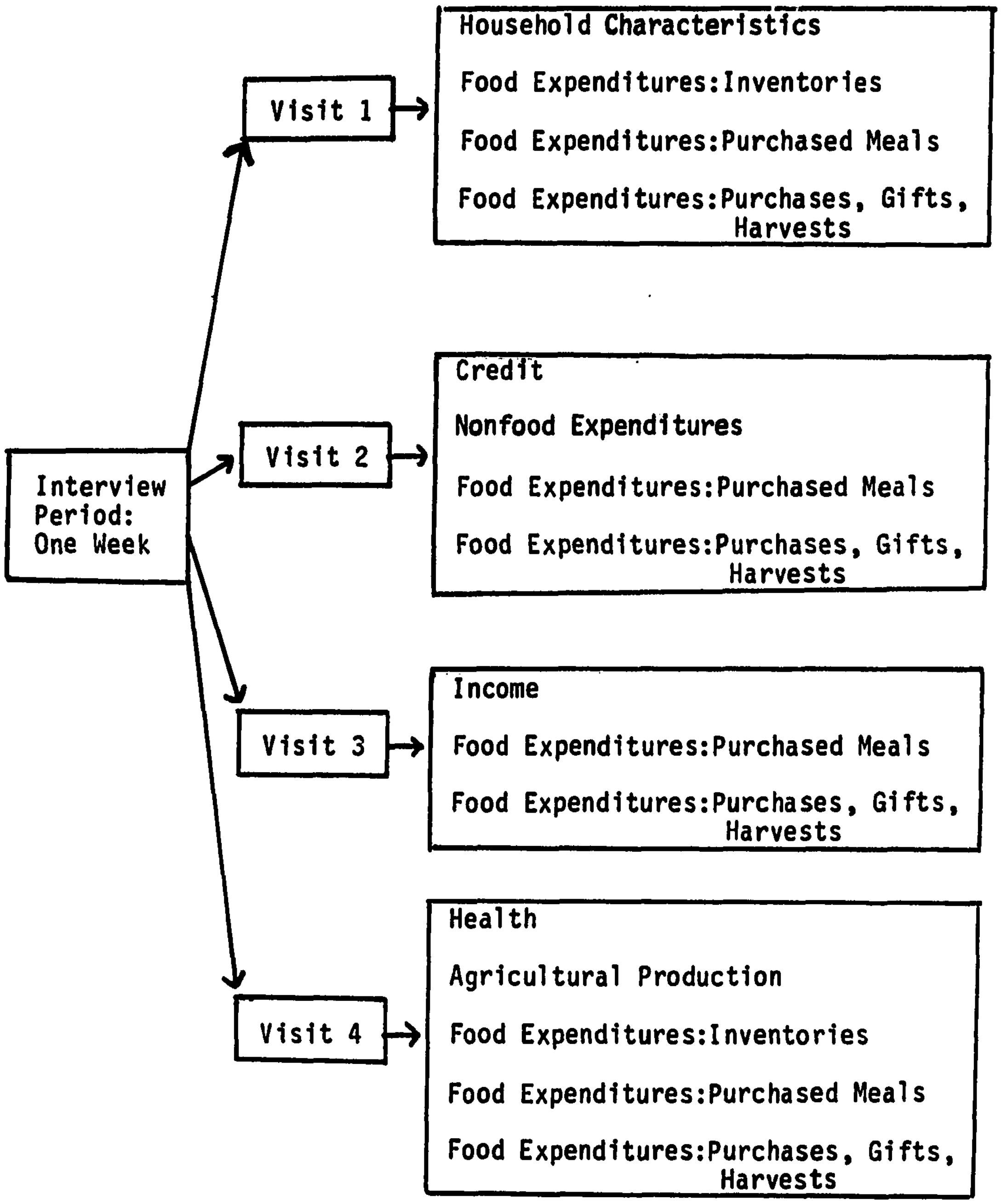

Figure 2.5. Allocation of Interview Period to Four Visits, and Sections of Questionnaire Covered During Each Visit

to recall food expenditures for the previous one or two days. Over the four visits together, the household recalled the entire week's expenditures on food from purchases, gifts and harvests. For the nonfood expenditures, however, the reference period was weekly for some items such as cigarettes, monthly for some items such as electricity, trimesterly for some items such as clothes, and annual for more durable items such as furniture.

For the food and nonfood sections of the questionnaire, items were precoded before the interviews, with the lists being made as comprehensive as possible. It was expected that during the interviews most of the food and nonfood items recalled as consumed would be identified in the list, by the code assigned. There were altogether 216 precoded food items, which were grouped according to nutritional characteristics into 11 food groups in the survey instrument. Similarly, there were 194 precoded items in the nonfood section of the survey instrument. In the subsample used for the present study, out of 350 coded food items, there were 134 items that had codes that were not included in the survey instrument. The remaining 216 were the food items coded in the survey instrument.

2.2.6 Comparison of HECS with other surveys

The design used for the HECS 1986-87 was somewhat different from those for other expenditure surveys. For example, HECS was designed to be conducted over 13 months; and to collect 13 monthly national subsamples, with each household being interviewed only once. Therefore, according to the design, seasonal effects would be estimated, and if the survey could not be completed, parts of it would still be representative since each monthly subsample was a national sample, and was therefore a 'mini' total sample.

By contrast for example, the Indonesian multipurpose household survey, SURGASAR, 1980 (Johnson et al., 1986) was a cross section survey conducted over two months. The Jamaican Household Expenditure Surveys, 1975-77 were conducted three months apart with the same dwellings being revisited. The surveys were conducted in 1975 with subsamples of it being resurveyed in 1976 and 1977.

HECS was also different in the range of characteristics on which data were collected. Data were collected not only on food and nonfood expenditures but also on health expenditures and anthropometric measurements of household children, thereby facilitating a possibility of nutritional analysis using dietary as well as health status indicators.

2.3 Description of Variables

The variables used in the analysis are demographic and expenditure. The unit of observation for all variables is the household. Given that the purpose of the present study is to estimate the effects of household size and composition, and income on food expenditures, the variables were selected accordingly. The demographic variables were six household compositional variables (numbers of persons in six age-sex categories), and total household size. The age cut-off points were selected based on past studies, (Brown, 1982; Goungetas, 1986) with a view to having variability with respect to food demand behavior across groups, and relative homogeneity within groups.

The expenditure variables were total expenditure, total food expenditure, and expenditures on 16 food groups by source (purchase, gift, and harvest). The first 15 food groups were formed broadly according to the grouping in the survey instrument, with some further disaggregation. A sixteenth group was formed to contain food items that had valid codes that were not listed among the precoded food items in the survey instrument. Total expenditure was used as a proxy for household income, and was the sum of total food and nonfood expenditures.

2.3.1 Demographic variables

Since one of the purposes of the study is to estimate the effects of household composition and size on food expenditure, in terms of weights of individual household members, and household size effects, the demographic variables considered were number of persons in six age-sex categories, and household size. These categories were exhaustive, so that household size was the sum of the number of persons in the categories.

The household compositional categories were created by age and sex because the impact of household composition on food expenditure was expected to vary by age, and for adoloscents and adults, also vary by sex. These variations were expected to reflect nutritional requirements and activity levels of household members.

The particular age-sex categories were males 19 and older (adult males), females 19 and older (adult females), males aged 10 to 18 years (adolescent females), females aged 10 to 18 years (adolescent females), children aged 4 to 9 years (children), and children aged 3 years and younger (infants). These age cut-off points were chosen because food consumption behavior was expected to vary the most among the groups and to be relatively homogeneous within groups. They were also chosen based on past studies (Brown, 1982; Goungetas, 1986). Furthermore, preliminary tabular analysis was undertaken to determine that the sample contained households with these compositional characteristics in rural and urban areas and in all five regions. Percentages of households by area and region, having members in the six compositional categories defined above are shown in Table 2.2. The results in Table 2.2 show that the unweighted sample data are not likely to present a problem for bias in compositional parameters. Households by composition were reasonably evenly distributed.

2.3.2 Expenditure variables

Since the purpose of the present study is to estimate food Engel curves, the expenditure variables created were total expenditure, total food expenditure, and expenditure by food group. Household total expenditure, the major explanatory variable for the Engel curves, is used as a proxy for household income. Since most of the households in the sample are poor, household savings are assumed to be negligible.

The expenditure variables varied in their reference period as collected by the survey instrument. All expenditure variables were annualized to standardize the time dimension, and to facilitate comparisons of expenditure patterns in Haiti with that in other countries.

Table 2.2 Percent of households having members in six age-sex categories, by area and region (U.S. Bureau of Census, 1986-87)

Age-Sex Categories	Area		Region					
	Urban	Rural	North	Trans-versale	West	South	Metro PAP[a]	Haiti
Males >= 19 yrs	72.91	82.28	76.47	73.90	74.48	79.95	76.12	76.18
Females >=19 yrs	88.68	89.01	91.18	83.60	88.74	89.63	91.34	88.79
Males 10-18 yrs	37.97	34.20	37.10	32.56	37.01	40.32	36.12	36.65
Females 10-18 yrs	43.67	33.65	40.72	39.26	38.85	38.02	45.07	40.16
Children 4-9 yrs	49.52	51.51	50.68	47.58	51.95	54.38	45.37	50.22
Infants 0-3 yrs	34.05	43.27	37.78	37.64	34.25	41.94	34.03	0.05
Age Not Reported	4.15	0.14	4.07	5.31	3.91	3.23	3.88	4.09
Sample Size	1351	728	442	433	435	434	335	2079

[a]Port-au-Prince.

2.3.3 Food expenditure variables

The food concept of interest in the present study is food available for consumption to the household. The food expenditure variables are values of food available for consumption in Gourdes. Foods were available for consumption from five sources: purchase, gift, harvest, inventory, and purchased meals. Total food available to the household was therefore the sum of foods available from these five sources.

However, data on inventories were unavailable at the time of this study. Thus, the expenditure variables are unadjusted for food from inventory. Therefore, total food expenditure is the sum of total purchases, total gifts, total harvest, and total purchased meals, and is an under- or overrepresentation of food actually available for consumption depending on whether value of food from inventory was positive or negative (implying adjustments to stocks).

According to the questionnaire, expenditures on purchased meals were defined for meal types, and not for food items. But expenditures for purchases, gifts and harvests were available by food item. Therefore, food expenditures by item were adjusted only for purchases, gifts and harvest, and not for inventories and purchased meals.

2.3.4 Formation of food groups

Food items were aggregated into 16 groups. The 216 precoded food items in the survey instrument were grouped into 15 food groups. The food items that had valid codes but were not coded in the survey instrument, were grouped into a sixteenth group named "other foods".

The 16 food groups were:

Corn

Wheat

Rice

Millet

Other cereals

Tubers

Vegetables

Fruits

Oil

Dairy and eggs

Meat

Fish

Sugar

Condiments and miscellaneous

Drinks

Other Foods.

The criteria used in choosing the 15 food groups involved mainly nutritional characteristics and policy interests. The grouping of the 216 food items with valid codes in the survey instrument was more or less maintained, but disaggregated further, based on policy interests and nutritional characteristics. For example, while oils, and dairy products and eggs were in the same group in the survey instrument, they were in two separate groups in the present study because they have different nutritional characteristics. Also, while cereals were all in one group in the survey instrument, they were disaggregated into corn, wheat, rice, millet, and other cereals because of policy interests in Haiti in the demand for individual cereals such as wheat. Finally, condiments and miscellaneous foods were separate groups in the survey instrument but were grouped for the present analysis.

2.3.5 Nonfood expenditures and total food expenditure

Total nonfood expenditure was the sum of expenditures on 3 types of items:

Nonfood items: clothing, toilet goods, electricity and gas, furniture, entertainment

Housing

Items purchased on credit.

Total expenditure was the sum of total food and nonfood expenditure.

2.4 Food Expenditures Patterns in Haiti

A sample of 2154 households was obtained for the nine-months data. However, some households were dropped because of incomplete surveys, and a few were dropped because they had household sizes of less than one. Therefore, the size of the sample used in the analysis was 2079 households.

For the 2079 households, observations were dropped for some food expenditures because of coding errors, or because the food items had invalid item codes. Outliers were defined as more than 25 Gourdes for food expenditures by item, source and visit. The distribution of households by area and region in the nine-months sample used in the present study is shown in Table 2.3.

This section contains a discussion of the food expenditure patterns in Haiti based on tabular analysis of the HECS data. The purpose of the tabular analysis is to identify important food groups, and sources of foods, and typical food expenditure patterns. Although the tabular analysis is intended only as a precursor of the regression analysis, the results of the tabular analysis should be interpreted with caution, since comparisons of average values in the tables are not based on statistical tests, and factors other than location which affect food expenditures were not controlled.

The statistics presented are means (average expenditure levels, and food budget shares), participation levels, and participation rates. Average food budget shares are presented to show the relative importance of the food groups and food sources in the food budget Food expenditure participation rates are percentage of sampled households that report expenditures on food groups and food sources. Participation rates are used to identify food groups and food sources that are relatively most frequently accessed.

First, summary statistics for selected variables are presented in Tables 2.4. Then average expenditure levels (Table 2.5), average food budget shares (Table 2.6), and participation rates (Table 2.7), are presented for food groups, for rural and urban location and for the five regions.

Table 2.3 Distribution of sample households by stratum (U.S. Bureau of Census, 1986-87)

Area	Region: North	%	Trans-versale	%	West	%	South	%	Metro PAP[a]	%	Haiti	%
Urban	270	61.09	254	58.66	244	56.09	248	57.14	335	100.00	1351	64.98
Rural	172	38.91	179	41.34	191	43.91	186	42.86	0	0.00	728	35.02
Total	442	100.00	433	100.00	435	100.00	434	100.00	335	100.00	2079	100.00

[a]Port-au-Prince.

Table 2.4 Summary statistics for selected variables (U.S. Bureau of Census, 1986-87)

Variable	Mean	Standard Deviation	Sample Size
Unweighted Household Size	4.98	2.71	2079
Total Expenditure	14928.23	19175.42	2079
Total Food Expenditure	5731.66	5161.45	2079
Food Share of Total Expenditure	50.57	20.05	2079

Table 2.5 Household average annual expenditure levels for food groups by source, by area and region (U.S. Bureau of Census, 1986-87)

Food Group	Source	Urban	Rural	North	Trans versale	West	South
Corn	Purchase	122.91	136.21	81.27	120.57	187.67	100.78
	Gift	9.84	8.78	10.04	9.09	5.39	9.77
	Harvest	29.44	32.47	18.80	43.07	40.45	24.51
	Total	162.20	177.46	110.11	172.72	233.51	135.06
Wheat	Purchase	413.53	233.06	256.12	288.83	366.28	386.98
	Gift	4.67	3.02	3.36	3.14	6.12	5.40
	Harvest	1.63	0.29	0.12	0.18	0.96	2.04
	Total	419.83	236.37	259.60	292.14	373.36	394.42
Rice	Purchase	543.80	285.53	373.58	432.04	475.64	404.08
	Gift	23.92	11.56	11.19	22.28	6.08	33.36
	Harvest	13.63	14.03	1.12	41.94	0.00	7.40
	Total	581.36	311.11	385.89	496.26	481.73	444.85
Millet	Purchase	36.33	62.34	13.21	42.45	88.87	55.67
	Gift	3.40	2.50	0.38	5.24	1.61	1.58
	Harvest	4.29	26.66	4.01	18.63	11.57	23.56
	Total	44.02	91.50	17.59	66.32	102.05	80.81
Other Cereals	Purchase	29.46	6.14	22.69	12.23	22.32	22.75
	Gift	1.45	0.00	0.09	0.12	1.39	0.72
	Harvest	0.10	0.14	0.53	0.00	0.00	0.00
	Total	31.00	6.28	23.32	12.35	23.70	23.47
Tubers	Purchase	380.24	147.80	207.17	278.65	286.17	360.16
	Gift	29.05	17.18	18.03	21.55	11.40	39.18
	Harvest	32.43	200.02	101.66	55.97	64.98	211.71
	Total	441.72	365.00	326.86	356.17	362.54	611.06

Table 2.5 Continued

Food Group	Source	Urban	Rural	North	Trans versale	West	South
Vegetables	Purchase	1035.79	463.85	611.81	850.36	857.38	794.12
	Gift	68.73	116.23	74.20	100.95	83.39	89.99
	Harvest	59.49	325.13	124.86	182.80	188.75	227.35
	Total	1164.01	905.22	810.87	1134.11	1129.52	1111.46
Fruits	Purchase	269.56	56.76	138.95	174.75	163.74	173.94
	Gift	12.56	7.82	11.10	8.14	10.01	13.44
	Harvest	13.10	30.05	17.98	16.80	19.03	33.52
	Total	295.23	94.63	168.04	199.69	192.78	220.91
Oil	Purchase	421.81	262.90	301.73	346.01	372.49	395.66
	Gift	13.40	8.26	1.61	12.91	16.78	6.07
	Harvest	33.57	41.41	25.25	41.36	57.49	27.09
	Total	468.77	312.57	328.59	400.28	446.76	428.82
Dairy and Eggs	Purchase	478.61	109.31	279.08	265.96	315.87	258.74
	Gift	31.70	5.10	12.61	27.53	42.40	11.64
	Harvest	31.19	27.69	9.72	51.90	15.19	66.29
	Total	541.50	142.10	301.41	345.39	373.47	336.67
Meat	Purchase	892.70	334.02	499.74	750.59	614.42	654.43
	Gift	21.59	7.57	17.14	27.24	9.91	7.55
	Harvest	11.44	20.12	10.60	12.64	15.80	22.47
	Total	925.73	361.71	527.48	790.47	640.13	684.44
Fish	Purchase	382.22	164.52	247.00	252.53	305.60	335.11
	Gift	12.58	3.82	5.41	5.84	7.53	17.69
	Harvest	9.54	0.86	8.93	0.19	11.19	10.60
	Total	404.33	169.20	261.34	258.55	324.32	363.41

Table 2.5 Continued

Food Group	Source	Urban	Rural	North	Trans versale	West	South
Sugar	Purchase	334.90	202.85	199.50	253.73	334.65	284.86
	Gift	3.88	2.07	2.56	3.92	3.51	4.06
	Harvest	58.77	77.67	67.75	50.96	89.77	73.78
	Total	397.56	282.60	269.81	308.60	427.94	362.69
Condiments and Misc.	Purchase	186.26	90.71	77.29	143.77	171.61	147.52
	Gift	9.87	13.48	11.32	10.89	16.58	3.58
	Harvest	14.90	32.13	18.55	21.95	18.87	29.55
	Total	211.02	136.31	107.16	176.61	207.06	180.64
Drinks	Purchase	193.69	49.90	99.34	112.34	140.46	126.98
	Gift	3.00	1.56	0.76	6.03	1.05	0.58
	Harvest	0.23	0.00	0.00	0.72	0.00	0.00
	Total	196.92	51.46	100.11	119.09	141.51	127.56
Other Foods	Purchase	145.17	55.79	74.89	127.08	104.62	91.02
	Gift	10.36	1.60	1.57	18.55	6.45	4.02
	Harvest	4.80	12.44	3.42	3.13	15.76	12.55
	Total	160.34	69.83	79.88	148.76	126.82	107.59
Total Food Expenditure	Purchase	5867.00	2661.70	3483.38	4451.88	4807.79	4592.80
	Gift	259.99	210.56	181.38	283.41	229.60	24.62
	Harvest	318.56	841.09	413.29	542.23	549.81	772.42
	Purchased Meals	347.48	48.68	132.53	184.84	158.68	107.33
	Total	6793.02	3762.02	4210.58	5462.36	5745.89	5721.17
Food Share of Total Exp		43.73	63.29	52.01	54.21	54.01	56.31
Total Expenditure		19083.00	7218.20	11755.00	11691.00	13176.00	12061.00

Table 2.6 Average shares of food groups by source, by area and region (U.S. Bureau of Census, 1986-87)

		Area		Region					
Food Group	Source	Urban	Rural	North	Trans versale	West	South	Metro[a]	Haiti
Corn	Purchase	2.05	3.79	2.18	2.85	3.97	1.99	2.18	2.66
	Gift	0.16	0.38	0.36	0.31	0.17	0.17	0.16	0.24
	Harvest	0.96	1.04	0.90	1.62	1.09	0.68	0.54	0.99
	Total	3.17	5.20	3.43	4.78	5.23	2.85	2.89	3.88
Wheat	Purchase	6.35	6.14	6.16	5.26	6.45	7.06	6.49	6.27
	Gift	0.12	0.11	0.11	0.09	0.16	0.13	0.06	0.11
	Harvest	0.03	0.01	0.01	0.00	0.02	0.03	0.05	0.02
	Total	6.49	6.25	6.28	5.35	6.64	7.22	6.60	6.41
Rice	Purchase	8.48	7.56	9.79	8.47	8.02	6.85	7.46	8.16
	Gift	0.62	0.44	0.46	0.84	0.13	0.92	0.41	0.56
	Harvest	0.24	0.30	0.04	0.88	0.00	0.21	0.18	0.26
	Total	9.34	8.31	10.29	10.19	8.16	7.98	8.05	8.98
Millet	Purchase	0.62	1.85	0.43	1.26	1.97	1.13	0.31	1.05
	Gift	0.07	0.21	0.02	0.28	0.11	0.08	0.11	0.12
	Harvest	0.10	0.82	0.12	0.47	0.29	0.80	0.00	0.35
	Total	0.79	2.88	0.57	2.01	2.37	2.00	0.42	1.52
Other Cereals	Purchase	0.46	0.12	0.41	0.23	0.35	0.31	0.41	0.34
	Gift	0.02	0.00	0.01	0.00	0.01	0.02	0.04	0.02
	Harvest	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00
	Total	0.48	0.13	0.43	0.23	0.36	0.33	0.45	0.36
Tubers	Purchase	4.96	3.48	4.61	4.09	3.90	5.27	4.31	4.44
	Gift	0.66	0.68	0.90	0.62	0.21	1.01	0.56	0.67
	Harvest	0.70	5.71	3.40	1.36	1.45	5.46	0.00	2.45
	Total	6.32	9.86	8.91	6.07	5.56	11.74	4.87	7.56

[a]Port-au-Prince.

Table 2.6 Continued

Food Group	Source	Area: Urban	Area: Rural	Region: North	Region: Trans versale	Region: West	Region: South	Region: Metro[a]	Haiti
Vegetables	Purchase	15.38	11.64	14.73	14.31	14.20	12.69	14.51	14.07
	Gift	1.36	4.62	2.75	3.90	2.12	2.35	1.05	2.50
	Harvest	1.20	8.71	4.46	4.20	3.74	5.70	0.21	3.83
	Total	17.94	24.97	21.94	22.41	20.06	20.74	15.77	20.40
Fruits	Purchase	3.56	1.33	2.52	2.29	2.62	2.38	4.48	2.78
	Gift	0.21	0.26	0.25	0.17	0.28	0.27	0.14	0.23
	Harvest	0.24	0.77	0.49	0.37	0.43	0.70	0.07	0.43
	Total	4.01	2.37	3.26	2.83	3.33	3.34	4.68	3.43
Oil	Purchase	6.67	7.65	7.84	6.95	6.91	7.38	5.68	7.01
	Gift	0.27	0.17	0.06	0.37	0.30	0.17	0.30	0.24
	Harvest	1.13	1.34	1.28	1.30	1.53	0.98	0.83	1.20
	Total	8.07	9.15	9.18	8.62	8.74	8.52	6.80	8.45
Dairy and Eggs	Purchase	5.66	2.30	4.78	3.51	4.33	3.03	7.40	4.48
	Gift	0.53	0.16	0.24	0.56	0.56	0.23	0.42	0.40
	Harvest	0.35	0.65	0.35	0.84	0.23	0.74	0.01	0.45
	Total	6.54	3.10	5.38	4.91	5.12	3.99	7.83	5.33
Meat	Purchase	10.34	6.33	7.74	10.45	7.79	8.29	10.88	8.94
	Gift	0.27	0.20	0.26	0.42	0.12	0.26	0.14	0.24
	Harvest	0.12	0.45	0.32	0.26	0.14	0.32	0.09	0.23
	Total	10.72	6.98	8.32	11.13	8.05	8.87	11.10	9.41
Fish	Purchase	5.47	4.05	5.04	4.39	5.01	5.53	4.86	4.97
	Gift	0.25	0.12	0.12	0.15	0.27	0.33	0.14	0.20
	Harvest	0.23	0.03	0.31	0.01	0.26	0.17	0.00	0.16
	Total	5.94	4.20	5.46	4.55	5.54	6.03	5.00	5.33

Table 2.6 Continued

Food Group	Source	Area: Urban	Area: Rural	Region: North	Region: Trans versale	Region: West	Region: South	Region: Metro[a]	Region: Haiti
Sugar	Purchase	5.10	5.41	4.74	4.72	5.73	5.48	5.42	5.21
	Gift	0.12	0.08	0.10	0.11	0.14	0.08	0.08	0.10
	Harvest	2.03	3.28	3.13	1.94	3.41	2.48	1.05	2.47
	Total	7.25	8.77	7.97	6.78	9.28	8.05	6.54	7.78
Condiments and Misc.	Purchase	2.75	2.23	1.83	2.45	2.83	2.62	3.30	2.57
	Gift	0.33	0.69	0.56	0.32	0.75	0.09	0.59	0.46
	Harvest	0.41	0.77	0.58	0.90	0.37	0.54	0.20	0.53
	Total	3.49	3.69	2.97	3.67	3.95	3.24	4.09	3.56
Drinks	Purchase	2.24	0.94	1.37	1.37	1.89	1.52	3.08	1.79
	Gift	0.03	0.08	0.02	0.12	0.06	0.01	0.05	0.05
	Harvest	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Total	2.28	1.02	1.39	1.49	1.96	1.53	3.14	1.84
Other Foods	Purchase	2.04	1.51	1.71	2.02	1.87	1.44	2.37	1.86
	Gift	0.12	0.07	0.08	0.18	0.14	0.05	0.05	0.10
	Harvest	0.09	0.30	0.13	0.10	0.26	0.27	0.01	0.16
	Total	2.26	1.88	1.92	2.31	2.28	1.77	2.44	2.13
Total Food Expenditure	Purchase	82.12	66.32	75.88	74.63	77.84	72.97	83.13	76.59
	Gift	5.15	8.25	6.30	8.44	5.54	6.17	4.30	6.24
	Harvest	7.81	24.16	15.54	14.25	13.21	19.06	3.24	13.54
	Purchased Meals	4.62	1.26	2.28	2.68	2.94	1.57	9.04	3.44
	Total	99.70	99.99	100.00	100.00	99.53	99.77	99.71	99.81

Table 2.7 Household participation rates for food expenditures by source, by area and region (U.S. Bureau of Census, 1986-87)

		Area		Region					
Food Group	Source	Urban	Rural	North	Trans versale	West	South	Metro[a]	Haiti
Corn	Purchase	55.59	54.67	52.49	54.04	61.84	48.16	61.19	55.27
	Gift	3.18	3.98	3.17	4.16	2.76	4.15	2.99	3.46
	Harvest	10.58	14.70	9.05	15.47	15.40	11.52	7.76	12.03
	Total	64.17	65.93	60.18	66.51	72.87	57.83	67.16	64.79
Wheat	Purchase	93.34	90.52	92.76	87.53	93.10	93.09	96.12	92.35
	Gift	3.85	3.98	2.94	3.23	5.75	4.84	2.39	3.90
	Harvest	0.52	0.14	0.23	0.23	0.46	0.46	0.60	0.38
	Total	94.40	90.52	92.99	87.76	94.02	93.78	96.12	92.78
Rice	Purchase	83.35	70.74	81.90	78.29	77.24	76.50	81.19	78.93
	Gift	4.59	3.85	4.30	4.39	1.61	6.91	4.48	4.33
	Harvest	1.33	3.16	0.68	6.47	0.00	1.84	0.60	1.97
	Total	85.12	74.18	83.71	82.45	77.47	80.18	82.99	81.29
Millet	Purchase	17.10	23.63	8.14	18.94	31.26	24.19	13.13	19.38
	Gift	1.26	1.92	0.68	2.77	0.92	1.15	2.09	1.49
	Harvest	1.41	8.52	1.58	4.39	3.91	8.53	0.30	3.90
	Total	18.95	30.36	9.50	23.33	34.94	30.18	15.22	22.94
Other Cereals	Purchase	25.46	8.38	19.23	14.32	23.91	16.36	24.78	19.48
	Gift	1.18	0.00	0.45	0.23	0.92	0.92	1.49	0.77
	Harvest	0.07	0.14	0.45	0.00	0.00	0.00	0.00	0.10
	Total	26.28	8.52	19.68	14.55	24.14	17.05	26.27	20.06
Tubers	Purchase	85.27	60.30	75.11	74.60	68.97	77.65	89.25	76.53
	Gift	14.58	16.21	15.16	19.86	8.28	19.35	12.54	15.15
	Harvest	7.25	41.35	24.43	17.78	12.87	35.94	0.60	19.19
	Total	87.79	79.95	86.88	81.52	76.09	91.71	90.15	85.04

[a]Port-au-Prince.

Table 2.7 Continued

Food Group	Source	Area		Region					
		Urban	Rural	North	Trans versale	West	South		
Vegetables	Purchase	94.15	87.36	93.44	92.38	90.34	90.55	92.24	91.77
	Gift	22.72	41.21	30.54	34.18	28.05	34.10	16.12	29.20
	Harvest	14.29	60.44	34.16	35.10	29.66	44.70	2.09	30.45
	Total	95.48	98.21	98.42	96.07	95.17	98.62	93.13	96.44
Fruits	Purchase	86.12	48.49	66.74	64.43	70.57	67.05	86.87	70.37
	Gift	12.14	18.68	14.93	14.55	13.79	19.59	7.76	14.43
	Harvest	12.88	32.28	20.59	18.94	21.15	25.81	9.55	19.67
	Total	85.79	68.68	77.15	74.29	81.38	82.26	87.76	79.80
Oil	Purchase	93.78	96.98	96.15	93.76	93.79	97.24	93.13	94.90
	Gift	2.22	2.75	2.04	2.54	2.53	3.23	1.49	2.41
	Harvest	9.99	9.89	8.37	11.55	11.72	5.99	12.84	9.96
	Total	97.78	99.31	98.19	98.85	98.85	99.08	96.12	98.32
Dairy and Eggs	Purchase	73.35	46.57	68.55	59.12	59.31	58.06	77.91	63.97
	Gift	7.62	5.22	6.33	8.55	6.44	7.37	4.78	6.78
	Harvest	3.11	15.52	6.56	9.93	7.59	11.06	0.60	7.46
	Total	76.09	56.32	73.08	66.05	64.60	65.44	78.81	69.17
Meat	Purchase	79.72	59.34	71.49	78.75	64.60	65.90	85.07	72.58
	Gift	3.48	3.02	2.26	5.31	2.07	4.38	2.39	3.32
	Harvest	1.41	3.85	2.49	2.77	2.30	2.76	0.60	2.26
	Total	80.98	61.40	72.85	80.83	65.52	68.66	85.37	74.12
Fish	Purchase	80.24	73.35	74.89	79.45	76.09	79.49	79.70	77.83
	Gift	3.92	3.02	2.26	3.00	2.76	6.45	3.58	3.61
	Harvest	1.92	0.55	1.13	1.15	2.76	1.61	0.30	1.44
	Total	81.20	74.31	75.57	79.68	77.70	81.11	80.30	78.79

Table 2.7 Continued

Food Group	Source	Area		Region					
		Urban	Rural	North	Trans versale	West	South		
Sugar	Purchase	92.15	89.42	91.18	87.99	90.34	94.24	92.54	91.20
	Gift	3.11	3.16	3.17	3.00	4.37	3.00	1.79	3.13
	Harvest	21.98	29.12	23.30	22.86	28.51	26.73	20.00	24.48
	Total	96.97	95.60	96.61	94.69	97.01	97.47	96.72	96.49
Condiments and Misc.	Purchase	88.16	69.09	74.43	80.37	81.84	82.03	91.04	81.48
	Gift	7.18	9.34	7.01	7.85	9.43	7.14	8.36	7.94
	Harvest	2.81	13.05	8.82	4.39	6.67	8.76	2.39	6.40
	Total	90.67	77.34	81.67	85.45	86.67	85.02	92.84	86.00
Drinks	Purchase	56.85	25.69	33.03	37.64	47.59	43.32	74.93	45.94
	Gift	1.78	1.51	0.90	3.00	1.38	0.69	2.69	1.68
	Harvest	0.15	0.00	0.00	0.46	0.00	0.00	0.00	0.10
	Total	57.44	26.51	33.48	38.80	48.05	43.78	75.82	46.61
Other Foods	Purchase	72.02	64.70	72.40	68.36	63.68	70.05	73.73	69.46
	Gift	4.22	4.67	2.71	6.24	3.22	6.22	3.28	4.38
	Harvest	2.89	13.60	4.52	5.77	7.36	13.36	0.90	6.64
	Total	73.35	69.78	74.43	70.67	66.21	75.58	74.03	72.10
Total Food Expenditure	Purchase	99.26	99.73	100.00	98.85	99.54	99.31	99.40	99.42
	Gift	49.00	64.01	55.43	62.12	52.18	55.76	43.28	54.26
	Harvest	48.19	86.40	64.93	66.51	63.45	71.66	35.22	61.57
	Purchased Meals	28.42	13.46	20.81	18.94	18.62	14.52	48.96	23.18
	Total	99.70	100.00	100.00	100.00	99.54	99.77	99.70	99.81

2.4.1 Total expenditure and total food expenditure

Average annual total expenditure in Haiti was 14,928 Gds (Table 2.4). Since the average household size was about five, the average annual per capita total expenditure in Haiti in dollars was almost 600 dollars.

As is fairly typical of developing countries like Haiti, total expenditure favored urban areas. For example, average total expenditure in urban areas (19083 Gds) was more than twice that in rural areas (7218 Gds). Among the regions, Metropolitan Port-au-Prince had an average total expenditure of 29288 Gds, compared to only 11691 Gds in the Transversale (Table 2.5).

Average total food expenditure in Haiti was 5732 Gds (1146 dollars), and the average food share of total expenditure was about 51 percent (Table 2.4).

Given that urban and rural areas, and the regions varied significantly in average total expenditure, variations in food expenditure patterns may be associated with variations in total expenditure. For example, food share of total expenditure might be expected to fall as total expenditure rises. Average food budget share was higher for rural (63%) than for urban (44%) areas, and was the highest in the South (56%) and the lowest in Metropolitan Port-au-Prince (32%) (Table 2.5).

2.4.2 Average shares by food group (Table 2.6)

2.4.2.1 Haiti Average shares were the highest for vegetables (20.4%) and meat (9.4%). The high average share for vegetables might have occurred because of food preferences, particularly for poorer households.

Average share of meat was high probably because of high meat prices.

Comparing the cereals, average share of rice was the highest (8.9%) followed by wheat (6.4%). The major food source was purchase.

The average share of total purchases was about 80% compared to only 14% for total harvests, 6% for total gifts, and 3% for purchased meals. Average shares for purchases were higher than average shares for gifts and harvests for all food groups.

2.4.2.2 Rural urban variations In urban areas too, average shares were the highest for vegetables (18%) followed by meat (11%). Given that the share of vegetables would have been expected to be lower than meat in the richer households, the high average share of vegetables even in urban households might be interpreted as having occurred because of a predominance of the urban poor in the urban sample.

In rural areas, average expenditures were the highest for vegetables (25%) followed by tubers (9.9%) instead of meat, since meat was probably too costly for many of the lower income rural households. It is also possible that tubers substituted meat in the diets of rural households, since past studies (Bureau of Nutrition, 1979) indicate that while poorer households combine cereals with tubers, richer households combine cereals with meat.

Among the cereals, average shares were the highest for rice followed by wheat in both urban and rural areas. While past studies (Beckles, 1975) found the consumption of rice and wheat to be confined to mainly urban areas, the high average shares for rice and wheat in both urban and rural areas in the HECS might have occurred because of lower prices and higher availability caused by imports. The major food source was purchase in both urban and rural areas. Average shares for purchases were greater than gift or harvest for all food groups in urban areas. This was also true in rural areas, except for tubers, for which, average shares for harvest were higher than average shares for purchases.

Comparing across urban and rural areas, average shares were higher in urban than in rural areas for all foods except for some foods such as corn, millet, tubers, and vegetables, which were probably more important in the diets of the relatively poorer households in rural areas. Average shares were also lower in urban than in rural areas for some food groups, like dairy and eggs, sugar, condiments and miscellaneous, and oil, which were probably relatively more expensive in rural areas.

As might be expected, average shares of total purchases, total gifts, and total purchased meals were higher in urban than in rural areas, while average shares for total harvest were higher in rural than in urban areas. Given the greater likelihood of purchasing meals away from home in urban work environment, average share of purchased meals was 4.6% in urban areas compared to only 1% in rural areas.

<u>2.4.2.3 Regional variations</u> Average shares were again the highest for vegetables in all the regions. Among the cereals, rice and wheat had the highest average shares in all the regions. Also, the major food source was purchases in all the regions.

Comparing across regions, the average share of vegetables was the highest (22%) in regions with lower average total expenditure like Transversale, and the lowest in regions with high average total expenditure, like Metropolitan Port-au-Prince (16%), implying the probable importance of vegetables in the diets of relatively poorer households. Average share of meat was the highest in Metropolitan Port-au-Prince, and Transversale (about 11%), but was fairly high (about 8%) in other regions, implying that meat prices were probably high in all the regions.

2.4.3 Participation rates for food groups

2.4.3.1 Haiti Household participation rates for food group expenditures were the highest for oil (98%), followed by sugar (97%), vegetables (96%), and wheat (93%), implying that these were the most frequently obtained food groups, and therefore either had relatively low prices, or were considered essential in the Haitian diet according to food preferences (Table 2.7). Among the cereals, wheat had the highest participation rate followed by rice (81%), implying again the possibility of lower prices on account of imports.

Purchases were the major source for all food groups. Participation rates for purchases were considerably higher than for gifts and harvests for all food groups. Participation rates for harvests were higher than those for gifts for about half the food groups. Exceptions were items that are not harvested, such as wheat (wheat is imported in Haiti), condiments and miscellaneous, drinks, and other items such as rice, meat, fish, and other cereals.

Comparing total purchases with total gifts, harvests and purchased meals, almost 100 percent of households in Haiti had positive total purchases, followed by 62 percent for total harvests, 54 percent for total gifts and 23 percent for total purchased meals.

2.4.3.2 Variations by rural and urban areas The previously discussed patterns for participation rates in Haiti were more or less preserved in urban and rural locations. In urban locations too, participation rates were the highest for oil (98%), followed by sugar (97%), vegetable (96%) and wheat (94%). In addition condiments and miscellaneous also had a high participation rate (91%). Among cereals, again wheat had the highest participation rate followed by rice (85%).

The major food source in urban locations was again purchases for all groups. Participation rates for purchases was again considerably higher than gifts or harvest for all food groups. Comparing harvest and gifts, participation rates for gifts in urban areas were higher than harvest for most food groups, which is plausible. There were some exceptions however. Participation rates were higher for harvest than for gifts in urban areas for oil and sugar, which were probably processed, and in that sense 'harvested' in urban areas, and for corn, other cereals and fruits.

Comparing total purchases with other food sources, participation rates for total purchases in urban locations were almost 100 percent, and participation rates were lowest for total purchased meals (28.42 percent).

In rural locations too, participation rates were the highest for oil (99%) followed by vegetables (98%) and sugar (96%). Among cereals, participation rates were again highest for wheat (91%) followed by rice (74%).

In rural locations, purchases were the major source for all food groups. Participation rates for purchases were higher than those for gifts and harvest for all food groups. Comparing harvest and gifts, participation rates for harvest were higher than those for gifts for all food groups except for groups such as wheat and drinks which are not harvested, and rice and fish. Comparing total purchases with other sources, participation rates were again the highest for total purchases at almost 100 percent followed by total harvest, total gifts and total purchased meals. Comparing rural and urban areas, participation rates were higher for urban than rural locations for all food groups except corn, millet, and vegetables, which were probably more characteristic of diets in poorer households, and oil, for which there was probably a highly inelastic demand. Comparing total purchases, participation rates for total purchases were almost 100 percent in both areas. Participation rates for total gifts and harvests were higher in rural than in urban areas. But participation rates for total purchased meals were about twice as high in urban as in rural locations, which again is plausible given that the urban work environment might encourage more meals away from home than the rural work environment.

2.4.3.3 Variations by region Some of the previously discussed patterns for participation rates in Haiti were preserved in all five regions. More than 90 percent of the households had expenditures on oil, vegetables and sugar in all five regions, and on wheat in all regions except Transversale, again implying low prices or food preferences as possible causes. Among cereals, in all five regions participation rates were the highest for wheat followed by rice, implying again the possibility of low prices due to imports.

The major source of food was again purchases. Participation rates for purchases were higher than those for gifts and harvest for all foods in all five regions. Comparing gifts and harvest, participation rates were higher for gifts than for harvest for most food groups in Transversale, and particularly in the Metro Region. Participation rates were higher for gifts than for harvest for foods that are not harvested such as wheat and drinks, and other foods such as other cereals and fish in all five regions.

Comparing total purchases with other food sources, the participation rate for total purchases was the highest at about 100 percent in all five regions, followed by total harvest, gifts and purchased meals in all regions except the Metro Region where participation rates for total purchased meals exceeded those for total gifts and participation rates for total harvests was the lowest.

2.5 Conclusion

This chapter consisted of descriptions of the survey design for the HECS, the variables used in the present study, and the empirical findings the from tabular analysis of the data in terms of food expenditure patterns for Haiti. A summary of the food expenditure patterns that emerge from the tabular analysis are:

1. Regardless of area and region, vegetables had the highest average share, and oil the highest participation rate.

2. More than 90 percent of the households obtained oil, sugar, vegetables, and wheat during the survey week in all regions and rural and urban areas.

3. Average share of meat was the highest after vegetables in urban areas. In rural areas, the second highest share was for tubers.

4. Among the cereals, average shares were the highest for rice followed by wheat, and participation rates were the highest for wheat followed by rice . This was true in all regions and in rural and urban areas.

5. Average shares in urban areas were higher than in rural areas for most food groups.

6. Participation rates were higher in urban compared to rural areas for all food groups; they were the highest in Metropolitan Port-au-Prince and the lowest in the North for almost all food groups.

7. Purchases were the major food source for all food groups in all regions and in rural and urban areas.

Comparing the findings in the present study to past studies, one major change is that rice and wheat are no longer consumed mainly in urban areas as they apparently were in the past (Beckles, 1975). While most of the patterns observed from the HECS seem plausible for a developing country like Haiti, some of the patterns appear unique to Haiti. For example, the extent of the market economy seems to be high. The importance of purchases in terms of both average shares and participation rates indicates a low degree of subsistence in all areas and regions. This is supported by at least one past study (Beckles, 1975).

Another unique pattern is that certain basic patterns are common to all (such as the importance of rice and wheat among cereals), although there are variations in average expenditure levels, shares and participation rates among the regions, and rural and urban areas. This is probably because the market economy exists in all regions and in rural and urban areas.

Finally, one food expenditure pattern expected of developing countries is that a preferred starchy staple dominates the food consumption picture (Timmer, Falcon and Pearson, 1983), this staple usually being rice, wheat, corn, cassava or yam. For example, for Indonesia (Johnson et al., 1986), average budget share was the highest for rice. But this was not the case in Haiti. Although rice and wheat were important among the cereals, average shares for rice and wheat were not among the largest for all food groups.

3. ALTERNATIVE CONCEPTUAL FRAMEWORKS

3.1 Introduction

The problem in this study is to model, in a theoretically plausible way, the effects of household size and composition, and total expenditure, on food demands. Engel curves have been used traditionally to characterize this relationship. For the application in the present study, from a theoretical perspective, the novelty lies in the inclusion of scaling, and the association of scales with specific foods. Two related conceptual frameworks are examined and compared in this chapter. They are traditional consumer theory, and the household production model. Under the household production model, two approaches are examined: the production approach, and the product characteristics approach. Each model is described conceptually in sections 3.1 and 3.2. Then, applications of these models for studying food consumption, and nutritional status are reviewed in section 3.3. Finally, conclusions are presented in section 3.4.

3.2 Traditional Consumer Theory

3.2.1 Utility maximization

Traditional consumer theory uses an axiomatic, utility maximizing, deductive conceptual framework, which is preserved in the household production models. The axiomatic approach is used to deduce empirically testable economic relationships, among which are the uncompensated and the compensated demand functions. Given a choice set of commodity bundles, the axioms define the consumers' preference ordering over this set, and represent this preference ordering by a real-valued (ordinal) utility function, u(q), where q is a vector of quantities of commodities and services consumed.

The axioms, reflexivity, completeness, transitivity and continuity are sufficient to represent the consumers' preference by a continuous real valued utility function. The axioms of nonsatiation and convexity ensure that the utility function is nondecreasing in q and quasi-concave (Lee, 1985). Therefore, the utility function resulting from the axioms is increasing in q, continuous, twice differentiable, and strictly quasi-concave (Johnson, Hassan and Green, 1984). These properties ensure a unique solution to the primal problem of maximizing utility subject to the budget constraint. The dual to this problem is the minimizing of total expenditure, m, subject to a fixed level of utility. Solving the first order conditions of the primal or the dual produce uncompensated and compensated demand relationships respectively.

The primal problem is

$$\text{Max } u=u(q), \text{ subject to } m=p'q \qquad 3.1$$

where p is a vector of prices of commodities and services. Alternatively, the optimization problem can be solved as,

$$\text{Max } L=L(q,\Omega)=u(q)+\Omega(m-p'q) \qquad 3.2$$

where Ω is the Lagrangian multiplier.

Maximizing utility subject to the budget constraint yields the first order conditions,

$$u'q-\Omega p=0, \qquad 3.3$$

$$\text{and } p'q-m=0. \qquad 3.4$$

The second order conditions for a maximum require that

$$q'Uq \leq 0 \text{ such that } p'q=0 \qquad 3.5$$

where U is the vector of derivatives of u(q).

$$U= \begin{matrix} u_{11} & \cdots & u_{1n} \\ u_{n1} & \cdots & u_{nn} \end{matrix} \qquad 3.6$$

and u_{ij} is the partial derivative of u(q) with respect to q_i and q_j. The assumption that the utility function is strictly quasi-concave ensures that the second order conditions for a maximum will be met (Johnson, Hassan and Green, 1984), and, by Young's theorem

$$u_{ij}=u_{ji} \quad \text{for all } i \text{ and } j \qquad 3.7$$

Solving the first order conditions (3.3 and 3.4) results in the following economic relationships.

1. The uncompensated or Marshallian demand curve relating the quantity demanded to prices and income.

$$q_i=q_i(p;m) \qquad i=1,\ldots,n \qquad 3.8$$

2. The marginal utility of money income (the Lagrangian multiplier Ω), as a function of prices, and income.

$$\Omega=\Omega(p;m) \qquad 3.9$$

3. The Engel curve relating quantity demanded to income, given prices.

$$q_i=q_i(m;p) \qquad i=1,\ldots,n \qquad 3.10$$

4. The indirect utility function or the maximum level of utility obtainable for given income and prices.

The indirect utility function is obtained by substituting the uncompensated demand functions into the utility function,

$$v(p;m)=u[q(p;m)]. \quad 3.11$$

The dual problem of minimising income subject to a fixed level of utility, u^0 is

$$\text{Min } m=p'q \text{ subject to } u=u^0 \quad 3.12$$

Solving the first order conditions for optimising the dual results in the economic relationships:

1. The compensated demand function relates quantity demanded to prices, given a level of utility. It is compensated for the income effect of a price change.

$$Q_i=Q_i(p;u), \quad i=1,\ldots,n \quad 3.13$$

2. The cost function relates income to prices, given utility. It is the minimum cost of achieving a fixed utility level, u^0, and is obtained by minimizing income with respect to quantity, q, subject to u equal to u^0, given prices. The cost function is in that sense the analogue of the indirect utility function.

$$c(p;u)=\text{Min}_q m, \text{ subject to } u=u^0, \text{ or}$$
$$c(p;u)=p'Q(p;u). \quad 3.14$$

3. The transformation function relates income to quantity demanded, given utility. It is the minimum cost of achieving a fixed utility level and is obtained by minimizing income with respect to prices, subject to $u=u^0$, given q.

$$T(q;u)=\text{Min}_p m, \text{ subject to } u=u^0. \quad 3.15$$

The behavioral functions resulting from the primal and dual are algebraically related. For example, the uncompensated demand functions can be obtained from the indirect utility function using Roy's identity. The indirect utility function, the direct utility function, the cost function, and the transformation function can all equivalently represent a specific preference ordering (Johnson, Hassan and Green, 1984). This is important for applied work because some of these functions have arguments that are in principal observable (cost function) while others do not (direct utility function).

3.2.2 General restrictions

Owing to the properties of the utility function, and the linearity of the budget constraint, and more generally, the deductive structure of the model, the resulting economic relationships are subject to restrictions. These general restrictions are testable hypotheses, or, they can be incorporated to reduce the number of parameters to be estimated in empirical applications. These restrictions involve parametric shifts (shifts in prices and income) in the first order conditions of the constrained utility maximizing problem.

Using scalar notation and elasticities (cross price elasticities, e_{ij}, and income elasticities, e_i) and budget shares (w_i), Engel aggregation, Cournot aggregation, homogeneity, and symmetry restrictions, called the Slutsky relations are:

1. Engel aggregation:

   $$\Sigma w_i e_i = 1 \qquad 3.16$$

   This follows from the linearity of the budget constraint.

2. Cournot aggregation:

$$\Sigma w_i e_{ij} + e_j = 0 \qquad 3.17$$

This also follows from the linearity of the budget constraint. Aggregation conditions (1 and 2) restrict changes in expenditure due to relative prices to rearrangements in purchases that do not violate the budget constraint.

3. Homogeneity: Consumers are assumed not to have money illusion. That is, they are assumed to be cognizant of real and not nominal income. If prices and income change equiproportionately, consumers do not change quantity demanded. The uncompensated demand function (3.8) is homogeneous of degree zero in prices and income, and the compensated demand function (3.13) is homogeneous of degree zero in prices. Applying Euler's theorem to the uncompensated and compensated demand functions yields the two homogeneity restrictions,

$$\Sigma e_{ij} + e_i = 0 \text{ and } \Sigma e_{ij} = 0. \qquad 3.18$$

4. The Slutsky results and the symmetry restrictions:

According to the Slutsky results, the effect of a price (own or cross) change on the uncompensated quantity demand is divided into substitution (k_{ij}) and income effects. The substitution effect is the result of a price change on quantity demanded, after income is adjusted to compensate for price change (the change in real income caused by the price change), such that, the same level of utility is maintained. Therefore it is the change in compensated demand with respect to a price change. Differentiating uncompensated demand (3.8) with respect to price p_j, the Slutsky result is,

$$\frac{dq_i}{dp_j}=\frac{dQ_i}{dp_j}-q_j\frac{dq_i}{dm} \qquad 3.19$$

where the first term on the right hand side is the substitution effect, k_{ij}, and the second term is the income effect.

The symmetry restriction means that all cross price substitution effects are equal (Johnson, Hassan and Green, 1984)

$$\text{i.e.,} \quad k_{ij}=k_{ji} \quad \text{for all } i, j \qquad 3.20$$

or, in elasticity terms,

$$e_{ij}=\left(\frac{w_j}{w_i}\right)e_{ji}-w_j(e_i-e_j) \text{ for all } i \text{ and } j. \qquad 3.21$$

5. Negativity: Because the utility function is quasi concave, the own price substitution effect, k_{ii} is negative for all i.

These general restrictions reduce the number of parameters to be estimated from a total of n^2+n elasticities in the unrestricted model (n direct price elasticities, n^2-n cross price elasticities, and n income elasticities) to $1/2(n^2+n)-1$ when the restrictions are imposed. Symmetry reduces the total number of independently calculated elasticities by $1/2(n^2-n)$. Engel aggregation reduces the total number by 1 and Cournot aggregation by n (Johnson, Hassan and Green, 1984).

3.2.3 Separability and more specific restrictions

The demand system developed to this point has few specializing assumptions. Often however, a sub demand system is more relevant, for instance when research interests and data availability are for certain commodity groups. To group commodities and preserve the principles from theory, an equivalence criterion must be satisfied. The optimal level of utility from allocating income among the grouped commodities must equal that from allocating income among disaggregated commodities comprising the groups. This grouping of commodities is possible when the utility function is separable.

The concept of a separable utility function involves the following ideas. It is assumed that there are n commodities that can be partitioned into S mutually exclusive and collectively exhaustive groups $N_1, \ldots, N_S$ each containing n_s commodities, where the total number of commodities, n equals n_s. The behavioral assumption is that the consumer first allocates income among commoditiy groups $N_1, \ldots, N_S$, and then within the commodity groups.

A utility function u(q) is strongly separable for the commodity groups $N_1, \ldots, N_S$, if the marginal rate of substitution between two commodities i and j from different groups I and J respectively does not depend upon quantities of commodities not in I and J, i.e.,

$$\frac{d(u_i/u_j)}{dq_k}=0 \text{ for all } i\varepsilon I,\ j\varepsilon J \text{ and } k\notin I,J\ (I\neq J) \qquad 3.22$$

where u_i and u_j are partial derivatives of u with respect to q_i and q_j respectively.

A utility function u(q) is weakly separable for groups $N_1, \ldots, N_S$, if the marginal rate of substitution between two commodities i and j from the same group, I, is independent of the quantity of all commodities not in that group, i.e.,

$$\frac{d(u_i/u_j)}{dq_k}=0 \text{ for all } i,j\in I \text{ and } k\notin I. \qquad 3.23$$

A related concept is Pearce separability. A utility function $u(q)$ is Pearce separable for groups $N_1, \ldots ,N_S$, if the marginal rate of substitution between two commodities i and j from the same group I does not depend upon quantities of all other commodities, including other commodities in I.

i.e., $$\frac{d(u_i/u_j)}{dq_k}=0 \text{ for all } i,\ j\in I \text{ and } k\neq i,j. \qquad 3.24$$

The concepts of separability are implied by preference orderings, and result from specific direct utility functions. And, these utility functions imply further restrictions on the parameters of the demand system.

The implications that the concepts of separability have for the algebraic form of the utility function are as follows. A utility function is strongly separable for the groups $N1, \ldots ,N_S$ $(S>2)$, if and only if the utility function $u(q)$ is of the form

$$u(q)=F[u^1(q^1)+ \ldots +u^S(q^S)] \qquad 3.25$$

where F is a function of one variable and for each $s=1,\ldots S$, u^s is defined as a function of quantities of the commodities in the subvector q^s.

A utility function is weakly separable if and only if the utility function $u(q)$ is of the form

$$u(q)=F[u^1(q^1), \ldots ,u^S(q^S)] \qquad 3.26$$

where F is a function of S variables, and for each s, u^s is defined as in (3.25).

A utility function is Pearce separable if and only if the utility function is of the form

$$u(q)=F[u^1\ \Sigma g_i(q_i)\ ,\ \ldots\ ,u^S\ \Sigma g_i(q_i)\ ] \qquad 3.27$$

where F is a function of S variables and

$$u^s=u^s[\Sigma g^i(q_i)] \qquad 3.28$$

These utility structures imply restrictions for the substitution term k_{ij}, or elasticities. Alternatively, the necessary and sufficient conditions for separability can also be stated in terms of the substitution terms k_{ij} and the elasticities.

A strictly quasi-concave utility function u(q) is strongly separable for the groups $N_1, \ldots ,N_S$ if and only if the substitution effects k_{ij} are of the form

$$k_{ij}=\theta\frac{dq_i}{dm}\frac{dq_j}{dm} \quad \text{for all } i\varepsilon I,\ j\varepsilon J\ (I=J) \qquad 3.29$$

where θ is a factor of proportionality common to all groups, or

$$e_{ij}=w_j\theta e_ie_j-w_je_i. \qquad 3.30$$

A strictly concave utility function u(q) is weakly separable for the groups $N_1, \ldots ,N_s$ if and only if the terms k_{ij} are of the form

$$k_{ij}=\theta_{IJ}\frac{dq_i}{dm}\frac{dq_j}{dm} \quad \text{for all } i\varepsilon I,\ j\varepsilon J\ (I=J), \qquad 3.31$$

or

$$e_{ij}=w_j\theta_{IJ}e_ie_j-w_je_i, \qquad 3.32$$

where the factor of proportionality θ_{IJ} varies by the pairs of groups considered.

A strictly quasi-concave utility function is Pearce separable for the groups, $N_1,\ldots,N_S$, if and only if k_{ij} are of the form,

$$k_{ij}=\theta_{IJ}\frac{dq_i}{dm}\frac{dq_j}{dm} \text{ for all } i\epsilon I \text{ and } j\epsilon J, \quad 3.33$$

or

$$e_{ij}=w_j\theta_{IJ}e_ie_j-w_je_i, \quad 3.34$$

where the factor of proportionality θ_{IJ} is now defined for all pairs of groups including I=J. That is, it varies among all pairs of commmodities regardless of the group.

These conditions on the elasticities result in a substantial reduction in the number of parameters to be estimated for the full demand system. For strong separability, the restrictions (3.30) imply that only n+1 (n income elasticities plus θ) parameters need to be estimated for the full demand system, instead of $n+n^2$. For weak separability, the restrictions (3.32) imply that only $n+1/2(S^2-S)$ parameters need to be estimated for the full demand system.

There are two classes of utility functions that satisfy selected separability conditions but have especially restrictive characteristics. They are the directly additive and the block additive utility functions.

The directly additive utility function is,

$$u(q)=u^1(q^1)+ \ldots +u^S(q^S) \quad 3.35$$

where each q^s contains one element only. This utility function has

$$u_{ij}=0 \text{ for all } i=j \quad 3.36$$

and

$$k_{ij}=\theta^*\frac{dq_i}{dm}\frac{dq_j}{dm} \text{ for all } i=j \quad 3.37$$

where $\theta^*=\Omega/(d\Omega/dm)$, and Ω, the Lagrangian multiplier, is the marginal utility of money income. In terms of elasticities, the additive utility function implies

$$e_{ij}=w_j \phi e_i e_j - w_j e_i \qquad 3.38$$

where

$$\pi=1/\phi=-m/\theta^* \qquad 3.39$$

and π is a money flexibility parameter describing how the marginal utility of income, Ω, changes with respect to changes in income.

Using the direct additive utility function means that estimates of n income elasticities, and the income flexibility parameter π are required for a complete characterisation of the demand system. However, there are highly restrictive behavioral consequences implied by this utility structure. If the additive utility function is used, either all goods are normal and substitutes for each other; or, if one good is normal and substitutes for every other good, the remaining goods are either all inferior and complementary to each other, or all neutral and unrelated to each other.

Nonetheless, the direct additive utility function may be useful for broadly defined classifications of commodities such as food and clothing. For lower degrees of aggregation, additivity is an overly strong assumption.

A weaker assumption is block additivity, which is also a case of strong separability.

$$u(q)=u^1(q^1)+ \ldots +u^S(q^S) \qquad 3.40$$

where q^s is the vector of commodities in the sth block. Under the assumption of block additivity, the number of parameters to be estimated in a complete system of equations depends on the number of groups and the number of commodities in each group. The number of parameters to be estimated now is $(n+\Sigma n_s^2)/2$ where S is the number of blocks, and n_s is the number of commodities in the sth block (Johnson, Hassan and Green, 1984). Block additivity is less restrictive in that it does not exclude inferiority for those commodities that are a part of a set consisting of more than one commodity.

3.2.4 Incorporation of household characteristics

Traditional consumer theory incorporates only the effects of prices and income on demand, with tastes as given. In order to explain tastes, applications of traditional consumer theory have used household characteristics such as socioeconomic or demographic variables. These household characteristics are incorporated by using the methods of translating and scaling and variations thereof (Sydenstricker and King, 1921; Barten, 1964; Engel, 1895; Prais and Houthakker, 1955).

First, it is assumed that preferences over goods and services are conditional on household characteristics. Then, a household utility function is defined instead of an individual demand function. Demand functions are then derived from a maximization problem in which the household maximizes a utility function conditional on these household characteristics, subject to its budget constraint. The primal problem now is

$$\text{Max } u=u(q\ \alpha) \text{ subject to } p'q=m \qquad 3.41$$

where α is a vector of household characteristics such that an element

α_k (k=1,...,K) is the number of persons with the kth category of household characteristics. The uncompensated demand curve resulting from the constrained maximization of utility, 3.40 is

$$q_i=q_i(p,m;\alpha) \qquad i=1,\ldots,n. \qquad 3.42$$

Thus, household characteristics explicitly affect demand, and tastes are no longer presumed given. They change as household characteristics change because it is now assumed that households with different characteristics may have different preferences.

The household is assumed to view prices (p), income (m) and implicitly also view household characteristics (α) as external. The existence of these demand functions is guaranteed by the implicit function theorem (Goungetas, 1986). They satisfy the general restrictions because they are derived from a utility maximization problem similar to that for traditional consumer theory.

For cross section data, the general method is to calibrate the Engel curve by a factor that represents household characteristics either in an _ad hoc_ way or based on utility theory. Engel (1895) first defined and estimated such a deflator y, exogenously, based on physiological (nutritional) information and then applied it to estimate per adult equivalent expenditure on a commodity,

$$(p_iq_i/y)=p_iq_i(m/y) \qquad i=1,\ldots,n. \qquad 3.43$$

A second approach has been to interpret y as an index of household size and composition and to estimate it directly as a parameter in (3.43). A third approach (Sydenstricker and King, 1921) has been to define a different scale, y_i for each commodity i, and an overall scale, y_0 for income (Prais and Houthakker, 1955), and to estimate

$$(p_i q_i / y_i) = p_i q_i (m/y_0); \qquad i=1,\ldots,n, \qquad 3.44$$

with n+1 new parameters (the n y_i and y_0) to be estimated. None of these approaches were based directly on utility theory. A fourth approach by Barten (1964) has presented a model based on utility theory by hypothesizing that household utility was a function of per equivalent adult consumption of commodities. Under certain conditions Barten's model yields an Engel curve specification identical to (3.44) (Goungetas, 1986).

These scaling methods, however, involve a fundamental identification problem which must be overcome either by a priori specifying one of the specific equivalence scales or the income scale. The identification problem means that the scales, y_i, cannot be identified from cross-section data. A proof of the identification problem was shown by Muellbauer (1975), and is given in the appendix.

To overcome the identification problem, a priori information has to be introduced. For example, one of the equivalence scales, y_j, or the income scales, y_0 can be specified a priori, where the information used to specify these scales can be obtained from behavior observed in previous studies, or, from physiological information. In the present study, the weight for the category adult male is assumed to be 1 and the scale for income is assumed to equal the unweighted household size, following the methods used in past studies (Brown, 1982; Goungetas, 1986).

Alternatively, the identification problem can be overcome by using pooled time series and cross data and the associated information on price variation (Goungetas, 1986). Under this latter approach, there are five general methods of incorporating household characteristics into complete demand systems:

1. Translating: Translation parameters d_i are first defined as depending on household characteristics, independent of the utility maximizing framework.

   $$d_i=d_i(\alpha). \quad 3.45$$

   Then, utility is defined as depending on d_i resulting in the following demand system:

   $$q_i=q_i(p;m,\alpha)=d_i+q_i^0(p;m-\Sigma p_i d_i); \quad i=1,\ldots,n, \quad 3.46$$

   where

   $$d_i=d_i(\alpha)=\Sigma a_{ik}\alpha_k \quad 3.47$$

   in the case of linear translating.

2. Scaling: As with translation parameters, scaling parameters are defined as depending on household characteristics exogenous to the utility maximizing process, and then utility is defined as depending on quantities demanded, q_i deflated by the scaling parameters y_i. The resulting demand system is

   $$q_i(p;m,\alpha)=y_i q_i(p_1 y_1,\ldots,p_n y_n;m); \quad i=1,\ldots,n, \quad 3.48$$

   where $y_i=y_i(\alpha)$. Each scaling parameter y_i is specific to commodity i.

3. Gorman specification: This method amounts to first scaling, then translating, and results in the following demand system,

   $$q_i(p;m,\alpha)=d_i+y_i q_i(p_1 y_1,\ldots,p_n y_n;m-\Sigma p_i d_i);i=1,\ldots,n, \quad 3.49$$

   where $d_i=d_i(\alpha)$ and $y_i=y_i(\alpha)$.

4. Reverse Gorman specification: This method involves first translating and then scaling, and results in the following demand system,

$$q_i(p;m,\alpha')=y_i[d_i+q_i(p_1y_1,\ldots,p_ny_n;m-\Sigma p_jy_jd_j)]; \quad 3.50$$

$i=1,\ldots,n,$

where according to the suggestion of Goungetas (1986),

$$d_i=d_i(\alpha')= \Sigma a_{ik}\alpha_k \quad 3.51$$

and

$$m_i=m_i(\alpha')=1+(1- \ )\Sigma b_{ik}\alpha_k \quad 3.52$$

5. Modified Prais-Houthakker procedure: As with the cross section data, scales specific to commodities, y_i are defined as depending on household characteristics. Scaling quantity demanded by y_i and deflating income by the income specific scale y_0, the demand system is

$$q_i=q_i(p;m,\alpha)=y_iq_i(p;m/y_0); \quad 3.53$$

where $y_i=y_i(\alpha)$ and $i=1,\ldots,n$.

Using the budget constraint with q_i defined as above, y_0 is derived as a function of household characteristics. The first four of these, yield theoretically plausible demand functions -- i.e., demand functions derivable from utility functions. The modified Prais-Houthakker procedure does not, except in very special cases, and only if the original demand system corresponds to an additive direct utility function (Goungetas, 1986).

Traditional consumer theory can be used to model Engel curves for food, incorporating household characteristics variables such as household size and composition as explanatory variables, by using the methods of scaling and translating. Traditional consumer theory can also be used to model the simultaneous determination of total food expenditure and nutrient availability. First, using the utility maximization framework, and grouping commodities into two groups, foods and nonfoods, households are assumed to maximize utility subject to the budget constraint, and thereby an Engel curve for total food expenditure is obtained. Using the methods of scaling, household characteristics variables such as household size and composition can be incorporated as explanatory variables in this Engel curve in a theoretically plausible way. This process is within the framework of traditional consumer theory. Thereafter however, nutritional consumption functions are specified ad hoc to the model, based on specific noneconomic hypotheses on the effects of household size, total food expenditure, and total expenditure on nutrient availability (Basiotis et al., 1983).

3.3 Household Production Models

The household production model, which is primarily an outgrowth of the traditional consumer theory, preserves the basic utility maximizing framework described in sections (3.2.1) and (3.2.3). However, it differs from traditional consumer theory in its conceptualization of the household, and therefore in incorporation of household characteristics variables. Unlike traditional consumer theory, the household production model conceptualizes the household as a joint consumer and producer, employing a household production technology. When applied to model the demand for product characteristics, it is conceptualized as a joint producer of commodities (through the household production technology) and commodity characteristics (through the household consumption technology).

While traditional consumer theory incorporates a priori household characteristics such as weighted and unweighted household size to explain changes in tastes through the methods of scaling and translating, the household production model endogenises the choice of characteristics that affect demand, and it incorporates these household characteristics variables through the household production technologies. Two types of household production models are the production, and the characteristics models. The latter are a special case of the former.

3.3.1 Production models

In the most general form, the household production model assumes that household utility is a function of three types of commodities: market purchased, home produced nontraded, and home produced traded commodities. As a producer, the household is assumed to be constrained by not only an income budget, but also by a household time budget Thereby a new concept, the concept of full income, is introduced. Full income is income that includes money income as well as the money value of time endowed to the household. The full income constraint is obtained by combining the money income and time constraints of the household.

The household maximizes utility subject to its full income constraint, as well as the production functions for the home produced goods. This maximization procedure yields household demands for market purchased and home produced goods, derived demands for variable inputs, and shadow prices of home produced nontraded goods.

Two results of this model to be noted are as follows (Strauss, 1986). First, the prediction regarding own price demand response is no longer always negative for normal goods as under traditional consumer theory. If markets exist for all commodities consumed, then in the household production model the own price response of commodity demand can be positive even for normal goods because even though the substitution effect is negative as under traditional consumer theory, and the income effect is positive and larger than the substitution effect for normal goods, total effect now depends in addition on the marketed surplus of home produced traded goods.

Second, if markets exist for all the commodities consumed, the household production model is recursive in that consumption and production decisions are separable even though simultaneous in time. In such a case, production decisions affect consumption decisions, but not vice versa. If, however, there are markets absent, this separability no longer holds. For example, if the household consumes only home produced nontraded goods then constrained utility maximization results in demands and supplies of these goods with the added equilibrium condition that demands equal to supplies. Such goods then have nonzero shadow prices and these shadow prices are determined not only by production parameters, but by consumption parameters as well. They are therefore determined by the household's preferences and the production technology. Now changes in market prices affect behavior directly as before, and indirectly via shadow prices, and production and consumption decisions are no longer separable.

An example of a household production model is as follows. Household utility is assumed to be a function of a vector of home produced nontraded commodities (z) to produce which, market purchased goods (q), home produced labor and other home produced variable inputs (t) are used. Household utility is maximized subject to the full income (F) constraint, and the implicit production function (G) defining the household production technology used, i.e.,

$$\text{Max } u=u(z) \qquad 3.54$$

subject to
$$p'q+w't=F \qquad 3.55$$

and
$$G(q,T,z;K)=0, \qquad 3.56$$

where T is household time stock, K is a vector of fixed inputs, and w is a vector of prices of variable inputs including wages. The constrained maximization of utility results in the following relations:

1. Derived demands for market goods

$$q_i=q_i(p,w,z;K) \qquad 3.56$$

2. Derived demands for variable inputs including home used labor

$$t_j=t_j(p,w,z;K). \qquad 3.58$$

3. Shadow price functions for shadow prices of the home produced nontraded goods,

$$P_k=P_k(p,w,z;K), \qquad 3.59$$

where Pk is the marginal cost of producing z_k

4. Demand functions for the home produced nontraded commodities,

$$z_k = z_k(F,P), \qquad 3.60$$

where F is full income, and P is a vector of shadow or implicit prices of z.

3.3.2 Characteristics models

The products characteristics model is a special case of the household production model. It is the household production model with home produced nontraded goods (z) conceptualised as commodity characteristics produced by a household consumption technology. In Lancaster's version of the product characteristics model, it was assumed that characteristics represent objective features of market goods that are measurable and the same for all consumers, that the consumption technology that transforms these characteristics into commodities is linear, that utility depends not on commodities themselves but on the levels of characteristics of commodities, that utility does not depend on the distribution of characteristics among commodities, and that the marginal utilities of characteristics are nonnegative (Ladd and Zober, 1977).

Lancaster's model was criticized because the assumptions of nonnegative marginal utility of characteristics, of utility being independent of the distribution of characteristics among products, and of linear technology were considered too restrictive (Ladd and Zober, 1977). Two alternative characteristics models that did not make any of these three assumptions were by Ladd and Zober (1977) and by Ladd and Suvannunt

(1976).

As a special case of the household production model, the product characteristics model also incorporates household characteristics variables as explanatory variables through the household consumption technology.

3.4 Applications

3.4.1 Traditional consumer theory

In the area of food demand, traditional consumer theory has been applied to study demand responses to prices, income, and household characteristics variables. In addition, some studies have derived nutrient demand from food using both single equation (Pitt, 1983) as well as simultaneous equations models (Basiotis, Brown, Johnson and Morgan, 1983).

In the study by Pitt (1983), a traditional consumer theory model was assumed, in order to evaluate the impacts of food prices on nutrient availabilities in Bangladesh. The analysis was done by income strata, because the poor were expected to respond differently to changes in prices and total expenditure. The hypothesis was that food subsidization may lead to lower availabilities of nutrients, if substitution effects were strong enough. Food demand functions were estimated for nine foods with the explanatory variables being real expenditure, food prices, time period (seasonal effects), and household characteristics variables such as household composition. The consumption and expenditure data were scaled to per capita terms. From the food demands, nutrient elasticities with respect to food prices were derived.

The underlying model, therefore, was that household utility is a function of food quantities consumed. Maximization of utility with respect to the household budget constraint results in food demand functions. From the food demand functions, using the food to nutrient conversion coefficients, nutrient elasticities with respect to food prices were obtained.

Basiotis, Brown, Johnson and Morgan (1983) also assumed the traditional consumer theory approach, but estimated food demand and nutrient availability simultaneously. Their purpose was to examine the impacts of participation in the food stamp program on nutrient availability, using data from the United States.

Household utility was assumed to depend on foods, and the household was assumed to allocate its budget in two stages. In the first stage, the household was assumed to allocate income to food, with the explanatory variables being household income, size, food and nonfood prices associated with regional and urbanization status, and participation in the food stamp program. This was the first equation in the simultaneous system. In the second stage, the household was assumed to allocate food budget to various foods. Explanatory variables for the resulting food demands were food budget, household size, and age-sex composition, relative prices of specific foods, participation of households in government food programs, and variables affecting household production, such as, home ownership, household headship, education, and opportunity cost of time.

Applying the food to nutrient conversion coefficients, nutrient consumption functions were obtained with the explanatory variables being total food budget, household size and composition, food stamp program participation, and socioeconomic variables assumed to reflect the household production process, and household preferences for food energy and nutrients. These nutrient consumption functions were the remaining equations in the simultaneous system estimated.

Other applications of traditional consumer theory in the area of food demand were by Goungetas (1986), Brown (1982), Davis et al. (1982), Smallwood and Blaylock (1979), and Timmer and Alderman (1979).

3.4.2 Household production models: Characteristics approach

As a characteristics approach, the household production model was applied in the area of food and nutrition, treating food nutrients as commodity characteristics, or, home produced nontraded goods from which households derive utility. Additional food characteristics studied were food taste (LaFrance, 1983), and variety (Lee, 1985). While some studies estimated only nutrient consumption functions (Adrian and Daniel, 1976), others estimated the implicit prices of nutrients (Lee, LaFrance).

In the study by Adrian and Daniel, household nutrient consumption per week was estimated as a function of income and socioeconomic household characteristics variables. These household characteristics variables were degree of urbanization, race, educational attainment of homemaker, stages of households in family life cycle, household size, meal adjustment, and employment status of homemaker. The underlying assumption was that household utility is derived from nutrients. Household utility is maximized subject to the budget constraint, and household production function, which has the household socioeconomic characteristics variables as explanatory variables.

LaFrance (1983) used the characteristics approach of the household production model to study the demand for food characteristics. The food characteristics considered were nutrients and taste. Household utility was assumed to depend on nutrients and food taste. A linear household production function was assumed for nutrients and a nonlinear production function for taste. First, food cost was minimized subject to the nutrient and taste production constraints. Then household utility, which is a function of nutrients available and taste, was maximized subject to the food characteristics budget constraint obtained from the optimisation in stage one. The resulting implicit prices for taste and nutrient availabilities were estimated as functions of food prices and household production variables.

Lee (1985) also used the characteristics approach to estimate implicit prices for nutrient availabilities, and for food variety, using which, he examined the effects of socioeconomic and demographic household characteristics on the implicit prices. The household characteristics considered were household income, food energy requirements, number of meals adjusted household size, and other socio-demographic variables, and the implicit prices were prices of food variety and nutrients available. Then, demand equations for nutrients and variety were obtained as functions of the implicit prices of nutrients and variety, and various socioeconomic variables.

3.4.3 Household production models: Production approach

As a production model, the household production approach has been applied to a variety of problems in the area of food and nutrition. A greater variety of variables related to food demand were examined. For example, in addition to food demand, household health production was also studied. Pitt and Rosenzweig (1986) studied household general health production, whereas Horton (1986) studied the production of household child nutritional health.

Pitt and Rosenzweig use the household production model to compare the effects of health programs and food programs on household production of health by comparing the effects of food price changes and health input price changes on the production of health. Measuring health by incidence of illness, they assumed utility to depend on health, home produced food, purchased food, and leisure. Household utility was then maximized subject to a health production function, other production functions, and the full income constraint. Health was assumed to be produced by dietary factors, work time, health goods, and the health environment. Production of health, leisure and home produced goods were assumed to be affected by each other. It was also assumed that markets do not exist for health and leisure but do exist for all other goods.

Two results of this model were as follows. First, although the production functions for health, home produced goods, and leisure were interdependent, since markets existed only for home produced goods and not for health, farm production decisions and consumption decisions were separable, but consumption and health production decisions were not separable. Second, given that the reduced form of the health production function embodied both health production technology as well as the household's preference ordering among the commodities it consumes, the effects of food price and health price on health had unpredictable directions.

In the paper by Battad (1978) the determinants of nutritional status of preschoolers was examined. Nutritional status was measured by child growth status (weight by age group). Household utility was assumed to depend on child nutritional status, and the explanatory variables in the production function for nutritional status were assumed to be household per capita income, level of education of mother, age of child, sex of child, mothers' percentage of weight for height, and number of children in the household from 0 to 6 years.

3.5 Conclusion

Traditional consumer theory, and the household production models all use a basic utility maximising framework but differ in their conceptualization of the the basic unit traded, and the decision unit. They also differ in the mechanisms whereby household characteristics variables are incorporated.

Traditional consumer theory conceptualizes commodities as being the basic units, and assumes that utility is derived from the consumption of commodities. But the characteristics approach conceptualizes commodities as comprising collections of characteristics, which are the basic units, and assumes that utility is derived from the consumption of these characteristics. Traditional consumer theory views the household as a consumer, whereas the household production models view the household as a joint consumer and producer.

Traditional consumer theory incorporates household characteristics variables such as household size and composition by using the methods of scaling and translating. Household utility is assumed to depend on quantities consumed of commodities, conditional on household characteristics variables, implying that tastes vary among households, as household characteristics vary. However, the choice of household characteristics variables is exogenous to the model.

The household production models also explain variations in taste - through variations in household characteristics variables, but incorporate these variables in a different way. In the household production models, utility is not conditional on household characteristics variables. But the household's production technology depends on household characteristics. Since the household's demand for commodities or characteristics depends on both preference structures and production technologies, household characteristics affect demand.

In the present study, the conceptual framework chosen was dictated by the data available. The estimation was for food Engel curves with household size and composition and total expenditure as explanatory variables. Data were not available on prices, household food production technology, or household time expenditure. Therefore, the household production models were not used. Traditional consumer theory, specifically, Barten's method of using scales, (Barten, 1964) was used.

4. ESTIMATION OF PER CAPITA ENGEL RELATIONSHIPS: OLS, TOBIT, AND LOGIT MODELS

4.1 Introduction

In this chapter, the effects of unweighted household size, and total expenditure on food group expenditures are specified and estimated using the traditional consumer theory approach described in Chapter 3. Barten's household model (Barten, 1964) is used to specify per capita Engel relationships. Linear, semi-log and double-log models of the per capita Engel relationship are estimated. But results are reported only for the linear model because, for the semi-log and double-log models, parameter estimates had implausible signs for some food groups, and were not significant for others.

First ordinary least squares was used to estimate the per capita model and calculate income elasticities. Then, recognizing that participation rates were less than 100 percent for all food groups, and fairly low for some (Table 2.7), the per capita Engel relationships were estimated using tobit. Finally, in order to study the effects of unweighted household size, and total expenditure on the probability of participation in food group expenditure, logit models were estimated. The regression analysis was done for 15 food groups and for the full sample, and the urban and rural subsamples.

This chapter consists of a description of the model specification (section 4.2), estimation procedures (section 4.3), empirical findings (section 4.4), and a summary of the results (section 4.5).

4.2 Model Specifications

The Engel relationships in Chapters 4 and 5 are specified using Barten's household model (Barten, 1964), under the traditional consumer theory approach described in Chapter 3. According to Barten's model, household utility is assumed to depend on the consumption of commodities scaled by behaviorally specified scales.

i.e., $$u=u(q_1/y_1, \ldots ,q_n/y_n) \quad 4.01$$

where $$y_i=y_i(N_1, \ldots ,N_k),\ i=1,\ldots,n \quad 4.02$$

The y_i are specific scales, or, weighted household sizes defined for each commodity in terms of weights appropriate to that commodity; N_j ($j=1,\ldots,k$) is the number of household members in the jth age-sex category.

According to Barten's model, the utility function, 4.01, is maximized subject to the budget constraint. Alternatively, the model is

Max $$u=u(q_1^*, \ldots ,q_n^*) \quad 4.03$$

subject to $$p_i^*q_i^*=m \quad 4.04$$

where $$p_i^*=p_iy_i,\ \text{and}\ q_i^*=q_i/y_i \quad 4.05$$

The resulting Marshallian demand equations are

$$q_i^*=q_i^*(p_1^*, \ldots ,p_n^*;m) \quad 4.06$$

or, $$q_i=y_iq_i(p_1y_1,\ldots,p_ny_n;m). \quad 4.07$$

The resulting Engel relationship in terms of expenditures, x_i, are

$$x_i=y_ix_i(m/y_i) \quad 4.08$$

Using 4.08, four models are examined: the per capita model, the general scales model, the specific scales model, and the household size effects model. The per capita model is discussed and estimated in

Chapter 4, and the general scales, specific scales, and household size effects models are discussed and estimated in Chapter 5.

In the per capita model, the scale factor used in the Engel relationship 4.08, is unweighted household size, N. Therefore, for the per capita model, the Engel relationship is

$$x_i = Nx_i(m/N) \quad i=1, \ldots, n \qquad 4.09$$

where unweighted household size, $N = N_j$.

The linear, semi-log and double-log specifications of the per capita Engel relationship 4.09 are as follows:

Linear	$x_i = a_i N + b_i m$	4.10
Semi-Log	$x_i = a_i \log(N) + b_i \log(m)$	4.11
Double-Log	$\log(x_i) = a_i \log(n) + b_i \log(m)$	4.12

4.3 Estimation of Engel Curves

First, ordinary least squares was used to estimate the linear (4.10), semi-log (4.11), and double-log (4.12) specifications of the per capita model, for 15 food groups and total food expenditure, for the full sample (Table 4.1), and the urban (Table 4.2) and rural (Table 4.3) subsamples. The dependent variable, was expenditure on food group i, x_i, or, total food expenditure, x, and the independent variables were unweighted household size, N, and total expenditure, m. Results were reported only for the linear specification (4.10) because for the semi-log and double-log specifications, parameter estimates were not significant for some food groups, and estimates of the coefficient for unweighted household size were negative for some food groups. From the Engel curves, income

Table 4.1 Linear per capita Engel relationships for 15 food groups and total food expenditure in Haiti: Parameter estimates (standard errors) and related statistics (U.S. Bureau of Census, 1986-87)

	Food Group							
	Corn	Wheat	Rice	Other Cereals	Tubers	Vege-tables	Fruits	Oil
Unweighted Household Size	22.934 (1.467)	43.945 (1.612)	58.867 (2.869)	14.040 (0.893)	56.634 (2.617)	134.021 (4.415)	14.666 (1.482)	42.779 (2.130)
Total Expenditure	0.002 (0.003)	0.008 (0.0004)	0.012 (0.001)	0.001 (0.0002)	0.008 (0.001)	0.021 (0.001)	0.009 (0.0003)	0.010 (0.0005)
Income Elasticity[a]	0.178	0.336	0.368	0.180	0.288	0.292	0.597	0.361
Percent RMSE[b]	171.66	88.88	115.57	210.98	123.64	80.63	129.12	100.85
Sample Size	2079	2079	2079	2079	2079	2079	2079	2079

[a]Income elasticity is calculated as ei-(dxi/dm)(m/xi), where xi is expenditure on food group i, m is total expenditure, and xi and m are means.

[b]Percent RMSE=(root mean square error/mean of dependent variable)x100.

Table 4.1 Continued

	Food Group							
	Dairy and Eggs	Meat	Fish	Sugar	Condiments and Misc.	Drinks	Other Foods	Total Food Expend
Unweighted Household Size	17.510 (3.595)	31.786 (4.384)	31.329 (2.091)	39.638 (1.938)	17.799 (1.210)	6.745 (1.508)	6.835 (1.338)	537.051 (19.141)
Total Expenditure	0.020 (0.001)	0.038 (0.001)	0.010 (0.001)	0.008 (0.0003)	0.005 (0.0003)	0.007 (0.0004)	0.006 (0.0003)	0.179 (0.005)
Income Elasticity[a]	0.743	0.779	0.464	0.334	0.404	0.716	0.696	
Percent RMSE[b]	175.48	118.01	127.30	106.33	128.33	202.50	203.81	65.46
Sample Size	2079	2079	2079	2079	2079	2079	2079	2079

Table 4.2 Linear per capita Engel relationships for 15 food groups and total food expenditure in urban areas: Parameter estimates (standard errors) and related statistics (U.S. Bureau of Census, 1986-87)

	Food Group							
	Corn	Wheat	Rice	Other Cereals	Tubers	Vege-tables	Fruits	Oil
Unweighted Household Size	17.156 (1.972)	44.952 (2.309)	59.402 (4.147)	10.087 (1.023)	45.015 (3.599)	116.241 (6.130)	12.073 (2.269)	38.652 (2.956)
Total Expenditure	0.003 (0.0004)	0.010 (0.001)	0.013 (0.001)	0.001 (0.0002)	0.010 (0.001)	0.026 (0.001)	0.012 (0.001)	0.012 (0.001)
Income Elasticity[a]	0.353	0.455	0.427	0.051	0.432	0.426	0.776	0.489
Percent RMSE[b]	175.65	79.48	103.08	206.74	117.75	76.11	111.05	91.11
Sample Size	1351.00	1351.00	1351.00	1351.00	1351.00	1351.00	1351.00	1351.00

[a]Income elasticity is calculated as ei-(dxi/dm)(m/xi), where xi is expenditure on food group i, m is total expenditure, and xi and m are means.

[b]Percent RMSE=(root mean square error/mean of dependent variable)x100.

[c]Not significant at a=0.05.

Table 4.2 Continued

	Food Group							
	Dairy and Eggs	Meat	Fish	Sugar	Condiments and Misc.	Drinks	Other Foods	Total Food Expend
Unweighted Household Size	8.452[c] (5.694)	25.819 (6.742)	30.531 (3.195)	31.853 (2.666)	14.197 (1.726)	4.278[c] (2.32)	5.261 (2.143)	450.819 (26.839)
Total Expenditure	0.025 (0.001)	0.042 (0.002)	0.012 (0.001)	0.010 (0.001)	0.006 (0.0004)	0.009 (0.001)	0.007 (0.001)	0.215 (0.006)
Income Elasticity[a]	0.881	0.866	0.566	0.480	0.543	0.872	0.833	
Percent RMSE[b]	151.95	105.25	114.19	96.90	118.23	170.26	193.16	57.10
Sample Size	1351.00	1351.00	1351.00	1351.00	1351.00	1351.00	1351.00	1351.00

Table 4.3 Linear per capita Engel relationships for 15 food groups and total food expenditure in rural areas: Parameter estimates (standard errors) and related statistics (U.S. Bureau of Census, 1986-87)

	Food Group							
	Corn	Wheat	Rice	Other Cereals	Tubers	Vege-tables	Fruits	Oil
Unweighted Household Size	30.327 (2.189)	40.203 (1.938)	54.734 (3.497)	18.890 (1.556)	69.353 (3.711)	152.103 (6.096)	14.573 (1.072)	46.111 (2.976)
Total Expenditure	0.002 (0.001)	0.003 (0.001)	0.004 (0.001)	0.0001(c) (0.001)	0.003 (0.001)	0.011 (0.002)	0.002 (0.0003)	0.006 (0.001)
Income Elasticity[a]	0.081	0.092	0.093	0.007	0.059	0.088	0.153	0.139
Percent RMSE[b]	162.49	107.97	148.02	209.55	133.89	88.69	149.14	125.40
Sample Size	728	728	728	728	728	728	728	728

[a]Income elasticity is calculated as ei=(dxi/dm)(m/xi), where xi is expenditure on food i, m is total expenditure, and xi and m are means.

[b]Percent RMSE=(root mean square error/mean of dependent variable)x100.

[c]Not significant at a=0.05.

Table 4.3 Continued

	Food Group							
	Dairy and Eggs	Meat	Fish	Sugar	Condiments and Misc.	Drinks	Other Foods	Total Food Expend
Unweighted Household Size	21.551 (1.888)	33.694 (4.088)	28.639 (1.805)	47.470 (2.727)	21.075 (1.563)	7.003 (1.214)	7.821 (0.979)	598.603 (21.858)
Total Expenditure	0.003 (0.001)	0.025 (0.001)	0.002 (0.001)	0.003 (0.001)	0.002 (0.001)	0.001 (0.0004)	0.004 (0.0003)	0.074 (0.007)
Income Elasticity[a]	0.152	0.499	0.085	0.077	0.106	0.140	0.414	
Percent RMSE[b]	175.03	148.84	104.49	127.11	151.00	310.80	184.65	76.52
Sample Size	728	728	728	728	728	728	728	728

elasticities were calculated at mean levels of total expenditure and food expenditures.

Since the per capita models do not contain intercepts, the coefficient of determination, or R squared is no longer bound between zero and one. Therefore, instead of the coefficient of determination, the percent root mean square error, or, the coefficient of variation was reported as a measure of goodness of fit. The coefficient of determination measures the variation of the predicted value about the mean as a proportion of the variation of the observed value about the mean. By contrast, the coefficient of variation, or, percent root mean square error, measures the variation of the observed values about the predicted values as a percentage of the mean of the observed values. A low percent root mean square error is, therefore, indicative of a better fit.

Following the ordinary least square estimations, the per capita Engel curve specification 4.10, was also estimated using the tobit model, since participation rates were less than 100 percent for all food groups, and were fairly low for some like 'other cereals' (Table 2.7), implying zero expenditures for several observations. Food group expenditures were therefore expected to have truncated distributions. The tobit models were also estimated for 15 food groups for the full sample (Table 4.4), and the urban (Table 4.5) and rural (Table 4.6) subsamples. Income elasticities were again calculated at mean levels of total expenditure and food expenditures.

Finally, in order to examine the effects of unweighted household size and total expenditure on the probability of household participation

Table 4.4 Tobit Engel relationships for 15 food groups in Haiti: Parameter estimates (standard errors) and related statistics (U.S. Bureau of Census, 1986-87)

	Food Group							
	Corn	Wheat	Rice	Other Cereals	Tubers	Vege-tables	Fruits	Oil
Unweighted Household Size	22.934 (1.387)	43.945 (1.435)	-[a]	14.040 (0.647)	56.633 (2.153)	134.021 (3.87)	-[a]	42.778 (2.215)
Total Expenditure	0.018[b] (0.015)	0.110 (0.006)	-[a]	-0.022 (0.007)	0.135 (0.012)	0.077 (0.016)	-[a]	0.038 (0.009)
Income Elasticity[c]	1.604	4.618		-3.957	4.858	1.071		1.370
Log Likelihood	-10636	-14081	-[a]	-7035	-14024	-16524	-[a]	-15293
Sample Size	2079	2079	2079	2079	2079	2079	2079	2079

[a]Estimates could not be obtained because of numerical problems.

[b]Not significant at a=0.05.

[c]Income elasticity is calculated as ei=(dxi/dm)(m/xi), where xi is expenditure on food group i, m is total expenditure, and xi and m are means.

Table 4.4 Continued

	Food Group						
	Dairy and Eggs	Meat	Fish	Sugar	Condiments and Misc.	Drinks	Other Foods
Unweighted Household Size	-[a]	31.786 (3.727)	-[a]	39.638 (1.875)	-[a]	6.745 (1.203)	6.835 (1.326)
Total Expenditure	-[a]	0.133 (0.017)	-[a]	0.106 (0.008)	-[a]	0.080 (0.006)	0.067 (0.007)
Income Elasticity[c]		2.726		4.429		8.181	7.774
Log Likelihood	-[a]	-13407	-[a]	-14880	-[a]	-8450.9	-11315
Sample Size	2079	2079	2079	2079	2079	2079	2079

Table 4.5 Tobit Engel relationships for 15 food groups in urban areas: Parameter estimates (standard errors) and related statistics (U.S. Bureau of Census, 1986-87)

	Food Group							
	Corn	Wheat	Rice	Other Cereals	Tubers	Vege-tables	Fruits	Oil
Unweighted Household Size	17.156 (2.012)	44.952 (2.121)	59.402 (3.915)	10.087 (0.706)	45.015 (3.015)	116.241 (5.926)	12.073 (2.178)	38.652 (3.175)
Total Expenditure	0.045 (0.019)	0.126 (0.016)	0.046 (0.023)	-0.030 (0.008)	0.134 (0.024)	0.094 (0.038)	0.041 (0.015)	0.044 (0.020)
Income Elasticity[a]	5.294	5.727	1.510	-7.630	5.789	1.541	2.650	1.791
Log Likelihood	-6847.6	-9311.4	-9312.1	4603.5	-9352.7	-10684	-8652.1	-9925.8
Sample Size	1351	1351	1351	1351	1351	1351	1351	1351

[a]Income elasticity is calculated as ei=(dxi/dm)(m/xi), where xi is expenditure on food group i, m is total expenditure, and xi and m are means.

[b]Not significant at a=0.05.

Table 4.5 Continued

	Food Group						
	Dairy and Eggs	Meat	Fish	Sugar	Condiments and Misc.	Drinks	Other Foods
Unweighted Household Size	8.452[b] (6.367)	25.819 (6.236)	30.523 (2.886)	31.853 (2.535)	14.197 (1.844)	-27.911 (3.538)	-5.172[b] (3.142)
Total Expenditure	0.085 (0.047)	0.148 (0.039)	0.040 (0.021)	0.134 (0.016)	0.079 (0.012)	0.044 (0.025)	0.94 (0.021)
Income Elasticity[a]	2.996	3.051	1.888	6.432	7.144	4.264	11.187
Log Likelihood	-8818.0	-9474.7	-8691.3	-9724.5	-8687.1	-6289.6	-7564.0
Sample Size	1351	1351	1351	1351	1351	1351	1351

Table 4.6 Tobit Engel relationships for 15 food groups in rural areas: Parameter estimates (standard errors) and related statistics (U.S. Bureau of Census, 1986-87)

	Food Group							
	Corn	Wheat	Rice	Other Cereals	Tubers	Vege-tables	Fruits	Oil
Unweighted Household Size	30.327 (1.933)	40.203 (1.841)	54.734 (3.536)	18.890 (1.546)	69.353 (3.608)	152.103 (5.609)	14.573 (0.902)	46.111 (3.756)
Total Expenditure	0.047 (0.021)	0.037 (0.009)	0.035 (0.020)	-0.080 (0.048)	0.033 (0.028)	0.041 (0.023)	0.022 (0.006)	0.084 (0.015)
Income Elasticity[a]	1.912	1.130	0.812	-5.906	0.652	0.327	1.678	1.940
Log Likelihood	-3782.3	-4696.4	-4375.9	-2413.6	-4662.1	-5815.6	-3542.2	-5350.0
Sample Size	728	728	728	728	728	728	728	728

[a]Income elasticity is calculated as ei=(dxi/dm)(m/xi), where xi is expenditure on food group i, m is total expenditure, and xi and m are means.

[b]Estimates could not be obtained because of numerical problems.

[c]Not significant at a=0.05.

Table 4.6 Continued

	Food Group						
	Dairy and Eggs	Meat	Fish	Sugar	Condiments and Misc.	Drinks	Other Foods
Unweighted Household Size	21.551 (1.728)	33.693 (3.533)	28.639 (1.586)	47.470 (2.969)	21.075 (1.499)	7.003 (1.277)	-[b]
Total Expenditure	0.030 (0.012)	0.087 (0.019)	0.015 (0.011)	0.044 (0.015)	0.021 (0.008)	-0.046[c] (0.027)	-[b]
Income Elasticity[a]	1.524	1.736	0.640	1.124	1.112	-6.452	
Log Likelihood	-3323.9	-3874.7	-4022.8	-5134.5	-4054.0	-1978.6	-[b]
Sample Size	728	728	728	728	728	728	728

in food expenditures, Engel relationships were also estimated using logit models. Participation variables D_i were defined such that

i.e., $$D_i = D_i(N,m) \qquad 4.15$$

where D_i is binary variable such that

$$D_i=0 \text{ if } x_i=0, \text{ and } D_i=1 \text{ if } x_i>0 \qquad 4.16$$

Using logit models, participation Engel relationships were estimated for the 15 food groups for the full sample (Table 4.7), and for the urban (Table 4.8) and rural (Table 4.9) subsamples. The interpretation of the parameter estimates of the logit models would differ from the interpretations for the ordinary least squares and tobit models. Estimated coefficients for the logit models do not determine magnitude of change in the probability of participation with respect to unit changes in unweighted household size or total expenditure. Rather, for the logit models, parameter estimates constitute the effect of a change in an independent variable on $\ln[P_i/(1-P_i)]$, where P_i is the true proportion, or in this case, true participation ratio (Formby, Mill and Johnson, 1984). That is, the partial derivatives of the true probability of participation, P_i, with respect to an explanatory variable, x_{ij}, are

$$(dP_i/dx_{ij})=f(x_i'\beta).\beta_j \qquad 4.17$$

where $f(x_i'\beta)$ is a probability density function, and β is the vector of coefficients. Therefore, parameter estimates β_j indicate the direction of change in probability of participation but the magnitude depends additionally on the probability density function.

The food groups used for the regression analysis were the same as the groups used for the tabular analysis in Chapter 2. One change,

Table 4.7 Participation Engel relationships for 15 food groups in Haiti: Parameter estimates (standard error) and related statistics (U.S. Bureau of Census, 1986-87)

	Food Group							
	Corn	Wheat	Rice	Other Cereals	Tubers	Vege-tables	Fruits	Oil
Intercept	0.392 (0.097)	0.672 (0.185)	0.456 (0.120)	-1.006 (0.098)	0.338 (0.139)	0.909 (0.242)	0.567 (0.123)	2.719 (0.330)
Unweighted Household Size	0.031[a] (0.018)	0.376 (0.048)	0.221 (0.026)	0.097 (0.018)	0.187 (0.030)	0.754 (0.09)	0.027[a] (0.024)	0.402 (0.093)
Total Expenditure	0[a] (0)	0 (0)	0[a] (0)	0[a] (0)	0 (0)	0[a] (0)	0 (0)	0 (0)
R	0.038	0.331	0.207	0.107	0.288	0.420	0.249	0.248
Sample Size	2079	2079	2079	2079	2079	2079	2079	2079

[a]Not significant at a=0.05.

Table 4.7 Continued

	Food Group							
	Dairy and Eggs	Meat	Fish	Sugar	Condiments and Misc.	Drinks	Other Foods	Total Food Expend
Intercept	-0.253 (0.112)	-0.256 (0.120)	0.406 (0.116)	2.865 (0.258)	0.816 (0.138)	-1.023 (0.106)	0.374 (0.105)	
Unweighted Household Size	0.043 (0.021)	0.099 (0.023)	0.174 (0.024)	0.004[a] (0.049)	0.130 (0.029)	-0.011[a] (0.019)	0.084 (0.020)	
Total Expenditure	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	
R	0.317	0.329	0.185	0.114	0.213	0.349	0.123	
Sample Size	2079	2079	2079	2079	2079	2079	2079	

Table 4.8 Participation Engel relationships for 15 food groups in Urban areas: Parameter estimates (standard error) and related statistics (U.S. Bureau of Census, 1986-87)

	Food Group							
	Corn	Wheat	Rice	Other Cereals	Tubers	Vege-tables	Fruits	Oil
Intercept	0.401 (0.119)	0.633 (0.243)	0.301[a] (0.162)	-0.940 (0.120)	0.388 (0.182)	0.639 (0.274)	0.709 (0.171)	2.426 (0.360)
Unweighted Household Size	0.025[a] (0.022)	0.461 (0.072)	0.367 (0.041)	0.090 (0.021)	0.230 (0.041)	0.757 (0.102)	0.057[a] (0.034)	0.439 (0.103)
Total Expenditure	0[a] (0)	0 (0)	0[a] (0)	0[a] (0)	0 (0)	0[a] (0)	0 (0)	0 (0)
R	0.000	0.370	0.305	0.104	0.308	0.434	0.269	0.269
Sample Size	1351	1351	1351	1351	1351	1351	1351	1351

[a]Not significant at a=0.05.

Table 4.8 Continued

	Food Group							
	Dairy and Eggs	Meat	Fish	Sugar	Condiments and Misc.	Drinks	Other Foods	Total Food Expend
Intercept	-0.162[a] (0.148)	-0.119[a] (0.158)	0.306 (0.149)	2.848 (0.331)	0.621 (0.200)	-0.805 (0.131)	0.300 (0.131)	
Unweighted Household Size	0.067 (0.028)	0.185 (0.033)	0.231 (0.033)	0.032[a] (0.065)	0.290 (0.049)	0.007[a] (0.023)	0.097 (0.025)	
Total Expenditure	0 (0)	0 (0)	0[a] (0)	0 (0)	0 (0)	0 (0)	0 (0)	
R	0.334	0.328	0.236	0.101	0.307	0.349	0.156	
Sample Size	1351	1351	1351	1351	1351	1351	1351	

Table 4.9 Participation Engel relationships for 15 food groups in rural areas: Parameter estimates (standard error) and related statistics (U.S. Bureau of Census, 1986-87)

	Food Group							
	Corn	Wheat	Rice	Other Cereals	Tubers	Vege-tables	Fruits	Oil
Intercept	0.092[a] (0.188)	0.753 (0.295)	0.685 (0.187)	-1.125 (0.178)	0.259[a] (0.225)	1.613 (0.594)	0.572 (0.181)	4.136 (0.936)
Unweighted Household Size	0.025[a] (0.035)	0.310 (0.069)	0.090 (0.037)	0.111 (0.032)	0.143 (0.045)	0.684 (0.199)	0.032[a] (0.034)	0.208[a] (0.219)
Total Expenditure	0 (0)	0[a] (0)	0[a] (0)	0[a] (0)	0 (0)	0[a] (0)	0[a] (0)	0[a] (0)
R	0.147	0.241	0.063	0.092	0.204	0.326	0.000	0.000
Sample Size	728	728	728	728	728	728	728	728

[a]Not significant at a=0.05.

Table 4.9 Continued

	Food Group						
	Dairy and Eggs	Meat	Fish	Sugar	Condiments and Misc.	Drinks	Other Foods
Intercept	-0.246[a] (0.179)	-0.445 (0.192)	0.634 (0.188)	2.850 (0.430)	1.035 (0.195)	-1.076 (0.188)	0.507 (0.179)
Unweighted Household Size	0.036[a] (0.033)	0.016[a] (0.035)	0.098 (0.037)	-0.041[a] (0.078)	0.043[a] (0.038)	-0.008[a] (0.035)	0.077 (0.035)
Total Expenditure	0 (0)	0 (0)	0[a] (0)	0 (0)	0[a] (0)	0[a] (0)	0[a] (0)
R	0.123	0.252	0.063	0.000	0.000	0.036	0.041
Sample Size	728	728	728	728	728	728	728

however, was that millet was added to 'other cereals' because the shares and participation rates for millet were very low (Tables 2.6 and 2.7).

4.4 Empirical Findings

4.4.1 Per capita Engel curves: Ordinary least squares models

Considering first the full sample (Table 4.1), estimates of coefficients for both unweighted household size and total expenditure were highly significant at the five or one percent significant levels, for all 15 food groups and total food expenditure. Percent root mean square error, reported as a measure of the goodness of fit was over 100 percent for most food groups. Exceptions were wheat, vegetables, and total food expenditure. These food groups and total food expenditure had relatively low percent root mean square error probably because they had very high participation rates (over 90 percent).

Parameter estimates for unweighted household size was the highest for vegetables, and the lowest for drinks. Given that vegetables also had the highest average food budget share (Table 2.6), a participation rate of over 90 percent (Table 2.7), and a relatively low income elasticity (0.292), it would appear that vegetables are a staple food consumed by members of several household age-sex categories.

Parameter estimates for total expenditure were positive and income elasticities ranged between zero and one for all food groups, implying that all food groups were normal and necessary goods (Johnson, Hassan, and Green, 1984). Income elasticities were the highest for meat (0.8), followed by dairy and eggs (0.74) and drinks (0.72). The high income elasticity for meat is plausible because past studies (Beckles, 1975) indicate that beef and lamb were generally too expensive for the poorer rural households, implying that these might be status foods, and therefore have high income elasticities. Similarly, dairy products such as fresh milk were found by past studies (Bureau of Nutrition, 1979) to be expensive, and consumed by the relatively wealthy, implying again that dairy products might be status foods. The high income elasticity for drinks might be explained in similar terms since drinks includes alcholic drinks such as wines, and nonalchoholic soft drinks such as Coca-Cola which might be costly and imported, and, therefore, status foods.

Income elasticity was the lowest for other cereals. Other cereals had relatively the lowest average expenditure level, and included cereals such as millet and oats which are often low status foods in developing countries. Therefore, it might be concluded that other cereals had a low income elasticity probably because it was a low status food in Haiti.

Considering the urban subsample (Table 4.2), parameter estimates for total expenditure were significant for all food groups, but parameter estimates for unweighted household size were significant for all food groups except dairy and eggs, and drinks. Percent root mean square error was more than 100 percent for all food groups except wheat, vegetables, oil, sugar, and total food expenditure, which were the food groups with the highest participation rates (more than 90 percent) (Table 2.7).

Some of the patterns described above for the full sample were preserved for the urban subsample. For example, parameter estimates for the coefficient for unweighted household size was the highest for vegetables, and income elasticity for vegetables was fairly low, implying that vegetables might be a staple food also for urban households.

Income elasticities were positive and ranged between zero and one for all food groups, implying that all food groups were normal and necessary goods for the urban sample too. Income elasticity was the highest for dairy and eggs, and meat, implying that, dairy and eggs, and meat are probably status foods even for urban households, especially since the urban sample includes the urban poor. Income elasticities were also high for drinks, fruits and other foods, which were probably costly foods in urban areas. Income elasticity was the lowest for other cereals, which also had the lowest average expenditure level, implying again that it might be a low status food as was indicated for the full sample.

For the rural subsample (Table 4.3), parameter estimates for unweighted household size were significant for all 15 food groups. But estimates for total expenditure were significant for all food groups except other cereals. Percent root mean square error was more than 100 percent for all food groups except vegetables and total food expenditure, and were relatively low for wheat, oil and sugar, all of which had participation rates of more than 90 percent.

For the rural subsample too, parameter estimates for unweighted household size was the highest for vegetables, and income elasticity for vegetables was fairly low, indicating again that vegetables might be a staple food. Income elasticities were again positive and between zero and one implying that all food groups are normal and necessary goods for rural households too. Income elasticity was the highest for meat, followed by other foods, and was the lowest for other cereals, implying again the possible high status of meat and other foods, and low status of other cereals.

4.4.2 Per capita Engel curves: Tobit models

For the tobit models (Tables 4.4 to 4.6), parameter estimates for unweighted household size were identical to the corresponding ordinary least square estimates (Tables 4.1 to 4.3) for most food groups. But parameter estimates for total expenditure were usually higher for the tobit models compared to the ordinary least squres estimates for all food groups except other cereals, implying higher income elasticities under the tobit models. Parameter estimates for total expenditure was negative for other cereals implying a negative income elasticity. Therefore for the tobit models, other cereals were an inferior good confirming the indications in the ordinary least squres models of its possible low status as a food.

For thee full sample (Table 4.4), parameter estimates for unweighted household size were significant for all food groups. But parameter estimates for total expenditure were significant for all food groups except corn. Owing to numerical problems (optimal points could not be found), parameter estimates could not be obtained for rice, fruits, dairy, fish, and condiments and miscellaneous for the full sample. Although parameter estimates for unweighted household size were identical to the ordinary least squares estimates, standard errors for unweighted household size were lower for the tobit models compared to the OLS models for all food groups except oil.

The income elasticity patterns were different for the tobit models compared to the OLS models. Income elasticities were positive and were more than one for all food groups except other cereals for which income elasticity was negative. This implied that all food groups were normal and luxury goods except other cereals which was an inferior good. Income elasticity was the highest for drinks followed by tubers. The high income elasticity for drinks may be explained in terms of drinks including items such as imported alchoholic beverages that may have been costly status foods. But the high income elasticity for tubers cannot be explained by considering tubers to be a status food, since past studies indicate that tubers are consumed more by rural households than urban (Bureau of Nutrition, 1979), assuming that status foods are likely to be consumed more by the relatively wealthy urban households. Furthermore, tubers could be interpreted as a staple food since its average share and participation rate are both fairly high (Tables 2.6 and 2.7). That is, average share for tubers was high probably because of quantities purchased rather than high prices, since participation rates are also high. However, a staple food could have a high income elasticity if consumers have incomes below the threshold level at which increases in income cause switches from staples to status foods. The high income elasticity for tubers might be explained in this way.

For the urban subsample (Table 4.5), parameter estimates could be obtained for all food groups without encountering numerical problems. Parameter estimates for unweighted household size were significant for all food groups except dairy and eggs, and other foods. Parameter estimates for total expenditure were significant for all food groups.

The empirical findings for the urban subsample (Table 4.5) were similar to that for the full sample. Parameter estimates for unweighted household size were identical to the corresponding ordinary least squares estimates (Table 4.2) for all food groups except fish, drinks and other foods.

Income elasticities were positive and were more than one for all food groups except other cereals. Therefore, for the urban subsample, all food groups were normal except other cereals (which was an inferior good) and luxury goods. Income elasticities were the highest for other foods followed by condiments and miscellaneous, and sugar. While the high income elasticity for other foods cannot be explained since the components of this food group are unknown, the high income elasticity for condiments and miscellaneous can be explained in terms of the food items included in this group. Condiments and miscellaneous include food items such as chocolates and salad oils, which are probably costly and imported, and regarded as status foods.

For the rural subsample (Table 4.6), parameter estimates for unweighted household size were significant for all food groups. Parameter estimates for total expenditure were significant for all food groups except other cereals. Parameter estimates for unweighted household size were identical to the corresponding ordinary least squares estimates in Table 4.3 for all food groups except rice, oil, sugar and drinks.

Income elasticities were positive for all food groups except other cereals and drinks, which were, therefore, inferior goods. The beverages available to rural households would more likely be local alchoholic and nonalchoholic drinks such as clairin, rather than imported beverages that might be regarded as status foods. The food group drinks includes both types of beverages. Therefore, it is plausible that the food group drinks is an inferior good for the rural subsample, but a luxury good for the urban subsample.

Income elasticities were positive and ranged between zero and one for rice, tubers, vegetables and fish implying that these are necessary goods for the rural subsample. Income elasticities were positive and more than 1 for the remaining food groups, which, therefore, were luxury goods.

Income elasticity was the highest for oil followed by corn, both of which might be food groups with price inelastic demands. The high participation rates for oil (Table 2.7) indicate that demand for oil might be highly inelastic. Past studies (Beckles, 1975) indicate that corn is one of the food staples most in demand. Therefore, the high income elasticity for oil and corn might be explained in terms of rural households having income levels below threshold levels at which there are some switches to status foods.

4.4.3 Participation Engel relationships: Logit models

Total expenditure was found to have no effect on probability of participation for any food group for the full sample and the urban and rural subsamples. One reason for this might be that according to the ordinary least squares models, all food groups were necessary goods for the full sample and the urban and rural subsamples. The effect of unweighted household size on the probability of participation was positive for the food groups for which parameter estimates were significant, for the full sample, and the urban and rural subsamples.

For the full sample, (Table 4.7), parameter estimates for unweighted household size were found to be significant for all food groups except corn, fruits, sugar, and drinks.

Parameter estimates for unweighted household size were the highest for vegetables and the lowest for dairy and eggs. The high estimates for vegetables corroborates the finding in the ordinary least squares models (Table 4.1), that the effect of unweighted household size was the highest for vegetables. The reason might again be that vegetables are a staple. Parameter estimates for total expenditure were significant for all food groups except corn, rice, other cereals, and vegetables.

The patterns observed for thhe full sample are preserved for the urban subsample, too (Table 4.8). Parameter estimates for unweighted household size were significant for all food groups except corn, fruits, sugar, and drinks and parameter estimates for unweighted household size were the highest for vegetables and the lowest for dairy and eggs. Parameter estimates for total expenditure were significant for all food groups except corn, rice, vegetables, other cereals and fish.

For the rural subsample, parameter estimates for unweighted household size were not significant for most food groups, and parameter estimates were the highest for vegetables (Table 4.9). For total expenditure, parameter estimates were significant only for corn, tubers, dairy and eggs, meat, and sugar.

4.5 Conclusion

In this chapter, per capita Engel curve specifications for the effects of unweighted household size and total expenditure on food expenditures was developed using Barten's household model, under the traditional consumer theory approach described in Chapter 3. Ordinary least squares, tobit and logit models were used to estimate the Engel relationships.

A summary of the empirical findings is as follows:

1. Ordinary least squares parameter estimates for unweighted household size were the highest for vegetables for the full sample as well as the urban and rural subsamples.

2. For the logit models parameter estimates for unweighted household size was the highest for vegetables and positive for all other food groups for which estimates were significant.

3. Income elasticities for ordinary least squares models indicated that all food groups were normal and necessary goods for the full sample and the rural and urban subsamples.

4. Income elasticities for the tobit models showed that for the full sample and the urban subsample, other cereals were an inferior good and all other food groups were luxury goods. For the rural subsample, income elasticities under the tobit models showed that some food groups were necessary goods, some were luxuries, and other cereals and drinks were inferior goods.

5. High income elasticities for some food groups, such as meat and dairy and eggs and drinks, could be explained in terms of their being status foods, or including items that might be status foods. For example, since drinks includes both imported beverages as well as local beverages, it is plausible that drinks were a luxury good in urban areas but an inferior good in rural areas.

While the ordinary least squares models give estimates of income elasticity that are fairly typical of developing countries (for example, high income elasticities for meat and low for other cereals), the tobit models give results that appear unusual. For example, under the tobit models, compared to meat, income elasticities are higher for drinks and tubers for the full sample, for other foods and condiments and miscellaneous for the urban subsample, and for oil and corn for the rural subsample.

Also the ordinary least squares estimates indicate that all food groups are necessary goods, which is similar to findings for developed countries (Goungetas, 1986). But the tobit models indicate that most food groups are luxuries in rural areas, and all food groups are luxuries in urban areas, which might be an indication of the extent of urban poverty in Haiti.

5. ESTIMATION OF ADULT EQUIVALENT SCALES: GENERAL AND SPECIFIC SCALES, AND SCALES WITH SIZE ECONOMIES

5.1 Introduction

In the Engel relationships estimated in this chapter, the effects of household composition and size on food expenditures are examined. Household composition and size are conceptually different in the general scales, specific scales, and household size effects models compared to the per capita models in Chapter 4. In the per capita models, unweighted household size was used as an explanatory variable, implying that a change in household composition affected food expenditures only via the consequent change in household size, because, all age-sex categories were unweighted. That is, all household members had equal weights regardless of age or sex. In this chapter however, the effects of household composition on food expenditures are examined by weighting the age-sex categories with a set of behavioral weights that are estimated. The distribution of the weights among the age-sex categories is fixed across commodities for the general scales model, varies, depending on the commodity, for the specific scales model, and, varies, depending on the commodity and the household size, for the household size effects model.

In this chapter, the general scales, specific scales, and household size effects models are specified using Barten's household model (Barten, 1964). Ordinary least squares is used to estimate the general scales model, and nonlinear least squares estimation methods are used to estimate the specific scales, and household size effects models since these models are nonlinear in the parameters. Estimations are undertaken for the full sample, and the urban and rural subsamples. The specific scales model is estimated for 15 food groups, but the household size effects model is estimated only for five food groups, which are selected from the 15 according to their participation rates. The four food groups with the highest participation rates (wheat, vegetables, sugar and oil), and a fifth food group (other cereals) with the lowest participation rate are selected for the household size effects models.

For the general scales model the linear, semi-log, and double-log specifications were estimated, but results were reported only for the linear specification, since parameter estimates for the semi-log and double-log specifications did not have plausible signs for some food groups. For the specific scales, and household size effects models only the linear model was estimated since the semi-log and double-log models specifications did not perform well for the ordinary least squares models in Chapter 4, or for the general scales model.

For the general scales, specific scales, and household size effects models, the weight for the adult male was assumed to be one. Weights for other age-sex categories were calculated as proportions of the weight for the adult male. For the specific scales, and household size effects models, the scale for income was assumed to be the unweighted household size, N.

This chapter consists of descriptions of the model specifications (section 5.2), estimation procedures (section 5.3), and empirical findings (section 5.3), and concludes with a summary of the results (section 5.4).

5.2 Model Specifications

Using the general specification of the Engel curve resulting from Barten's model (4.08), the general scales, specific scales, and household size effects models are obtained. In the general scales model, the scale factor used is weighted household size, which is weighted by a fixed set of weights for each household age-sex category, that do not vary across commodities. The general scales Engel relationship is

$$x_i = y x_i(m/y) \qquad 5.01$$

where y, the general scale or weighted household size, is a function of the number of persons in the different age-sex categories in the household, $N_1, \ldots N_k$. i.e.

$$y = y(N_1, \ldots, N_k) \qquad 5.02$$

A linear specification for the general scale, y, is

$$y = \Sigma w_j N_j \qquad 5.03$$

where w_j is the weight for the jth household age-sex category. While the per capita model allows an examination of how household size and income affect expenditures, the general scales model allows, in addition, an examination of how household composition ($N_1, \ldots, N_k$) and, therefore, weighted household size (y) affects expenditures, where the weights are estimated and therefore behavioral as opposed to the physiological weights used by Engel (1895). However, the scale, y, and therefore the weights, $w_1, \ldots, w_k$, are assumed to remain fixed across commodities. That is, in the general scales model, adults and children are assumed to carry different weights which are fixed across commodities, whereas in the per capita model, adults and children are assumed to weigh equally for all commodities.

Substituting (5.03) into (5.01), and assuming a linear specification for (5.01), the general scales model is

$$x=a(\Sigma w_j N_j)+bm \qquad 5.04$$

or,

$$x=\Sigma a_j N_j+bm \qquad 5.05$$

where x is total food expenditure, and $a_j=aw_j$.

The specific scales model also uses weighted household size to scale expenditures, but now, the set of weights used, and therefore, the weighted household sizes (y_i) are assumed to vary across commodities. Furthermore, now a unique scale, y_0, is used for income. According to this model a child is assumed to have a particular weight for milk, but a different weight for beer. The specific scales model is

$$x_i=y_i x_i(m/y_0) \qquad 5.06$$

where y_i is the scale (weighted household size) specific to commodity i, and y_0 is the scale (weighted household size) for income. y_i (i= 1,...,n) and y_0 are assumed to depend on household compositional variables, $N_1,...N_k$. A linear specification for y_i is

$$y_i=\Sigma w_{ij}N_j \qquad 5.07$$

where w_{ij} is the weight of the jth age-sex category for commodity i. If a linear specification is assumed for (5.06), and the income scale, y_0, is assumed to be equal to the unweighted household size, N, substituting (5.07) in (5.06) gives the following linear specification of the specific scales model.

$$x_i=a_i\Sigma w_{ij}N_j+b_i(m/N)\Sigma w_{ij}N_j \qquad 5.08$$

or

$$x_i=\Sigma B_{ij}[N_j(A_i+m/N)] \qquad 5.09$$

where, $B_{ij}=b_iw_{ij}$, and $A_i=a_i/b_i$.

The household size effects model allows an examination of household size effects on expenditures according to the following definitions of household size effects. For commodity i, household size effects exist if $[d(dx_i/dN_j)]/(dN_t)$ is not equal to zero. Household size effects may exist for some age-sex categories, but not for others. Also, because the budget constraint is linear, a change in household size and composition that increases the consumption of some commodities (i.e., $(dx_i/dN_j)>0$) must decrease the consumption of other commodities (i.e., $(dx_t/dN_j)<0$). That is, the linear budget constraint

$$\Sigma x_i=m \qquad 5.10$$

implies $\Sigma(dx_i/dN_j)=0$, and $\Sigma[d(dx_i/dN_j)/dN_k]=0$ 5.11

Therefore, various household size effects may occur. For example,

$$(dx_i/dN_j)>0, \text{ and } [d(dx_i/dN_j)/dN_k]<0 \qquad 5.12$$

or, $(dx_i/dN_j)<0$, and $[d(dx_i/dN_j)/dN_k]<0$ 5.13

One specific type of household size effect is economies of scale. Economies of scale for commodity i, with respect to age-sex category k, are said to exist if

$$(dx_i/dN_k)>0, \text{ and } [d(dx_i/dN_k)/dN_k]<0 \qquad 5.14$$

Therefore, economies of scale may be present for household members in some age-sex categories, but not for others.

Household size effects, as defined in (5.12), (5.13), and (5.14) are introduced through the scales, y_i, or weighted household sizes--specifically through the weights (w_{ij}) themselves.

i.e., $w_{ij}=w_{ij}^0+w_{ij}^1N$, $i=1,\ldots,n$, $j=1,\ldots,k$ 5.15

where, as before, w_{ij} is the weight of the jth age-sex category for the ith commodity.

Compared to the general scales and specific scales models, the household size effects model has two changes. First, adult equivalent weights are no longer with reference to the adult male alone, but with reference to an adult male for a household of specific size. Second, two persons in the same age-sex category no longer carry equal weight if they belong to households of unequal size.

Substituting (5.15) into (5.07) gives the following expression for y_i, the scale or weighted household size for the ith commodity.

$$y_i=\Sigma w_{ij}{}^0 N_j+\Sigma w_{ij}{}^1(N_j N) \qquad 5.16$$

Again assuming a linear specification for (5.06), and assuming the income scale, y_0, to equal the unweighted household size, N, substituting (5.16) into (5.06) gives the following linear Engel curve specification for the household size effects model,

$$x_i=\Sigma P_{ij}[N_j(A_i+m/N)]+\Sigma M_{ij}[N_j(A_i+m/N)N] \qquad 5.17$$

where $P_{ij}=b_i w_{ij}{}^0$, $M_{ij}=b_i w_{ij}{}^1$, and as before, in 5.09, $A_i=a_i/b_i$.

Economies of scale exist for commodity i with respect to age-sex category N_j if M_{ij} is negative.

5.3 Estimation Procedures

For the general scales model, a linear specification (5.05), and semi-log and double-log specifications were estimated using ordinary least squares. The analysis was done for the full sample, and the urban and rural subsamples. The dependent variable was total food expenditure, and the independent variables were total expenditure, m, and the household compositional variables, $N_1,\ldots,N_6$. Assuming the weight for males aged 19 and older to be 1, adult equivalent weights for other age-sex categories were calculated as follows:

$$w_j = a_j / a_i \qquad 5.18$$

where, from equation (5.05), $a_j = aw_j$, and $w_1 = 1$ is the weight assumed for males aged 19 and older. Results were reported only for the linear specification (Table 5.1), because parameter estimates for the full sample, as well as for the rural and urban subsamples, were not significant for several age-sex category coefficients, and had negative signs for some age-sex category coefficients implying negative weights.

Since the semi-log and double-log specifications did not perform well for the ordinary least squres models in Chapter 4, or for the general scales models, only the linear specification was estimated for the specific scales, and household size effects models. The linear specification of the specific scales model (5.09) is nonlinear in the parameter A_i. Therefore, nonlinear estimation methods were used to estimate 5.09 for 15 food groups for the full sample (Table 5.2), and the urban (Table 5.3) and rural subsamples (Table 5.4). Assuming the weight for males aged 19 and older to be 1, adult equivalent specific scales were calculated for other age-sex categories as follows.

$$w_{ij} = B_{ij} / B_{i1} \qquad 5.19$$

where $B_{ij} = b_i w_{ij}$, and $w_{i1} = 1$ is the weight assumed for males aged 19 and older.

Table 5.1 Linear Engel relationships with general scales: Parameter estimates (standard errors), scales and related statistics (U.S. Bureau of Census, 1986-87)

	Haiti Parameter Estimates (S.E.)	Haiti Scales	Urban Parameter Estimates (S.E.)	Urban Scales	Rural Parameter Estimates (S.E.)	Rural Scales
Males >= 19 yrs	686.946 (83.994)	1.00	610.259 (105.75)	1.00	658.352 (118.389)	1.00
Females >= 19 yrs	769.138 (82.250)	1.12	517.826 (97.67)	0.85	1093.229 (133.043)	1.66
Males 10-18 yrs	543.693 (104.795)	0.79	579.397 (128.500)	0.95	369.996 (147.923)	0.56
Females 10-18 yrs	346.004 (97.295)	0.50	79.979[a] (117.366)	0.13	784.752 (144.569)	1.19
Children 4-9 yrs	378.020 (82.449)	0.55	408.745 (105.279)	0.67	384.498 (107.059)	0.58
Infants 0-3 yrs	338.524 (111.385)	0.49	486.526 (151.250)	0.80	69.346[a] (133.298)	0.11
Total Expenditure	0.175 (0.005)		0.215 (0.006)		0.067 (0.007)	
Percent RMSE[b]	65.42		57.05		75.49	
Sample Size	2079		1351		728	

[a]Not significant at a=0.05.

[b]Percent RMSE=(root mean square error/mean of dependent variable)x100.

Table 5.2 Linear Engel relationships with specific scales for 15 food groups in Haiti: Parameter estimates (standard errors), scales and related statistics

		Food Group			
		Corn		Wheat	
Independent Variables	Coef-ficient	Parameter Estimates (S.E.)	Scales	Parameter Estimates (S.E.)	Scales
Males >=19 yrs	Bi1	0.004 (0.001)	1.00	0.008 (0.001)	1.00
Females >=19 yrs	Bi2	0.001 (0)	0.25	0.008 (0.001)	1.00
Males 10-18 yrs	Bi3	0.002 (0.001)	0.50	0.014 (.001)	0.57
Females 10-18 yrs	Bi4	0.001[a] (0.001)	0.25	0.006 (0.001)	0.75
Children 4-9 yrs	Bi5	0.002 (0.001)	0.50	0.012 (0.001)	1.50
Infants 0-3 yrs	Bi6	0.001[a] (0.001)	0.25	0.011 (0.002)	1.38
	A	12251.300 (2779.60)		4352.36 (359.68)	
Percent RMSE[b]		170.715		88.608	
Sample Size		2079		2079	

[a]Not significant at a=0.05.

[b]Percent RMSE=(root mean square error/mean of dependent variable)x100.

Food Group					
Rice		Other Cereals		Tubers	
Parameter Estimates (S.E.)	Scales	Parameter Estimates (S.E.)	Scales	Parameter Estimates (S.E.)	Scales
0.009 (0.001)	1.00	0.001 (0)	1.00	0.008 (0.001)	1.00
0.013 (0.001)	0.69	0.001 (0)	1.00	0.008 (0.001)	1.00
0.009 (0.002)	1.00	0.001[a] (0)	1.00	0.007 (0.002)	0.88
0.014 (0.002)	1.56	0[a] (0)	0.00	0.006 (0.001)	0.75
0.013 (0.002)	1.44	0.001[a] (0)	1.00	0.009 (0.002)	1.125
(0.013 (0.003)	1.44	0.001[a] (0)	1.00	0.008 (0.002)	1.00
4900.89 (543.32		26209.58 (12128.84)		7111.7 (894.95)	
116.131		211.174		123.781	
2079		2079		2079	

Table 5.2 Continued

Independent Variables	Coef-ficient	Vegetables: Parameter Estimates (S.E.)	Vegetables: Scales	Fruits: Parameter Estimates (S.E.)	Fruits: Scales
Males >=19 yrs	Bi1	0.022 (0.002)	1.00	0.089 (0.001)	1.00
Females >=19 yrs	Bi2	0.023 (0.002)	1.05	0.009 (0.001)	1.00
Males 10-18 yrs	Bi3	0.024 (0.003)	1.09	0.013 (0.002)	1.44
Females 10-18 yrs	Bi4	0.015 (0.002)	0.68	0.007 (0.001)	0.78
Children 4-9 yrs	Bi5	0.022 (0.003)	1.00	0.14 (0.002)	1.56
Infants 0-3 yrs	Bi6	0.017 (0.003)	0.77	0.017 (0.002)	1.89
	A	6548.720 (545.05)		1053.00 (178.37)	
Percent RMSE[b]		80.850		128.814	
Sample Size		2079		2079	

Food Group					
Oil		Dairy & Eggs		Meat	
Parameter Estimates (S.E.)	Scales	Parameter Estimates (S.E.)	Scales	Parameter Estimates (S.E.)	Scales
0.014 (0.001)	1.00	0.028 (0.003)	1.00	0.030 (0.003)	1.00
0.009 (0.001)	0.64	0.015 (0.002)	0.54	0.036 (0.003)	1.20
0.009 (0.002)	0.64	0.018 (0.005)	0.64	0.049 (0.006)	1.63
0.010 (0.001)	0.71	0.012 (0.004)	0.43	0.042 (0.005)	1.40
0.010 (0.002)	0.71	0.020 (0.004)	0.71	0.043 (0.005)	1.42
0.008 (0.002)	0.57	0.064 (0.007)	2.29	0.064 (0.008)	2.13
4322.05 (426.14)		319.84[a] (166.75)		574.87 (127.28)	
100.887		173.558		117.812	
2079		2079		2079	

Table 5.2 Continued

Independent Variables	Coef-ficient	Fish: Parameter Estimates (S.E.)	Fish: Scales	Sugar: Parameter Estimates (S.E.)	Sugar: Scales
Males >=19 yrs	Bi1	0.009 (0.001)	1.00	0.008 (0.001)	1.00
Females >=19 yrs	Bi2	0.010 (0.001)	1.11	0.010 (0.001)	1.25
Males 10-18 yrs	Bi3	0.008 (0.002)	0.89	0.007 (0.001)	0.88
Females 10-18 yrs	Bi4	0.012 (0.002)	1.33	0.004 (0.001)	0.50
Children 4-9 yrs	Bi5	0.011 (0.002)	1.22	0.006 (0.001)	0.75
Infants 0-3 yrs	Bi6	0.015 (0.003)	1.67	0.007 (0.002)	0.88
	A	2844.66 (346.62)		5697.11 (611.93)	
Percent RMSE[b]		127.184		106.129	
Sample Size		2079		2079	

Food Group					
Condiments & Misc.		Drinks		Other Foods	
Parameter Estimates (S.E.)	Scales	Parameter Estimates (S.E.)	Scales	Parameter Estimates (S.E.)	Scales
0.007 (0.007)	1.00	0.008 (0.001)	1.00	0.003 (0.001)	1.00
0.005 (0.001)	0.71	0.003 (0.001)	0.38	0.003 (0.001)	2.67
0.006 (0.001)	0.86	0.013 (0.002)	1.63	0.011 (0.002)	3.67
0.002[a] (0.001)	0.29	0.010 (0.002)	1.25	0.004 (0.001)	1.33
0.006 (0.001)	0.86	0.010 (0.002)	1.25	0.007 (0.001)	2.33
0.005 (0.001)	0.71	0.024 (0.003)	3.00	0.004[a] (0.002)	1.33
3301.31 (416.76)		149.50[a] (168.82)		1019.11 (278.82)	
128.019		200.326		202.553	
2079		2079		2097	

Table 5.3 Linear Engel relationships with specific scales for 15 food groups in urban areas: Parameter estimates (standard errors), scales and related statistics

		Food Group			
		Corn		Wheat	
Independent Variables	Coef- ficient	Parameter Estimates (S.E.)	Scales	Parameter Estimates (S.E.)	Scales
Males >=19 yrs	Bi1	0.005 (0.001)	1.00	0.008 (0.001)	1.00
Females >=19 yrs	Bi2	0.002 (0.001)	0.40	0.010 (0.001)	1.25
Males 10-18 yrs	Bi3	0.002 (0.001)	0.40	0.017 (0.002)	2.12
Females 10-18 yrs	Bi4	0.001[a] (0.001)	0.10	0.007 (0.001)	0.88
Children 4-9 yrs	Bi5	0.003 (0.001)	0.60	0.014 (0.002)	1.75
Infants 0-3 yrs	Bi6	0.001[a] (0.001)	0.20	0.012 (0.002)	1.50
	A	7315.88 (1976.95)		3810.12 (399.73)	
Percent RMSE[b]		175.008		78.801	
Sample Size		1351		1351	

[a]Not significant at a=0.05.

[b]Percent RMSE=(root mean square error/mean of dependent variable)x100.

Food Group					
Rice		Other Cereals		Tubers	
Parameter Estimates (S.E.)	Scales	Parameter Estimates (S.E.)	Scales	Parameter Estimates (S.E.)	Scales
0.011 (0.002)	1.00	0.001[a] (0.0003)	1.00	0.010 (0.002)	1.00
0.015 (0.002)	1.36	0.002 (0.0003)	2.00	0.011 (0.001)	1.10
0.013 (0.003)	1.18	0.001 (0.001)	1.00	0.012 (0.002)	1.20
0.013 (0.002)	1.18	0.001[a] (0.0004)	1.00	0.009 (0.002)	0.90
0.017 (0.003)	1.55	0.002 (0.001)	2.00	0.015 (0.002)	1.50
0.017 (0.003)	1.55	0.002 (0.001)	2.00	0.012 (0.003)	1.20
4083.90 (578.86)		8145.82 (2526.88)		3965.48 (627.81)	
103.785		206.488		117.837	
1351		1351		1351	

Table 5.3 Continued

Independent Variables	Coef-ficient	Vegetables: Parameter Estimates (S.E.)	Vegetables: Scales	Fruits: Parameter Estimates (S.E.)	Fruits: Scales
Males >=19 yrs	Bi1	0.025 (0.003)	1.00	0.012 (0.001)	1.00
Females >=19 yrs	Bi2	0.028 (0.001)	1.12	0.010 (0.001)	0.83
Males 10-18 yrs	Bi3	0.035 (0.004)	1.40	0.016 (0.002)	1.33
Females 10-18 yrs	Bi4	0.019 (0.003)	0.76	0.009 (0.002)	0.75
Children 4-9 yrs	Bi5	0.033 (0.004)	1.32	0.017 (0.002)	1.42
Infants 0-3 yrs	Bi6	0.024 (0.005)	0.96	0.015 (0.003)	1.25
	A	4179.42 (440.51)		763.42 (219.07)	
Percent RMSE[b]		75.939		110.827	
Sample Size		1351		1351	

Food Group					
Oil		Dairy and Eggs		Meat	
Parameter Estimates (S.E.)	Scales	Parameter Estimates (S.E.)	Scales	Parameter Estimates (S.E.)	Scales
0.016 (0.002)	1.00	0.035 (0.004)	1.00	0.031 (0.004)	1.00
0.010 (0.001)	0.63	0.018 (0.003)	0.51	0.042 (0.003)	1.36
0.014 (0.002)	0.88	0.024 (0.006)	0.69	0.062 (0.007)	2.00
0.012 (0.002)	0.75	0.016 (0.005)	0.46	0.043 (0.006)	1.38
0.013 (0.002)	0.81	0.022 (0.005)	0.63	0.041 (0.006)	1.32
0.009 (0.003)	0.63	0.057 (0.008)	1.63	0.062 (0.009)	2.00
3139.70 (418.69)		178.43[a] (234.37)		422.25 (175.70)	
91.178		151.06		104.955	
1351		1351		1351	

Table 5.3 Continued

Independent Variables	Coef-ficient	Fish: Parameter Estimates (S.E.)	Fish: Scales	Sugar: Parameter Estimates (S.E.)	Sugar: Scales
Males >=19 yrs	Bi1	0.011 (0.002)	1.00	0.011 (0.001)	1.00
Females >=19 yrs	Bi2	0.012 (0.001)	1.09	0.011 (0.001)	1.00
Males 10-18 yrs	Bi3	0.010 (0.003)	0.91	0.011 (0.002)	1.00
Females 10-18 yrs	Bi4	0.015 (0.002)	1.36	0.005 (0.002)	0.46
Children 4-9 yrs	Bi5	0.012 (0.002)	1.09	0.010 (0.002)	0.91
Infants 0-3 yrs	Bi6	0.016 (0.003)	1.46	0.010 (0.002)	0.91
	A	2407.22 (409.26)		3447.84	
Percent RMSE[b]		114.072		96.675	
Sample Size		1351		1351	

Food Group					
Condiments & Misc.		Drinks		Other Foods	
Parameter Estimates (S.E.)	Scales	Parameter Estimates (S.E.)	Scales	Parameter Estimates (S.E.)	Scales
0.007 (0.001)	1.00	0.010 (0.002)	1.00	0.003 (0.001)	1.00
0.006 (0.001)	0.86	0.005 (0.001)	0.50	0.008 (0.001	2.67
0.008 (0.001)	1.14	0.017 (0.003)	1.70	0.013 (0.002)	4.33
0.002[a] (0.001)	0.29	0.012 (0.002)	1.20	0.005 (0.002)	1.67
0.008 (0.001)	1.14	0.010 (0.002)	1.00	0.010 (0.002)	3.33
0.005 (0.002)	0.71	0.021 (0.003)	2.10	0.002[a] (0.003)	0.67
2262.35 (419.11)		-4.763[a] (225.80)		522.03[a] (345.06)	
117.94		168.721		46.629	
1351		1351		1351	

Table 5.4 Linear Engel relationships with specific scales for 15 food groups in rural areas: Parameter estimates (standard errors), scales and related statistics (U.S. Bureau of Census, 1986-87)

		Food Group			
		Corn		Wheat	
Independent Variables	Coef-ficient	Parameter Estimates (S.E.)	Scales	Parameter Estimates (S.E.)	Scales
Males >=19 yrs	Bi1	0.004 (0.001)	1.00	0.003 (0.001)	1.00
Females >=19 yrs	Bi2	0.001[a] (0.001)	0.25	0.003 (0.001)	1.00
Males 10-18 yrs	Bi3	0.003[a] (0.001)	0.75	0.002 (0.001)	0.67
Females 10-18 yrs	Bi4	0.002[a] (0.001)	0.50	0.002 (0.001)	0.67
Children 4-9 yrs	Bi5	0.002[a] (0.001)	0.50	0.002 (0.001)	0.67
Infants 0-3 yrs	Bi6	0.032[a] (0.001)		0.002[a] (0.001)	0.67
	A			16078.16 (4180.13)	
Percent RMSE[b]		161.085		108.475	
Sample Size		728		728	

[a]Not significant at a=0.05.

[b]Percent RMSE=(root mean square error/mean of dependent variable)x100.

Food Group					
Rice		Other Cereals		Tubers	
Parameter Estimates (S.E.)	Scales	Parameter Estimates (S.E.)	Scales	Parameter Estimates (S.E.)	Scales
0.001[a] (0.001)	1.00	0[a] (0.001)		0.003 (0.002)	1.00
0.005 (0.002)	5.00	0.027 (0)		0.003 (0.002)	1.00
0.001[a] (0.001)	1.00	0.021 (0)		0.001[a] (0.001)	0.33
0.006 (0.002)	6.00	0[a] (0.001)		0.001 (0.001)	0.67
0.002[a] (0.001)	2.00	0.043 (0)		0.002 (0.001)	0.67
0[a] (0.001)	0.00	0.033 (0)		0.001[a] (0.001)	0.33
22921.62 (8378.57)		248935[a] (1403572)		30487.37 (13956.99)	
146.220		209.462		133.685	
728		728		728	

Table 5.4 Continued

		Food Group			
		Vegetables		Fruits	
Independent Variables	Coef-ficient	Parameter Estimates (S.E.)	Scales	Parameter Estimates (S.E.)	Scales
Males >=19 yrs	Bi1	0.008 (0.002)	1.00	0.002 (0.001)	1.00
Females >=19 yrs	Bi2	0.011 (0.003)	1.38	0.002 (0.001)	1.00
Males 10-18 yrs	Bi3	0.006 (0.002)	0.08	0.002 (0.001)	1.00
Females 10-18 yrs	Bi4	0.007 (0.002)	0.88	0.002[a] (0.001)	1.00
Children 4-9 yrs	Bi5	0.004 (0.002)	0.50	0.001[a] (0.001	0.50
Infants 0-3 yrs	Bi6	0.002[a] (0.002)	0.25	0[a] (0.001)	
	A	23520.83 (5841.93)		9813.90 (2307.26)	
Percent RMSE[b]		88.450		149.330	
Sample Size		728		728	

Food Group					
Oil		Dairy and Eggs		Meat	
Parameter Estimates (S.E.)	Scales	Parameter Estimates (S.E.)	Scales	Parameter Estimates (S.E.)	Scales
0.008 (0.002)	1.00	0.003 (0.001)	1.00	0.022 (0.004)	1.00
0.008 (0.00)	1.00	0.004 (0.001)	1.33	0.017 (0.006)	0.77
-0.136[a] (0.002)		0.002[a] (0.001)	0.67	-0.006[a] (0.011)	-0.27
0.005 (0.002)	0.63	0.002[a] (0.001)	0.67	0.065 (0.010)	2.96
0.004 (0.002)	0.50	0.002[a] (0.001)	0.67	0.050 (0.008)	2.72
0[a] (0.002)	0.00	0.001[a] (0.001)	0.33	0.034 (0.014)	1.55
10418.98 (2119.27)		9287.22 (2505.4)		852.70 (210.81)	
123.964		175.265		146.515	
728		728		728	

Table 5.4 Continued

Independent Variables	Coef-ficient	Fish: Parameter Estimates (S.E.)	Fish: Scales	Sugar: Parameter Estimates (S.E.)	Sugar: Scales
Males >=19 yrs	Bi1	0.003 (0.001)	1.00	0.001[a] (0.001)	1.00
Females >=19 yrs	Bi2	0.002 (0.001)	0.67	0.005 (0.002)	5.00
Males 10-18 yrs	Bi3	0.001[a] (0.001)	0.33	0[a] (0.001)	0
Females 10-18 yrs	Bi4	0.001[a] (0.001)	0.33	0.002 (0.001)	2.00
Children 4-9 yrs	Bi5	0.002 (0.001)	0.67	0.001[a] (0.001)	1.00
Infants 0-3 yrs	Bi6	0.001[a] (0.001)	0.33	0.001[a] (0.001)	1.00
	A	18178.52 (6575.78)		25291.21 (8986.00)	
Percent RMSE[b]		140.292		125.475	
Sample Size		728		728	

Food Group					
Condiments & Misc.		Drinks		Other Foods	
Parameter Estimates (S.E.)	Scales	Parameter Estimates (S.E.)	Scales	Parameter Estimates (S.E.)	Scales
0.006 (0.001)	1.00	0.002(a) (0.001)	1.00	0(a) (0.001)	1.00
0.001[a] (0.001)	0.17	-0.049[a] (0.001)		0.010 (0.001)	3.33
0.002[a] (0.001	0.33	0.002[a] (0.002)	1.00	0.011 (0.003)	3.33
0.002[a] (0.001)	0.33	0.003[a] (0.002)	1.50	-0.005[a] (0.002)	-1.67
0.003 (0.001)	0.50	0.002[a] (0.001)	1.00	0[a] (0.002)	0.00
0.004 (0.002)	0.67	0.001[a] (0.002)	0.50	0.011 (0.004)	3.67
6544.96 (1594.25)		4762.23[a] (2323.07)		1077.66 (348.02)	
150.732		311.160		177.686	
728		728		728	

Equation 5.09 was estimated using least squares non-linear estimation procedures under which, the minimum sum of squared errors can be obtained by various iterative methods. The nonlinear estimation procedure used PROC SYSNLIN from the Statistical Analysis System (SAS). Marquardt's convergence method was selected as opposed to other iterative methods (Gauss-Newton, or the method of steepest descent), because in other studies (Goungetas, 1986), Marquardt's method was found to converge relatively faster.

In order to ensure convergence as well as speed of convergence to the optimal (minimum) point, a question arose as to the choice of starting values for the parameters. Following the method used in other studies (Goungetas, 1986), a three step method was used to obtain starting values for the parameters B_i, ... ,B_6, and A_i in equation 5.09: (1) The per capita model, 4.10 was estimated using ordinary least squares to obtain $\hat{a}_i$ and $\hat{b}_i$, and therefore $\hat{A}_i=\hat{a}_i/\hat{b}_i$. (2) The $\hat{A}_i$ obtained in step 1 was applied to equation 5.09 to linearize it in terms of its parameters, and the resulting linearized equation was estimated using ordinary least squares to obtain parameter estimates for the coefficients $\hat{B}_1$, ... ,$\hat{B}_6$. (3) Equation 5.09 was estimated using PROC SYSNLIN, with $\hat{B}_i$,...,$\hat{B}_6$ from step 2, and $\hat{A}_i$ from step 1 as starting values.

The Engel relationship with size economies, equation 5.17, is also nonlinear in the parameter A_i. Therefore, 5.17 was also estimated using the nonlinear method described above. Engel relationships with size economies were also estimated for the full sample (Table 5.5), and the urban (Table 5.6) and rural (Table 5.7) subsamples, but the estimation

Table 5.5 Linear Engel relationships with size economies for five food groups in Haiti: Parameter estimates (standard errors) and related statistics (U.S. Bureau of Census, 1986-87)

Independent Variables	Coef-ficient	Wheat	Oil	Vegetable	Sugar	Other Cereals
Males	P1	0.010	0.020	0.031	0.012	0.001[a]
>= 19 yrs		(0.001	(0.002)	(0.003)	(0.002)	(0.001)
Females	P2	0.010	0.023	0.037	0.011	0.001[a]
>= 19 yrs		(0.002)	(0.00s)	(0.003)	(0.002)	(0.0003)
Males	P3	0.013	0.007[a]	0.038	0.013	0.014[a]
10-18 yrs		(0.003	(0.004)	(0.007)	(0.003)	(0.004)
Females	P4	0.012	-0.005[a]	0.030	0.008	0.001[a]
10-18 yrs		(0.003)	(0.003)	(0.006)	(0.003)	(0.001)
Children	P5	0.018	0.014	0.024	0.010	0.0001[a]
4-9 yrs		(0.003)	(0.003)	(0.006)	(0.003)	(0.0003)
Infants	P6	0.008	0.008[a]	0.014	0.011	0.001[a]
0-3 yrs		(0.004)	(0.004)	(0.007)	(0.004)	(0.001)
Males	M1	-0.114	-0.002	-0.002	-0.169	-0.067[a]
>= 19 yrs		(0.0002)	(0.0003)	(0.001)	(0.0003)	(0.037)
Females	M2	-0.075[a]	-0.002	-0.003	-0.070[a]	-0.012[a]
>= 19 yrs		(0.0002)	(0.0003)	(0.001)	(0.0002)	(0.021)
Males	M3	0.0003[a]	0.001[a]	-0.002[a]	-0.131[a]	0.042[a]
10-18 yrs		(0.0004)	(0.001)	(0.001)	(0.0004)	(0.039)
Females	M4	-0.073[a]	0.003	-0.157[a]	-0.028[a]	-0.032[a]
10-18 yrs		(0.0003)	(0.0004)	(0.001)	(0.0004)	(0.033)
Children	M5	-0.126[a]	-0.071[a]	0.057[a]	-0.063[a]	0.036[a]
4-9 yrs		(0.0004)	(0.0004)	(0.001)	(0.0004)	(0.033)
Infants	M6	0.0005[a]	0.0001[a]	0.001[a]	0.073[a]	-0.041[a]
0-3 yrs		(0.0005)	(0.001)	(0.001)	(0.001)	(0.042)
	A	4336.87[a]	4653.15	6568.29	5884.71	32589.20[a]
		(354.93)	(432.17)	(512.67)	(608.36)	(16711.08)
Percent RMSE[b]		87.75	97.08	77.91	104.18	210.54
Sample Size		2079	2079	2079	2079	2079

[a]Not significant at a=0.05.

[b]Percent RMSE=(root mean square error/mean of dependent variable)x100.

Table 5.6 Linear Engel relationships with size economies for five food groups in urban areas: Parameter estimates (standard errors) and related statistics (U.S. Bureau of Census, 1986-98)

Independent Variables	Coef-ficient	Wheat	Oil	Vegetable	Sugar	Other Cereals
Males >= 19 yrs	P1	0.008 (0.002)	0.021 (0.002)	0.025 (0.004)	0.150 (0.002)	0.001 (0.001)
Females >= 19 yrs	P2	0.010 (0.002)	0.022 (0.002)	0.042 (0.004)	0.011 (0.002)	0.001[a] (0.001)
Males 10-18 yrs	P3	0.018 (0.004)	0.008[a] (0.004)	0.056 (0.009)	0.016 (0.004)	-0.167[a] (0.001)
Females 10-18 yrs	P4	0.015 (0.003)	-0.001[a] (0.004)	0.045 (0.007)	0.016 (0.003)	0.002[a] (0.001)
Children 4-9 yrs	P5	0.015 (0.003)	0.015 (0.004)	0.026 (0.008)	0.010 (0.004)	0.001[a] (0.001)
Infants 0-3 yrs	P6	0.014 (0.005)	0.014 (0.006)	0.024[a] (0.011)	0.015 (0.005)	0.003[a] (0.002)
Males >= 19 yrs	M1	0.038[a] (0.0003)	-0.002 (0.0004)	-0.077[a] (0.001)	-0.178 (0.0004)	-0.030[a] (0.066)
Females >= 19 yrs	M2	-0.032[a] (0.0003)	-0.002 (0.0003)	-0.003 (0.001)	-0.037[a] (0.0003)	0.046[a] (0.055)
Males 10-18 yrs	M3	-0.063[a] (0.001)	0.001[a] (0.001)	-0.003 (0.001)	-0.110[a] (0.001)	0.0003[a] (0.0002)
Females 10-18 yrs	M4	-0.156 (0.0004)	0.002 (0.001)	-0.003 (0.001)	-0.001 (0.0004)	-0.023[a] (0.0001)
Children 4-9 yrs	M5	-0.020[a] (0.0004)	-0.082[a] 0.001)	0.001[a] (0.001)	0.009[a] (0.001)	0.007[a] (0.0001)
Infants 0-3 yrs	M6	-0.072[a] (0.0006)	-0.093[a] (0.001)	0.0003[a] (0.002)	-0.146[a] (0.001)	-0.046[a] (0.0002)
	A	4030.99 (426.52)	3886.41 (482.56)	4599.43 (462.83)	4026.23 (540.17)	8811.10 (2806.49)
Percent RMSE[b]		78.45	87.96	73.27	95.52	206.12
Sample Size		1351	1351	1351	1351	1351

[a]Not significant at a=0.05.

[b]Percent RMSE=(root mean square error/mean of dependent variable)x100.

Table 5.7 Linear Engel relationships with size economies for five food groups in rural areas: Parameter estimates (standard errors) and related statistics (U.S. Bureau of Census, 1986-87)

Independent Variables	Coef-ficient	Wheat	Oil	Vegetable	Sugar	Other Cereals
Males >= 19 yrs	P1	0.012 (0.002)	0.019 (0.003)	0.029 (0.005)	0.005 (0.002)	0.001[a] (0.001)
Females >= 19 yrs	P2	0.012 (0.004)	0.023 (0.006)	0.019 (0.006)	0.005 (0.002)	0.001[a] (0.002)
Males 10-18 yrs	P3	0.008[a] (0.004)	0.013[a] (0.006)	0.013[a] (0.007)	0.006 (0.003)	0.001[a] (0.002)
Females 10-18 yrs	P4	0.004[a] (0.004)	-0.020 (0.007)	0.001[a] (0.007)	-0.008 (0.003)	0.002[a] (0.002)
Children 4-9 yrs	P5	0.010 (0.004)	0.0004[a] (0.005)	0.010[a] (0.006)	0.005[a] (0.002)	-0.160[a] (0.001)
Infants 0-3 yrs	P6	-0.003[a] (0.004)	-0.003[a] (0.005)	0.003[a] (0.006)	0.003[a] (0.002)	0.0004[a] (0.001)
Males >= 19 yrs	M1	-0.002 (0.0004)	-0.002 (0.001)	-0.004 (0.001)	-0.136 (0.0003)	-0.021[a] (0.045)
Females >= 19 yrs	M2	-0.001 (0.001)	-0.002 (0.001)	-0.109[a] (0.001)	0.0001[a] (0.0003)	-0.032[a] (0.0003)
Males 10-18 yrs	M3	0.048[a] (0.001)	-0.002 (0.001)	-0.043[a] (0.001)	-0.160 (0.0004)	-0.026[a] (0.0002)
Females 10-18 yrs	M4	0.001[a] (0.001)	0.005 (0.001)	0.002[a] (0.001)	0.002 (0.001)	-0.020[a] (0.0002)
Children 4-9 yrs	M5	-0.027[a] (0.001)	0.001[a] (0.001)	-0.039[a] (0.001)	-0.087[a] (0.0003)	0.0002[a] (0.0003)
Infants 0-3 yrs	M6	0.002 (0.001)	0.001[a] (0.001)	0.0004[a] (0.001)	-0.054[a] (0.0003)	-0.024[a] (0.051)
	A	7026.37 (1431.72)	7393.13 (1456.39)	15679.72 (2941.35)	19141.63 (5503.21)	46225.46[a] (63445.31)
Percent RMSE(b)		103.89	118.62	84.93	122.35	207.35
Sample Size		728	728	728	728	728

[a]Not significant at a=0.05.

[b]Percent RMSE=(root mean square error/mean of dependent variable)x100.

was undertaken only for 5 food groups. The 5 food groups were selected from the 15 according to their participation rates. Wheat, oil, vegetables and sugar were selected because they had the highest participation rates for the full sample, as well as the urban and rural subsamples. Other cereals (including millet) were also selected because other cereals and millet had the lowest participation rates among all food groups for all three samples (Table 2.7).

Since the general scales (5.05), specific scales (5.09), and household size effects (5.18) models do not contain intercept terms, the coefficient of determination was not used as a measure of goodness of fit. Instead, percent root mean square error was reported, as before, for the ordinary least squares estimations in Chapter 4.

5.4 Empirical Findings

For the Engel relationships with adult equivalent scales, the distribution of weights among the different age-sex categories could be caused by a number of behavioral reasons, as a result of which, using the weights to draw inferences about food consumed and nutritional consequences might be inappropriate. For example, the weight of an age-sex category may depend on food distributional behavior patterns within the family. Alternatively, the weight of persons in an age-sex category may depend on their role as homemakers in the family. For example, if they are the planners and providers of the meals, the weight of their age-sex category might reflect food purchase behavior patterns motivated by goals such as food cost minimization, or achievement of nutritional well being for the household. The weight of an age-sex category may also depend on biologically and culturally determined diets eaten by members belonging to that category. For example, the category might include pregnant and lactating women, or, infants, who require specialized diets that are culturally specified. Finally, the weight of an age-sex category might depend on the work performed by persons in that category, reflecting nutritional requirements appropriate to the work load. Given that the distribution of weights among the age-sex categories depends on a variety of behavioral reasons, using the weights to draw inferences about the nutritional consequences of a relatively high or a low weight for a particular age-sex category may not be appropriate. However, in past studies for the United States (Goungetas, 1986), a 'natural' distribution of weights was considered to be one for which the weights decrease with age, and are higher for males compared to females.

5.4.1 Engel relationships with general scales

For the general scales model, parameter estimates were significant for most age-sex categories and total expenditure (Table 5.1). For the full sample, parameter estimates were significant for all age-sex categories and total expenditure. For the urban subsample, parameter estimates were significant for all independent variables except number of adolescent females (aged 10 to 18 years). Similarly, for the rural subsample, parameter estimates were significant for all independent variables except number of infants (aged 0 to 3 years).

The distribution of the weights among the different age-sex categories varied considerably depending on the sample. For example, for the full sample, weight was highest for adult females (aged 19 and older), followed by adult males (aged 19 and older), adolescent males (aged 10 to 18 years), children (aged 4 to 9 years), adolescent females and infants. This distribution of weights seems plausible, except for the relatively low weights for adolescent females.

For the urban subsample, the weights were the highest for adult males, followed by adoloscent males, adult females, infants, children, and adoloscent females. While the relatively high weight for infants may be explained in terms of supplemental and weaning foods being costly and perhaps imported in urban areas, the relatively low weight for adolescent females again seems implausible.

For the rural subsample, the distribution of weights was entirely different, reflecting perhaps entirely different family structures and occupational patterns. Weights were the highest for adult females, followed by adolescent females, adult males, children, adolescent males, and infants. The relatively low weights for adolescent and adult males seems implausible.

5.4.2 Engel relationships with specific scales

For the Engel relationship with specific scales, parameter estimates for the full sample were significant for most food groups and most age-sex categories. The distribution of weights seemed plausible for some food groups such as dairy and eggs, for which, weights were the highest for infants, reflecting the use of dairy products as supplemental foods. For drinks, the weights were the highest for infants. Since the food group drinks includes teas and coffees, which are used as supplemental foods for infants in Haiti (Bureau of Nutrition, 1979), the high weight for infants for the food group drinks is plausible. However, the distribution of weights for food groups like meat and fish seems implausible because the weights are the highest for infants and children, and past studies (Bureau of Nutrition, 1979) show that the consumption of animal products by children is low. For the full sample, two patterns observed are, that for more than half the food groups, the weight for the adolescent female is the lowest, and that the 'natural' distribution of weights does not exist for any food group.

Regarding the urban and rural subsamples, past studies (Bureau of Nutrition, 1979) indicate some patterns that might be expected for the distribution of weights among infants and children. In the study by the Bureau of Nutrition (1979), it was found that, for infants, the consumption of most foods increased with age with the exception of foods that were important prior to weaning. For urban and rural areas, these foods were wheat flour, milk, bread, and tubers. In urban areas, additional foods which were important prior to weaning were sugar, homemade fats, cassava, fruits and vegetables. In rural areas, additional foods that were important prior to weaning included teas and coffees. In the present study, this means that for most food groups, weights for the age-sex category, children, may be expected to be higher than weights for the age-sex category, infants, with the exception of food groups that include supplemental food items that are used to feed infants prior to weaning. The weights for infants may, therefore, be expected to be higher than the weights for children for wheat, dairy and eggs, and tubers. In urban areas weights of infants may also be expected to be higher than the weights of children for sugar, oil, fruits and vegetables. In rural areas weights of infants are expected to be higher than weights of children for drinks.

For the urban subsample (Table 6.3), parameter estimates were significant for most food groups, and age-sex categories. The weights of children were higher than the weights of infants for all food groups except dairy and eggs, meat and fish. While this is a plausible pattern for most food groups, it is not plausible for food groups like fruits, vegetables, oil, sugar, tubers, and wheat. However, these food groups probably include food items that are not used as supplemental foods, so that, weights for children being higher than weights for infants is plausible.

The distribution of weights appeared implausible for food groups such as meat and fish because of the relatively high weights for infants. Also, the weight for the adolescent female was the lowest for more than half the food groups, and a 'natural' distribution of weights was not observed for any food group.

For the rural subsample (Table 6.4), parameter estimates were not significant for several food groups, particularly with respect to the independent variables, number of adolescent males, and number of infants. Also, for some food groups such as corn and other cereals, parameter estimates were not significant for most age-sex categories.

For the rural subsample, the distribution of weights observed was very different from the distribution observed for the urban and the full samples. For example, for the rural subsample, a 'natural' distribution of weights was observed for some food groups (fruits and oil). Also, for most food groups, weights were lower for children and infants, and the weights for children were higher than the weights for infants for all food groups, including food groups with rural supplemental foods. However, the weights for infants were not significant for most food groups, so that a valid comparison of weights for children and infants is not possible. The distribution of weights for meat seemed implausible for the rural subsample too because of the relatively higher weights for the lower age groups.

5.4.3 Engel relationships with size economies

For the Engel relationships with size economies, parameter estimates were not significant for a number of coefficients for all five food groups (wheat, oil, vegetables, sugar, and other cereals). For example, for the full sample (Table 5.6), parameter estimates were not significant for any coefficient for other cereals. For the remaining food groups, parameter estimates were not significant mainly with respect to the coefficients indicating economies of size--i.e., M1 through M6. For the urban subsample (Table 5.6) also, parameter estimates were not significant with respect to several coefficients for each of the five food groups. For example, parameter estimates for wheat were not significant with respect to any of the coefficients indicative of economies of scale. Similarly, parameter estimates of almost all coefficients were insignificant for other cereals, reflecting perhaps the low participation rates for other cereals. For the rural subsample (Table 5.7) too, parameter estimates for other cereals were insignificant with respect to all coefficients, and parameter estimates for vegetables were insignificant for most of the coefficients. For wheat, oil, and sugar, parameter estimates were significant for about half the coefficients.

Economies of scale could occur for a number of behavioral reasons, including more cost efficient meal planning, and varying food preferences across different age-sex categories. Considering only parameter estimates that were significant, for the full sample, economies of scale were found to exist for wheat, oil, vegetables, and sugar with respect to adult males, and for oil and vegetables with respect to adult females.

For the urban subsample, economies of scale with respect to adult males were found to exist for oil and sugar. Economies of scale with respect to adult females were found to exist for oil, and vegetables. Economies of scale with respect to adolescent males existed for vegetables. Finally, economies of scale with respect to adolescent females existed for wheat, vegetables, and sugar. The finding that economies of scale for vegetables existed with respect to three of the four adult and adolescent age-sex categories supports the indications in the ordinary least squares, tobit and logit models (Chapter 4) of the significant and large effect of unweighted household size on expenditure on vegetables, and on its positive effect on the probability of participation in the expenditure on vegetables.

For the rural subsample (Table 5.7), economies of scale existed with respect to adult males for wheat, oil, vegetables, and sugar. Economies of scale existed for adult females with respect to wheat and oil. Economies of scale also existed for adolescent males with respect to oil and sugar.

5.5 Conclusion

In this chapter, the general scales, specific scales, and household size effects models were specified and estimated for the full sample, and the urban and rural subsamples. For the general scales, and specific scales models, weights were calculated, and for the household size effects models, economies of scale of the food groups with respect to the household compositional variables were identified.

For the general scales models, the distribution of weights varied considerably depending on the sample. For the full sample, and the rural subsample, weights for the age-sex category adult female were the highest among all the categories. The weight for the adult female exceeding the weight for the adult male has also been found in studies for developed countries (Brown, 1982).

For the specific scales models, the distribution of weights was plausible for some food groups like dairy and eggs, but implausible for others like meat, based on information about food consumption patterns of infants and children in Haiti from past studies. Using the information from the past studies, the distribution of weights among infants and children were found to be plausible for some food groups like dairy and eggs, but not for others like fruits and vegetables, reflecting, perhaps, the grouping criteria used for creating the 15 food groups. That is, food groups like fruits and vegetables probably included several food items that are not used as supplemental or weaning foods in Haiti. A 'natural' distribution of weights was not observed for any food groups for the full sample, or the urban subsample. It was observed for some food groups (fruits and oil) for the rural subsample.

Parameter estimates for the Engel relationships with size economies were not significant for several food groups, particularly with respect to other cereals, reflecting, perhaps, the low participation rates for other cereals. Considering the parameter estimates that were significant, economies of scale were observed for wheat, vegetables, oil and sugar, particularly with respect to adult males and females. Economies of scale were not observed with respect to infants or children for any food group, probably because of the smaller quantities consumed by infants and children.

6. CONCLUSION

Malnutrition is one of Haiti's serious development problems, and it has been documented by previous studies (Bureau of Nutrition, 1979). Most of the previous studies were on nutritional status in Haiti, but a few were also on dietary status. However, the studies on dietary status examined food consumption rather than food expenditure patterns (Bureau of Nutrition, 1979).

Although the previous studies included descriptions of the linkages between nutritional status or dietary status, and household socioeconomic characteristics, they did not examine the food expenditure behavioral causes of malnutrition. Furthermore, the analyses in the past studies were not structured in the sense that they did not quantify the linkages between the causal socioeconomic household characteristics variables, and nutritional or dietary status. Also, the analyses in the past studies did not examine household composition as an etiological variable.

The purpose of the present study was to undertake a more structured analysis, and to focus on food expenditure behavior in Haiti. Household size and composition, and total expenditure were selected as appropriate explanatory variable based on past studies for the United States, which indicated strong evidence that these variables had significant effects on food expenditure. Using Barten's household model from traditional consumer theory, per capita Engel relationships, and adult equivalent scales (general, and specific scales, and economies of scale) models were specified and estimated.

The analysis in the present study was carried out at three levels. First, a tabular analysis was undertaken to describe the food expenditure patterns in Haiti by area (rural and urban) and region. Then, per capita Engel relationships were estimated using ordinary least squares and tobit models, and participation Engel relationships were estimated using logit models. Finally, ordinary least squares was used to estimate the general scales model, and nonlinear least squares was used to estimate the specific scales and household size effects models.

The food expenditure patterns that emerged from the tabular analysis were fairly typical of developing countries in some ways. For example, average shares and participation rates were higher in urban than in rural areas for all food groups. But some of the patterns were not what might be expected of most developing countries. For example, the extent of the market economy was high in all regions and in rural and urban areas, as indicated by high average shares and participation rates for total purchases. Comparison of these food expenditure patterns with results from previous studies was not possible given that expenditure data for Haiti were unavailable prior to the HECS.

The empirical findings from the estimation of per capita Engel relationships and the adult equivalent scales models were considered plausible for some food groups based on information on food consumption patterns from past studies on Haiti, and on estimation of scales from studies on U.S.A. For example, for the per capita models, parameter estimates for total expenditure were highly significant for all food groups for the ordinary least squares per capita Engel relationships, as was indicated by the studies on the United States (Morgan, 1986).

For the per capita logit models, parameter estimates were not used to calculate the effects of the independent variables on probability of participation. Therefore, magnitudes of the partial derivatives of the probability of participation with respect to the independent variables, or elasticities of participation were not calculated. However, parameter estimates were used to indicate the signs of these partial derivatives. According to the logit models for the full sample as well as the urban and rural subsamples, total expenditure had no effects on the probability of participation for any food group, and parameter estimates for unweighted household size were positive for all food groups for which estimates were significant.

For the adult equivalent scales models, parameter estimates were used to calculate weights for the six age-sex categories, assuming the weight for the adult male to be equal to one. Calculation of the weights enabled a study of the impact of weighted household size on food expenditure. A relatively high weight for an age-sex category with respect to expenditures on a food group implied that the change in expenditures on the food group in response to a change in the size of the age-sex category was relatively high. Weights were calculated for the general scales, specific scales, and household size effects models. The empirical findings for the weights were plausible for some food groups (for example, dairy and eggs) and implausible for others (for example, meat). Possible reasons for the implausible weights could be the grouping of the food items, or the age cut-off points used to create the age-sex categories.

For the general scales model, the distribution of weights favored adult females compared to adult males, which is a pattern that has been found in studies for the United States, too (Brown, 1982).

The empirical findings of the present study could be applied for further analysis in two ways. First, using prices, food expenditures could be converted to food quantities available for consumption. A food composition table was compiled for the HECS from four source tables (Bureau of Nutrition, 1979). For each food item in the survey instrument of the HECS, the nutritional composition was found for eleven nutrients. Using the food quantities obtained from food expenditures, the food composition table could be applied to convert food quantities to nutrient availabilities. Using nutrient availabilities, an examination of dietary status could be undertaken. Using the conceptual frameworks of either traditional consumer theory, or the characteristics approach, the effects of household size and composition, and total expenditure on total food expenditure and nutrient availabilities could be estimated in a simultaneous equations model as described in section (3.4.1).

Second, the empirical findings in the present study could be used for policy implications for possible food subsidization programs in Haiti. Since the HECS is a national survey, target groups could be identified in the entire nation. Using household size and composition, total expenditure, and other socioeconomic characteristics variables available in the HECS such as occupation and education of household head, nutritional availabilities could be predicted and compared to recommended daily allowances, thus estimating the numbers of households with nutrient availabilities below recommended allowances, and identifying such target populations by area, region and socioeconomic characteristics. Finally, the present study could be extended to compare predicted food expenditures based economic optimization to food expenditures based on nutritional optimization such as the Thrifty Food Plan for the U.S.A. (Goungetas, 1986). That is, for given levels of total food expenditure, subject to dietary standards, nutritionally optimal allocations of the food budget could be obtained for each age-sex category using recommended daily allowances. Such allowances could be compared with allocations of the total food budget predicted for each age sex category given total expenditure and the weights for each category from the specific scales and household size effects models. Alternatively, household total food budgets implied by the nutritionally optimal budgets like the Thrifty Food Plan, and by the economically optimal budgets like those resulting from the specific scales, or household size effects models could be compared.

The results obtained in the present study might be improved by using simultaneous estimation methods and further editing of the data. The estimation methods used in the present study were mainly ordinary least squares estimations of single equations. Tobit and logit models were also estimated for the per capita models. The tobit results differed greatly from the ordinary least squares models with respect to total expenditure but not unweighted household size probably because of low participation rates for some food groups and because variations in household size were low compared to variations in total expenditure.

The specific scales models were estimated as single equation models. However, since interrelationships may be expected among the expenditure patterns, the quality of the specific scales estimates might be improved considerably by estimating the share equations in a simultaneous equations framework. For example, since there is a capacity limit on households for amounts consumed of protein, expenditures on meat products would affect expenditures on other sources of protein in the household. Estimating the share equations in a simultaneous equations framework would incorporate such interrelationships in the expenditure patterns and improve the estimates.

The data used for the present study were only preliminarily edited. Further editing of the data and application of final weights to the data might be expected to improve the results. However, in conclusion, it might be said that the results of the present study are considered, nonetheless, to be useful because the purpose of the study was exploratory.

7. BIBLIOGRAPHY

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8. APPENDIX: PROOF OF THE IDENTIFICATION PROBLEM

The proof of the identification problem incurred in the estimation of specific scales Engel curves (with specific scales for commodities and income) from cross section data is as follows.

The Engel curve with specific scales for commodities and income, is

$$x_i = y_i x_i(m/y_0) \qquad \text{A.1}$$

where $x_i = p_i q_i$, $y_i = y_i(N_1,\ldots N_k)$, and $y_0 = y_0(N_1,\ldots,N_k)$.

Let

$$f_{ij} = (dx_i/dN_j).(N_j/x_i) \qquad \text{A.2}$$

$$h_{ij} = (dy_i/dN_j).(N_j/y_i) \qquad \text{A.3}$$

$$e_i = (dx_i/dm).(m/x_i) \qquad \text{A.4}$$

From A.1,

$$(dx_i/dm) = (y_i/y_0)x_i'(m/y_0) \qquad \text{A.5}$$

$$(dx_i/dN_j) = x_i(m/y_0)(dy_i/dN_j) -$$
$$(y_i m/y_0^2)x_i'(m/y_0)(dy_0/dN_j) \qquad \text{A.6}$$

Substituting A.1 and A.5 in to A.6 results in

$$(dx_i/dN_j) = (x_i/y_i)(dy_i/dN_j) - (m/y_0)(dx_i/dm)(dy_0/dN_j) \qquad \text{A.7}$$

Therefore,

$$f_{ij} = (x_j/y_i)(dy_i/dN_j) - (m/y_0)(dx_i/dm)(dy_0/dN_j)\ (N_j/x_i)$$

or,

$$f_{ij} = h_{ij} - e_i h_{0j} \qquad \text{A.8}$$

Multiplying A.8 through by the budget share, $w_i = (x_i/y)$, and adding up over i implies

$$\Sigma w_i f_{ij} = \Sigma w_i h_{ij} - h_{0j}\Sigma w_i e_i. \qquad \text{A.9}$$

By the Engel aggregation condition, (3.16),

$$\Sigma w_i e_i = 1. \qquad \text{A.10}$$

Since a change in household characteristics N_j, ceteris paribus, causes only a reallocation of expenditures among commodities, but no change in income,

$$\Sigma(dx_i/dN_j)=0 \qquad \text{A.11}$$

Therefore, A.9 becomes

$$\Sigma w_i f_{ij}=\Sigma(x_i/m)(dx_i/dN_j)(N_j/x_i)=(N_j/m)\Sigma(dx_i/dN_j)=0 \qquad \text{A.12}$$

Therefore,

$$\Sigma w_i h_{ij}-h_{0j}=0. \qquad \text{A.13}$$

Substituting A.13 into A.8,

$$f_{ij}=h_{ij}-e_i\Sigma w_t h_{tj}, \qquad \text{A.14}$$

or, in matrix notation,

$$F=(I-ew')H \qquad \text{A.15}$$

where $F=(f_{ij})$, $H=(h_{ij})$, $e'=(e_1,\ldots,e_n)$, $w'=(w_1,\ldots,w_n)$, and I is an n by n identity matrix.

For cross section data, F, e and w are observable. H is unobservable, and must be estimated from A.15. The identity problem means that H cannot be estimated uniquely, since, (I-ew') is singular, which can be demonstrated by pre-multiplying (I-ew') by w'.

$$w'(I-ew')=w'-w'ew'=w'-w'=0 \qquad \text{A.16}$$

because of the Engel aggregation condition.