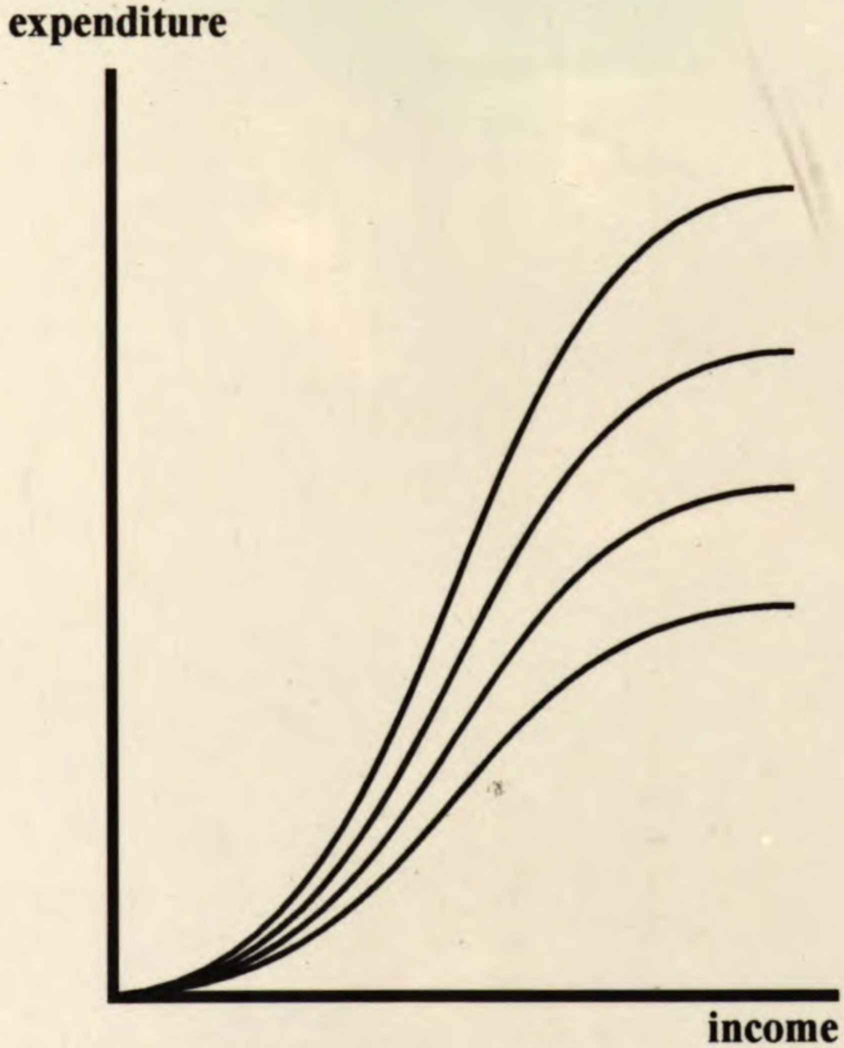
Domestic Demand for Food in Costa Rica:

a double-hurdle analysis



Jørgen A.M.M. Geurts
Hans G.P. Jansen
Aad van Tilburg

Agricultural University Wageningen

Serie Técnica
Informe Técnico No. 286

DOMESTIC DEMAND FOR FOOD IN COSTA RICA: *A DOUBLE-HURDLE ANALYSIS*

Jørgen A.M.M. Geurts, Hans G.P. Jansen, and Aad van Tilburg

Centro Agronómico Tropical de Investigación y Enseñanza

CATIE

Turrialba, Costa Rica

1997

CATIE is an international, non-profit regional scientific, and educational institution. Its main purpose is research and education in the fields of agricultural science and natural resources and related subjects in the American tropics, with emphasis on Central America and the Caribbean.

ISBN 9977-57-272-0

363.8097286
G395 Geurts, Jørgen A.A.M.
Domestic demand for food in Costa Rica: a double-hurdle analysis / Jørgen A.A.M. Geurts, Hans G.P. Jansen and Aad van Tilburg. -- Turrialba, C.R., : CATIE, 1997.
62 p. ; 27 cm. -- (Serie técnica. Informe técnico / CATIE ; no. 286)

1. Consumo alimentario - Costa Rica 2. Abastecimiento de alimentos - Costa Rica I. Jansen, Hans G.P. II. Tilburg, Aad van III. CATIE IV. Título V. Serie

This is a publication of the Research Program on Sustainability in Agriculture (REPOSA), a cooperation between Wageningen Agricultural University (WAU), the Center for Research and Education in Tropical Agriculture (CATIE), and the Ministry of Agriculture and Livestock, Costa Rica (MAG), financed by the Wageningen Agricultural University (WAU).

TABLE OF CONTENTS

ABSTRACT

Food consumption patterns in Costa Rica are analyzed using budget data from the 1987-88 National Household Income and Expenditure Survey. Limited dependent variable models are employed to determine factors influencing the structure of Costa Rican food demand. Expenditure and income elasticities are estimated for 24 different food categories. The results provide strong support to reject the standard Tobit procedure in favor of a two-stage Cragg-type specification which includes both infrequency-of-purchase models and market participation models. Per capita expenditure on a particular food category is hypothesized to primarily depend on total expenditure, own-price, the general price level, and household size. In addition, dummy variables for regions (corresponding to planning zones as distinguished by the government) as well as zones (rural-urban) are incorporated in the models to allow for spatial differences in food consumption behavior. A quadratic expenditure term and an interaction term of own-price and total expenditure are also included, to enable estimation of expenditure and own-price elasticities by income stratum. With few exceptions, expenditure and price elasticity estimates are within the expected range and decline with increasing income level. The value of this study consists of the fact that, using state-of-the-art estimation techniques, it has produced the first estimates of expenditure and price elasticities for a relatively large number of different food categories for Costa Rica which should prove useful to Costa Rican food policy makers.

Key words: Costa Rica, Cragg models, double hurdle analysis, expenditure elasticities, food demand, infrequency of purchase models, market participation models, price elasticities, Tobit model

PREFACE

This report was made within the framework of the Research Program on Sustainability in Agriculture (REPOSA, formerly the Atlantic Zone Program) which is a cooperation between Wageningen Agricultural University (WAU, The Netherlands), the Tropical Agriculture Research and Graduate Education Center (*Centro Agronómico Tropical de Investigación y Enseñanza* or CATIE, Costa Rica), and the Costa Rican Ministry of Agriculture and Livestock (*Ministerio de Agricultura y Ganadería* or MAG).

The content of the report is the result of a team effort. Jørgen Geurts initiated the work on demand models for Costa Rica in his 1994 M.Sc thesis. Responsibility for model estimation in the current study is shared with Hans Jansen. Together they further refined and improved the methodology which work resulted in the use of double-hurdle Cragg models. Hans Jansen, economist and coordinator of the WAU field team in Costa Rica, was responsible for most of the final text and the editing and production of the report. Aad van Tilburg, associate professor in the Department of Marketing and Marketing Research at WAU, helped in all stages of the study including data preparation, model specification, interpretation of the results, and text editing.

Thanks are due primarily to the *Dirección General de Estadística y Censos, Ministerio de Economía, Industria y Comercio* (General Directorate for Statistics and Census, Ministry of Economics, Industry and Commerce) in Costa Rica for generously making the necessary data available to the authors. Allison Burrell, associate professor in the Department of Agricultural Economics and Policy at WAU, provided substantial advice on model specification and other technical aspects. Rob Schipper of the Department of Development Economics at WAU, André Nieuwenhuyse of REPOSA, and Jetse Stoorvogel, formerly of REPOSA and now at the Department of Soil Science and Geology at WAU, reviewed an earlier draft version of the report. The comments of two anonymous reviewers are gratefully acknowledged. The cover design is by Jaap Bijkerk of the Department of Marketing and Marketing Research at WAU.

Jørgen A.M.M. Geurts
Hans G.P. Jansen
Aad van Tilburg

Rubén Guevara Moncada
Director General

1. INTRODUCTION

1.1. BACKGROUND AND JUSTIFICATION

This study was carried out under the auspices of the Research Program on Sustainability in Agriculture (REPOSA) that focuses on the development of a methodology for the evaluation of sustainable land use options in Costa Rica (Schipper *et al.*, 1995; Stoorvogel *et al.*, 1995). REPOSA is a cooperation between Wageningen Agricultural University (WAU) of the Netherlands, the Center for Research and Education in Tropical Agriculture (CATIE) in Costa Rica, and the Costa Rican Ministry of Agriculture and Livestock (MAG). Marketing and consumer behavior have important implications for (changes in) land use and crop production, insofar as the latter are market driven and influenced by institutional incentives. However, while a number of studies have been conducted looking at the structure, conduct and performance of both domestic and international markets for the main agricultural products of Costa Rica (Hoekstra 1993; Kreijns, 1993; Logtesteijn, 1993; Kruseman *et al.*, 1994; Portier 1994; Jansen *et al.*, 1996), no research, other than Kreijns (1993), Geurts (1994) and Lizano (1994), is available on the demand side of some of these commodities. Consequently, the main purpose of this study is to evaluate the buying behavior of consumers regarding major food product categories in Costa Rica. Relationships between income, prices, location and the demand for several groups of food products are assessed for various income strata. Engel functions (depicting the relationship between income and expenditure) and related expenditure elasticities as well as own-price elasticities are estimated for various product groups. Despite their obvious importance for the definition of policy interventions, such elasticity estimates are extremely scarce in Costa Rica; in fact, they only exist for rice (Stewart, 1987) and beans (Céspedes, 1973). Even though government price policies have been the subject of economic research (Quirós *et al.*, 1987), such analyses worked with assumed, rather than estimated, elasticity values.

While chapter two offers an in-depth discussion of the data set used in this study, the original data source is described in the next section. Main characteristics of data on composition of income and expenditure, as well as data limitations, are discussed.

The third chapter contains a description of the household sample in terms of location, size, and variation in income, food expenditure, and total expenditure.

Chapter four provides a comparative analysis between the various types of demand models available in the literature. Specifically, both Tobit and Cragg specifications are discussed and model selection is performed based on empirical evidence.

Chapter five focuses on empirical results. Both expenditure and own-price elasticities are estimated for twenty-four different food categories, followed by a discussion regarding their interpretation.

The final chapter summarizes the main conclusions of this study, including some recommendations to improve future demand studies in Costa Rica.

1.2. THE NATIONAL HOUSEHOLD AND INCOME EXPENDITURE SURVEY

The original data, part of which was used in this study, is known as the *Encuesta Nacional de Ingresos y Gastos de los Hogares* (National Household Income and Expenditure Survey, or NHIES). The NHIES was carried out nation-wide between November 1987 and November 1988. The agency responsible for conducting the survey was the *Dirección General de Estadístico y Censos* (DGEC or General Directorate for Statistics and Census) of the *Ministerio de Economía, Industria y Comercio* (Ministry of Economics, Industry and Commerce, or MEIC). The main objectives of the NHIES were to study the structure of the household budget by eliciting the various sources of income and the use of this income for the purchase of goods and services. Other objectives of the NHIES included the following (DGEC, 1990):

- estimate the extent to which poverty is a problem, by estimating the number and location of people living in conditions of malnutrition and poverty (Anonymous, 1995; DGEC, 1995);
- obtain the information necessary to revise the weights used in the calculation of consumer price indices; and
- provide basic information to assist in decision-making for economic and social planning.

The NHIES defines a household as a group of people (related or not) who live together and have a common financial arrangement for their upkeep. A single person living alone with a separate budget was considered as a single person household. Members included those living in it on a permanent basis while fulfilling the conditions of the above definition. Members who lived away from home were considered as such only when their period of absence did not exceed six months. Domestic servants were considered as members as well (DGEC, 1988).

The NHIES was conducted over a period of 12 months in order to capture information on seasonal variation in income and expenditure, and to facilitate estimating a range as large as possible of expenditures on goods and services. The information was collected both by means of direct interviews and through recorded information from diaries. An average of four visits per household over a period of eight consecutive days was made by interviewers. An exception to this were some households in rural areas which, due to the level of education of their members, were unable to record the information requested in diaries, in particular with regard to daily expenditure. In this case, the interviewer completed the questionnaire on the basis of direct interviews only.

The guidelines used in the NHIES to assess income were largely equivalent to those adopted by the United Nations (United Nations *et al.*, 1993). Substantial efforts were made to record income in kind, home-grown and produced goods, and goods received free of charge. Total income received by each individual was determined by summing up main income (*i.e.*, both income in cash and in kind obtained by the individuals from employment); income from property (*i.e.*, income in cash resulting from the possession of financial assets or the ownership of real estate and other assets); regular transfers and other benefits received (*i.e.*, income received regularly on a gratuitous basis); and other income (for more details see Appendix I). Total income was defined as the sum of all components of income received, either in cash or in kind, independently of whether or not they were totally or partially intended to be put into a common fund to cover the expenditure of the household.

Household expenditure was divided into consumption expenditure and non-consumption expenditure, because only expenditures on items actually consumed are considered when revising the weights of the consumer price index. Consumption expenditure included the following items:

1. Expenses of household members for certain goods and services which can generally be considered to be for consumption, either by their own household or by other households.
2. The value of home-grown and produced goods consumed, goods received free of charge and consumed, income in kind, and the estimated value of the rent of the household's dwelling (either owned or rent-free).

Non-consumption expenditure includes expenditures, either voluntary or obligatory, in cash or kind, regular or occasional, made for:

- Payments to the Costa Rica Social Security Fund, the *Banco Popular y de Desarollo Comunal*, and payments to other pension schemes.
- Direct taxes.
- Interest payments.
- Alimonies.
- Membership fees for private, non-profit, non-recreational associations (trade unions, professional associations, etc.).
- Payments for life and other insurance.
- Expenses on maintenance and repairs of premises and houses rented out.
- Donations to non-profit institutions or other households.
- Other expenditures.

The NHIES recorded goods and services according to the classification of the so-called New National Accounting System (ILO, 1992; United Nations *et al.*, 1993). In addition to information on income and expenditure of households used in this study, the NHIES also collected information on socio-economic determinants of the distribution of income, and information necessary to further study poverty in Costa Rica.

2. DESCRIPTION OF THE DATA

2.1. QUESTIONNAIRES

The sampling frame was derived from the results of the 1984 Population Census for which the country was divided into 10,500 so-called Primary Sampling Units (PSUs), each consisting of between 40 and 60 households and stratified by region (1-6) and by zone (urban and rural) (DGEC, 1987). A total of 514 PSUs were sampled with probability proportional to the number of households in each PSU. Within each of those segments twelve households were sampled, six of which were interviewed in the first half of the twelve month survey period, and six households in the second half of the survey period. Even though the survey was designed to provide a sample of 6,168 households, due to errors and problems during data collection, on net only 3,908 acceptable household observations were obtained. Each household was visited an average of four times during a period of eight consecutive days. The information was obtained with seven questionnaires, as follows: general characteristics of the dwelling and the members the household; inventory of purchased food products; daily expenditure of the household; daily personal expenditure; budget of the household; agricultural production; and (only for rural households) infrastructure of the residential area.

To resolve various methodological and operational issues, a pilot survey was conducted in May 1987, before the main NHIES was carried out. About 70 interviewers were trained during a period of four weeks.

2.2. DATA

2.2.1. Description

The data set contains 3,908 observations (households) with information about household characteristics, household income, household expenditure, and quantities and value of food products bought during the eight-day period of interrogation. It also includes a variable named *factor de expansión* which can be used as a weight factor (Norusis, 1993). The use of such a weight factor becomes necessary when conclusions are to be drawn for the entire Costa Rica population (which consists of about 617,000 households) because the proportion of households living in the various regions differs between the sample and reality. Using this weight, the sample becomes representative. For example, households in the heavily populated Central region receive a higher weight than households in less populated regions such as Huetar Norte and Pacífico.

Individual households have as many records as different products bought during the period of interrogation. The large number of individual food products purchased were aggregated into a smaller number of food categories, and new variables were created for the expenditures on each food category. Appendix II shows the contents of each of these newly created food categories. A table with summary statistics for the variables used in regression analysis is shown in Appendix III.

2.2.2. *Limitations and errors*

One shortcoming of the data set used in this study consists of the way in which the individual household members were added; *i.e.*, the same weight[1] was used for all members, irrespective of their age and sex. Such lack of information regarding intra-household characteristics may complicate the interpretation of the results which could have been enhanced by using adult equivalency scales in lieu of household size (Tedford *et al.*, 1986). In addition, no information was available on intra-household food distribution. For many decades, analyzing consumption patterns across households has been the central theme of demand analysis. Recently, however, allocation of expenditure within the household received a considerable amount of interest. For food items in particular, obtaining insight into intra-household allocation is not only of academic, but also of social importance. For example, evidence exists that inappropriate allocation of food within the household may exacerbate the effect of inadequate food supply on certain household members. For Asia, evidence has been found that boys tend to be favored over girls in intra-household distribution of nutrients (*e.g.*, Deaton 1989a, Sen and Sengupta (1983), and Behrman and Deolalikar (1990) for India; and Senauer *et al.* (1988) for the Philippines). Thomas (1990) found evidence that mothers prefer to devote resources to daughters and fathers to sons, while Dobbelsteen (1996) analyzed the effect of food allocation on different categories of children in a case study for Peru. Thus, information about intra-household food allocation is particularly important to design schemes of food subsidies targeted towards particular person categories within households.

Second, simple checks revealed some inconsistencies in the data. For example, a comparison between total expenditure and total income showed that some households had unrealistically low total consumption in relation to their total income, while other households consumed considerably more than their income. Table 2.1 indicates that 20 per cent of the households spent less than 55.3 per cent of their total household income. On the other hand, for almost 30 per cent of the households, expenditure exceeded income, with nearly one-third of these spending more than 133.9 per cent of their income. The average expenditure share of income was 0.930. Part of the difference between expenditure and income can be explained by savings and taxes, though only if the difference between total income and expenditure is not too large. Extremely low or extremely high expenditure shares of income are usually a matter of data errors caused by, *e.g.*, underreporting of income. On the other hand, extremely low expenditure shares also arose when farmers (especially coffee producers) were interviewed at a time in which they had not yet sold their crop and/or had not yet received payment. Other potential sources of inconsistencies include poor understanding of the questionnaires by the respondents, insufficient time coverage of the survey, and incorrect data entering and processing.

[1] The variable in the data set that refers to the number of household members is just a simple counting function of the number of household members, irrespective of the composition of the household. However, both income and consumption behavior are likely to depend on the composition of the household. Thus, it would have been preferable to use household equivalents instead of the number of persons, with children only counting fractionally. Several sets of weights exist, one of which is the so-called Amsterdam scale (Stone, 1954a; Deaton and Muellbauer, 1980a):

Age group	male	female
under 14 years	0.52	0.52
14 - 17 years	0.98	0.90
18 years and over	1.00	0.90

Table 2-1: Frequency distribution of total expenditure as a percentage of total income, 1987-1988

Ratio monthly total expenditure/ monthly total income*	Percentage	Cumulative percentage
< 0.410	10.0	10.0
0.410 - 0.553	10.0	20.0
0.553 - 0.654	10.0	30.0
0.654 - 0.733	10.0	40.0
0.733 - 0.817	10.0	50.0
0.817 - 0.902	10.0	60.0
0.902 - 0.998	10.0	70.0
0.998 - 1.116	10.0	80.0
1.116 - 1.339	10.0	90.0
> 1.339	10.0	100.0

* cut-off points for ten equal groups, n=3908

A third potential source of bias has to do with the infrequency-of-purchase problem. All monetary variables included in the survey relate to income and expenditure per household for a specific one-month period. The fact that households were questioned an average of four times over a period of only eight days resulted in a high incidence of infrequency of purchasing goods. That is, it is possible that regularly bought products coincidentally were not bought during the time covered by the survey, resulting in a relatively large number of zero observations. Similarly, non-zero observations can be influenced by infrequency of purchases. The infrequency-of-purchase problem receives further attention in chapter IV.

Finally, a more detailed analysis could have been carried out if the data would have contained better information on prices. Rather than provided directly by the NHIES, prices were imputed by dividing a product group's expenditures by its corresponding quantities. No attempt was made to adjust prices for possible quality differences, causing a potential source of bias in price elasticity estimates (Cox and Wohlgenant, 1986; Deaton, 1989b). As in any other demand study based on household budgeting data, price data used reflect actual prices paid by consumers which, in the case of Costa Rica, have been established to differ (sometimes substantially) from world market prices (Quirós *et al.*, 1987). Such price distortions may act as another potential source of bias in elasticity estimates, in the sense that the latter may have been different under alternative governmental pricing policies.

3. ANALYZING HOUSEHOLD CHARACTERISTICS

In this chapter an analysis of selected socio-economic characteristics of the sample households is performed. The primary purpose of this analysis was to determine whether or not there exist significant differences between sample households in terms of geographical location, size, income, and expenditure pattern. Such information can then be used to adequately specify the demand models which are developed in the next chapter. To determine the effect of geographical location, Costa Rica was divided into two zones (urban and rural) and six regions (Central, Chorotega, Pacífico, Brunca, Atlántico, and Huetar Norte; Fig. 1). Regions correspond to planning zones as distinguished by the Costa Rican government during the period 1986-1988 in accordance with *Decreto No. 1729-Plan*. Differences between households in terms of size, income, and expenditure pattern were analyzed by region and zone.

3.1. LOCATION OF HOUSEHOLDS

In a developing country one might expect that more people live in rural than in urban areas. Though still generally true, this situation is changing rapidly. Indeed, the World Bank forecasts that, in the developing world by the year 2010, the number of people in urban areas will exceed that in rural areas (World Bank, 1994).

Food consumption behavior generally differs by location due to, *e.g.*, differences in food availability, traditions etc. Consequently, a Chi-square test (Norusis, 1993) was applied to test whether the number of sample households is independent of region and zone. Because the analysis refers to the entire country, this test was carried out with and without using the weight factor (*factor de expansión*). Tables 3.1 and 3.2 include the expected (E_{ij}) and observed (O_{ij}) numbers of households in every category that are necessary for calculating the Chi-square test. Using weights, more than 60 per cent of the households lives in the Central region. In most regions, the majority of households is classified as rural, except for the Central region where almost 63 per cent live in urban areas and for Pacifico where people are nearly equally divided between the urban and rural areas. For the country as a whole, there is an almost equal number of households living in urban and rural areas.

Table 3-1: Number of households interviewed

	REGION						
ZONE	Central	Chorotega	Pacífico	Brunca	Huetar Atlántico	Huetar Norte	Costa Rica
Urban O_{ij}	781	182	265	106	165	74	1575
E_{ij}	512	230	204	229	206	193	40.3%
Rural O_{ij}	490	389	242	461	347	404	2333
E_{ij}	761	341	303	339	306	285	59.7%
Total	1273	571	507	567	512	478	3908
%	32.6	14.6	13.0	14.5	13.1	12.2	100.0

O_{ij}: Observed number of HH and E_{ij}: Expected number of HH

Figure 1 Regional division of Costa Rica into planning zones (1986-1988)

Table 3-2: Derived number of households by location (using weights)

		REGION					
ZONE	Central	Chorotega	Pacífico	Brunca	Huetar Atlántico	Huetar Norte	Costa Rica
Urban O_{ij}	1564	127	106	68	104	27	1998
E_{ij}	1270	177	106	180	172	93	51.5%
Rural O_{ij}	922	219	101	284	231	155	1912
E_{ij}	1216	169	101	172	164	89	48.9%
Total	2486	346	207	352	336	181	3908
%	63.6	8.8	5.3	9.0	8.6	4.6	100.0

O_{ij}: Observed number of HH and E_{ij}: Expected number of HH

The calculated Chi-square statistics are compared to the critical points of the theoretical Chi-square distribution to produce an estimate of how likely (or unlikely) this calculated value is if the two variables would in fact be independent. Even though the Pearson Chi-square test is most commonly used to test independence hypotheses, an alternative is formed by the Likelihood-Ratio Chi-square test. The latter is based on maximum likelihood theory, and for large samples such as the one used in this study, both test statistics should give similar results. The results of both types of Chi-square tests are shown in Table 3-3. Significance levels are all small, implying that the hypothesis that the number of households does not significantly differ by region and zone is rejected or, in other words, that there exists a significant difference among the number of households living in the different regions and zones. The implication of this result is that, to the extent that the specification of demand models in the next chapter needs to allow for spatial differences in food consumption behavior, it is important to explicitly incorporate binary variables for both zone and region.

Table 3-3: Chi-square statistics on differences of numbers of households by region and zone

Chi-square	Value	DF	Critical value
without using weights			
Pearson Chi-square	531.22	5	11.07
Likelihood Ratio Chi-square	554.35	5	11.07
using weights			
Pearson Chi-square	460.99	5	11.07
Likelihood Ratio Chi-square	483.83	5	11.07
Number of observations: 3908			

3.2. HOUSEHOLD SIZE

Household size is the only demographic variable in the available data set. Demographic variables are potentially important since food demand patterns will change with composition and size of the household, even if other variables remain constant (Musgrove, 1978). Therefore, in this section, statistical analyses are carried out in order to determine whether or not household size differs significantly between zones and/or regions. The next section includes an analysis of the influence of household size on income and expenditures.

Total household size varied from 1 to 20 members (Table 3-4). About 17.5 per cent of all households in Costa Rica have more than 6 members and only 5.3 per cent are single households. To test the *a-priori* expectation that average size in rural areas exceeds that in urban zones, and to test the hypotheses of no difference in size between regions, a Chi-square test would be inappropriate because of the presence of some cells with insufficient observations. Consequently, a *F*-test (Churchill, 1991) was used, the results of which indicated a significant zone effect, though neither a significant region effect nor a significant interaction effect. Thus, it appears unlikely that the households in the two zones are of the same size, but the hypotheses of no difference in size between regions cannot be rejected.

Table 3-4: Derived distribution of household size in Costa Rica (using weights)

Size	Number in sample	%
1 member	209	5.3
2 members	387	9.9
3 members	637	16.3
4 members	831	21.2
5 members	675	17.3
6 members	486	12.4
7 or more members	683	17.5

Table A4, Appendix IV, demonstrates that the size distribution differs between urban and rural areas. Only 11.7 per cent of households in the urban zone contain seven or more members as opposed to 21.4 per cent in the rural zone, and the proportion single or two member households is 17.8 per cent in urban areas but only 13.5 per cent in rural areas. Even though inter-regional differences regarding size are statistically not significant, Table A4 shows that there do exist differences between regions. For example, percentages households with seven or more members vary between 22.2 (Brunca) and 13.8 (Central), and percentages with one or two members between 12.7 (Brunca) and 17.4 (Huetar Atlántico).

The results obtained with the F-test were validated by regressing size on the variables region and zone. Explanatory variables included five regional dummy (*i.e.*, binary) variables and one zone dummy; one category was omitted from both the regional and the zone variables to avoid singularity due to the use of binary variables. Households living in the urban zone in the Huetar Norte region served as the reference (*i.e.*, are included in the intercept term). The regression equation was specified as follows:

$$\text{size} = \beta_0 + \beta_1 x_{\text{Atlántico}} + \beta_2 x_{\text{Brunca}} + \beta_3 x_{\text{Central}} + \beta_4 x_{\text{Chorotega}} + \beta_5 x_{\text{Pacífico}} + \beta_6 x_{\text{Rural}} + \xi.$$

None of the regional dummies has a significant coefficient, but the coefficient for the zonal dummy is positive and significant (Table 3-5). Thus, while size does not significantly differ between regions, rural households are significantly larger than urban households, with an average of almost half a member. The implication of this result is that size needs to be explicitly incorporated as a separate variable in the demand models developed in the next chapter.

Table 3-5: Results of regression[2] of regional and zonal dummies on household size

Variable	ß	std. error	t-value	P-value
Dummy Atlántico	-0.16	0.20	-0.81	0.42
Dummy Brunca	0.15	0.20	0.75	0.46
Dummy Central	-0.10	0.17	-0.55	0.58
Dummy Chorotega	-0.02	0.20	-0.07	0.94
Dummy Pacífico	-0.27	0.22	1.20	0.23
Dummy rural	0.44	0.07	5.96	0.00
(Constant)	4.45	0.17	25.75	0.00

3.3. INTER-HOUSEHOLD VARIATION IN INCOME AND EXPENDITURE

The only income-related variable included in the data set related to total monthly income of the entire household. However, in this study, per capita total expenditure was used as a proxy for total income. If consumers have better control over their expenditures than income receipts (*i.e.*, consumers may want to stick to their customary expenditure patterns as long as their savings will allow them to do so, despite fluctuations in income), income elasticity estimates using total expenditures will be closer to "true" long-run elasticities than income elasticity estimates based on models using some measure of disposable income (Houthakker and Taylor, 1966).

Nevertheless, it remains interesting to further investigate some aspects of income distribution. Using the *factor de expansión* as a weight factor, average monthly income per sample household in 1987-1988 was colones[3] (¢) 28,082, with a standard deviation of ¢ 26,713. Regional and zonal income differences (without using weights) are depicted in Table 3.6.

Table 3-6: Mean total monthly income (¢) per household, by region and zone (without using weights), 1987-1988

	REGION						
ZONE	Central	Chorotega	Pacífico	Brunca	Huetar Atlántico	Huetar Norte	Costa Rica
Urban	37,094	25,510	22,042	22,485	28,195	32,634	30,917
Rural	24,583	16,232	15,996	16,798	20,988	21,488	19,701
Mean	31,920	19,642	19,134	18,005	23,523	22,675	24,221

To test the hypothesis that income does not differ between regions and zones, a F-test was conducted which included the effect of household size. Significant results were obtained for the effects of regions, zones and size on total income, with probabilities of corresponding F-values all

[2] The White and Glejser tests (Maddala, 1992) did not detect heteroskedasticity.

[3] The colon is the Costa Rican currency, the exchange rate of which to the US dollar changed from about ¢70 to about ¢80 between the beginning and the end of the survey period.

lower than 0.001. Thus, it appears unlikely that households in the different regions, zones and of different size have similar incomes. In addition, as established earlier, even though household size does not significantly differ between regions, there does exist a statistical difference in size between zones. However, there is no significant interaction effect between the three variables (*i.e.*, region, zone and size) as indicated by the lowest probability for a significant interaction effect of 0.156.

In spite of the fact that the F-test results show no significant interaction effects, some combinations of region and zone may lead to income levels that are significantly higher than that of reference households. To test this hypothesis, household size was regressed on regional and zone dummy variables, as well as on interaction effects of region and zone. The following regression model was estimated, with the results described in Table 3-7:

$$\text{total household income} = \beta_0 + \beta_1\, x_{\text{household members}} + \beta_2\, x_{\text{Atlántico}} + \beta_3\, x_{\text{Brunca}} + \beta_4\, x_{\text{Central}} + \beta_5\, x_{\text{Chorotega}} + \beta_6\, x_{\text{H.Norte}} + \beta_7\, x_{\text{Urban}} + \beta_8\, x_{\text{Central/urban}} + \beta_9\, x_{\text{Norte/urban}} + \xi.$$

The variable representing size is included as an interval variable, while all other variables are dummies. Reference households (included in the intercept term) live in the rural areas of the Pacífico region. Two interaction dummy variables are included, for the combinations of Central/urban (*e.g.*, San Josė) and Huetar Norte/rural. In case of a significant interaction of one of these combinations, the results in Table 3-6 suggest that the effects on total income should be positive.

Table 3-7: Results of regression[4] of size and regional and zonal dummies (including interaction effects) on total income

Variable	ß	t-value	P-value
Number of household members	2038.99	13.22	0.00
Dummy Huetar Atlántico	5746.20	4.22	0.00
Dummy Brunca	497.95	0.37	0.71
Dummy Central	9305.27	6.36	0.00
Dummy Chorotega	1347.15	1.01	0.31
Dummy Huetar Norte	8896.97	3.27	0.00
Dummy urban	8580.59	8.41	0.00
Dummy Central/urban	4047.16	2.53	0.01
Dummy Huetar Norte/rural	-3677.80	-1.27	0.21
(Constant)	5704.51	4.35	0.00

Not surprisingly, the estimated coefficient of the size variable is highly significant and positive. Larger households have higher total income[5], with on average every additional member contributing ¢ 2,039 to total monthly income. Compared to reference households in Pacífico (the region with the lowest household income), incomes are significantly higher in the Central, Huetar Atlántico, and Huetar Norte regions, though not in Chorotega and Brunca. The zonal effect is included in the dummy for the urban zone which coefficient is significant and positive,

[4] The White and Glejser tests (Maddala, 1992) did not detect heteroskedasticity.

[5] It is likely that the main causality within this relationship is not from the number of household members to income but vice versa.

suggesting that households in urban zones have significantly higher income (on average ¢ 8,580 per month higher) than households in rural areas which are included in the intercept term. In spite of the results of the F-test which did not indicate any interaction effect, two potentially significant interaction effects of regions and zones are included (because of high average income relative to that of the households in the intercept), *i.e.*, households in Central/urban and those in Huetar Norte/rural. Only the Central/urban dummy was statistically significant, with a positive effect of ¢ 4,047 on total income.

The regression results depicted in Table 3.7 are consistent with the data in Table 3.6. For example, while the actual difference in average monthly income between Central/urban and reference households is ¢ 21,098 (¢ 37,094 - ¢15,996), the predicted difference is ¢ 21,933 (¢ 9,305 + ¢ 8,581 + ¢ 4,047).

In order to further refine the analysis of inter-household income distribution, monthly income was used to split the sample into eight categories which contain an equal number of observations(Table A5, Appendix V). For each of these categories, the number of households was calculated per region and per zone. The majority of low-income households live in the rural areas, with the percentage belonging to the lowest two income categories being 37.4 in the rural zone against 13.3 in the urban zone. Correspondingly, higher income levels are more often found in the urban areas, as evidenced by 35 per cent of the households in urban areas belonging to the two highest income categories, against only 14.5 per cent in rural areas. Similarly, referring to the lowest income category, 78.5 per cent are found in rural areas and only 21.5 per cent in urban areas, compared with corresponding statistics for the whole sample of respectively 48.9 per cent and 51.1 per cent. Thus, the majority of the poorest households resides in the rural areas. Moreover, average size in rural areas considerably exceeds that in urban areas (Table 3-5), thus making households in rural areas even poorer on a per capita basis.

At the regional level, 31.3 per cent in the Central region belongs to the two highest income categories, against only 9.5 per cent, 12.3 per cent and 13.8 per cent in respectively the Brunca, Pacífico and Chorotega regions. Percentages of the lowest two income categories in the Central, Chorotega, Pacífico, Brunca, Huetar Atlántico and Huetar Norte regions are respectively 16.7, 47.4, 39.5, 44.7, 29.4, and 34.1. Thus, the richest region is Central while the poorest regions include Pacífico, Brunca and Chorotega, with Huetar Atlántico and Huetar Norte in between.

The data base employed in this study contains information regarding both income[6] and expenditure, expressed in ¢ per household per month. This information is stored in five variables, *i.e.*, total monthly income (*totalinc*); monthly per capita income (*inccap*); food expenditure per month (*foodexp*); households' monthly expenditure on food away from home (*foodout*); and monthly expenditure on all consumption goods (*totexp*). Before embarking on the estimation of expenditure elasticities, it is useful to assess the distribution of these income and expenditure-related variables across households, and the relations between them. Consequently, for all these variables, their mean values by region and by zone were calculated (Table 3-8). The figures in Table 3-8 are consistent with earlier results, showing again that relatively higher income and expenditure levels are found in the Central region, and in urban areas. However, expenditures on food eaten away from home are an exception in this respect, being higher in the rural areas of Huetar Atlántico than in the rural areas of the Central region. The lowest mean income and

[6] For more information about income levels and distribution in Costa Rica, see Baldares (1984).

expenditure are mostly found in the Chorotega, Pacífico and Brunca regions. Households in Atlántico and Huetar Norte belong mostly to the middle income and expenditure group.

Table 3-8: Means of income and expenditure variables (in ¢ per month), by region and zone, 1987-1988

	REGION					
	Central	Choro-tega	Pacífico	Brunca	Huetar Atlántico	Huetar Norte
ZONE						
Urban						
Total household income	37,094	25,510	22,042	22,485	28,195	32,634
Total income per capita	10,232	7,381	6,097	5,436	7,944	8,565
Total household food exp.	8,829	6,497	6,615	6,303	8,215	7,224
Household food exp. away from home	2,124	1,279	1,675	845	1,232	1,302
Total household exp.	30,445	19,024	17,720	16,874	21,347	23,168
Rural						
Total household income	24,583	16,232	15,996	16,798	20,988	21,488
Total income per capita	6,110	3,631	3,892	3,932	4,942	4,983
Total household food exp.	7,123	5,890	5,059	5,625	6,994	6,396
Household food exp. away from home	1,256	921	595	734	1,462	1,139
Total household exp.	19,413	12,423	13,894	13,210	16,068	18,895

F-tests were used to draw conclusions based on statistical inference regarding the existence of a region and zone effect on average income and expenditure levels, as well as interaction effects between regions and zones. The results (not listed) were significant for the single effects of regions and zones, implying that it is unlikely that income and expenditure levels are the same across regions and zones. At the 10 per cent significance level, there was an interaction effect of region and zone on the variables *foodout* and *totexp*. This means it is not particularly useful to continue with hypothesis testing of the single effects of regions and zones, since they jointly affect both *foodout* and *totexp*.

Since there exist clear regional and zonal effects for all income and expenditure variables, as well as an interaction effect for the *foodout* and *totexp* variables, it is useful to investigate the effects of individual variables. Regression models were estimated which relate income and expenditure variables (*i.e.*, *foodexp*, *totalinc* and *inccap*) to dummy variables for regions and zones, and to the interval variable household size. The right-hand side of the regression model was identical for the three latter dependent variables, as follows:

$$\beta_0 + \beta_1 x_{\text{household members}} + \beta_2 x_{\text{Atlántico}} + \beta_3 x_{\text{Brunca}} + \beta_4 x_{\text{Central}} + \beta_5 x_{\text{Chorotega}} + \beta_6 x_{\text{Norte}} + \beta_7 x_{\text{Urban}} + \xi.$$

The regression models with *totexp* or *foodout* as the dependent variable included only the interaction effects of regions and zones, and an interval variable for the number of household members, as explanatory variables since earlier F-tests suggested significant interaction effects of regions and zones on these two dependent variables. The right hand side of the regression model for these two variables is therefore:

$\beta_0 + \beta_1 x_{household\ members} + \beta_2 x_{Atlántico/Rural} + \beta_3 x_{Atlántico/Urban} + \beta_4 x_{Brunca/Rural} + \beta_5 x_{Brunca/Urban} + \beta_6 x_{Central/Rural} + \beta_7 x_{Central/Urban} + \beta_8 x_{Chorotega/Rural} + \beta_9 x_{Chorotega/Urban} + \beta_{10} x_{H.Norte/Rural} + \beta_{11} x_{H.Norte/Urban} + \beta_{12} x_{Pacífico/Urban} + \xi$.

The results of both regression specifications are shown in Table 3-9 and Table 3-10, respectively. As before, the reference households (included in the intercept term) live in the rural areas of the Pacífico region.

Table 3-9: Regression[7] of total food expenditure, total income and total income per head (in ¢ per month), on household size and regional and zonal dummy variables, 1987-1988

Variable	Total household food expenditure		Total household income		Total per capita income	
	ß	t-value	ß	t-value	ß	t-value
Household members	709.11	18.89	2045.75	13.26	-828.84	-16.45
Dummy Atlántico	1614.80	14.89	6103.63	4.50	1630.10	3.68
Dummy Brunca	-15.65	-0.05	1094.56	0.81	657.14	1.50
Dummy Central	2022.60	7.34	11628.18	10.27	3310.13	8.95
Dummy Chorotega	408.62	1.27	1709.07	1.29	768.21	1.78
Dummy Huetar Norte	660.85	1.94	6443.80	4.60	1777.76	3.89
Dummy urban	1717.62	9.30	10370.02	13.66	2808.87	11.33
(Constant)	1856.75	6.06	4739.56	3.77	224.43	17.57
F-value	52.17		85.15		95.21	
R-square	0.12		0.13		0.15	

The results in Table 3-9 again confirm a strong positive effect of size on all three dependent variables. In spite of the fact that larger households have higher total income than smaller ones, their per capita income is lower. Total expenditure on food for the household as a whole increases with approximately 35 per cent (709/2046) of the increase in total income that results from adding an additional member. The coefficient of the urban area dummy variable is positive and significant in all three regressions in Table 3-9. This result should be interpreted relative to the income and expenditure levels of reference households in rural areas of the Pacífico region. As indicated before, income and expenditure levels in the Central, Huetar Norte and Huetar Atlántico regions are substantially higher than in the other three regions. The coefficients of the dummy variables for Chorotega and Brunca are not significant, *i.e.*, their income and expenditure levels are not significantly different from those in the Pacífico region. The size of the coefficients is consistent with the information in Table 3-8. Income differences between the Central, Huetar Norte and Huetar Atlántico regions on the one hand, and Pacífico on the other hand, are approximated by the size of the corresponding regression coefficients (relative

[7] Both the White and Glejser tests (Maddala, 1992) failed to detect heteroskedasticity.

to households living in the rural parts of the Pacífico region). For example, *ceteris paribus*, the estimated difference between total food expenditure of households located in the urban parts of the Central region and that of reference households (equal to ¢ 3741 (= ¢ 2023 + ¢ 1718)) is very close to the actual difference (¢ 3770 (= ¢ 8829 - ¢ 5059), see Table 3-8). However, not all the predictions are this accurate, because of likely misspecification and possible multicollinearity effects which must be kept in mind when drawing conclusions from Table 3-9.

Table 3-10: Regression[8] of expenditure on food away from home, and total expenditure on all consumption goods (in ¢ per month), on household size and interaction dummy variables for region and zone, 1987-1988

Variable	Total household expenditure		Household food exp. away from home	
	ß	t-value	ß	t-value
Number of household members	1302.63	9.18	152.77	7.82
Dummy Atlántico/rural	2352.61	1.42	902.52	3.96
Dummy Atlántico/urban	8382.14	4.19	649.35	2.36
Dummy Brunca/rural	-1050.03	-0.67	0.83	0.00
Dummy Brunca/urban	3627.26	1.57	235.85	0.74
Dummy Central/rural	5665.10	3.65	622.84	2.91
Dummy Central/urban	16070.09	11.04	1398.62	6.98
Dummy Chorotega/rural	-1869.35	-1.15	252.38	1.13
Dummy Chorotega/urban	7910.93	4.07	887.02	3.32
Dummy Huetar Norte/rural	3232.00	2.01	449.93	2.03
Dummy Huetar Norte/urban	9486.97	3.61	823.02	2.27
Dummy Pacífico/urban	4837.12	2.75	1066.18	4.40
(Constant)	7651.98	5.34	-100.62	-0.51
F-value	34.94		13.84	
R-square	0.10		0.04	

The figures in Table 3-10 also show a positive and highly significant influence of household size on both expenditure variables. However, an additional household member increases expenditure on food away from home by only ¢ 153, while expenditure on all consumption goods increases by ¢ 1,303. This implies that larger households spend relatively less on food away from home compared to smaller households. The F-test indicates the presence of a significant overall interaction or joint effect of regions and zones on both expenditure on food away from home and on total consumption expenditure (results not listed). To determine which of the interactions are significant, eleven dummy variables were included in the regression models (Table 3-10). Where the interaction dummy variables resulted in significant coefficients, they were virtually equal to the actual differences in expenditure between households in question and reference households (compare Table 3-8 and Table 3-10). Nevertheless, misspecification and possible multicollinearity effects should be kept in mind when drawing conclusions from Table 3-10 also.

[8] Both the White and Glejser tests (Maddala, 1992) failed to detect heteroskedasticity.

It is often useful to quantify the strength of the association between two variables by calculating a summary index. Consequently, the Pearson correlation coefficient (Norusis, 1993) was calculated for all five income and expenditure variables (Table 3-11). Correlation matrices for the various regions and zones are given in Appendix VI. For the whole of Costa Rica the weight factor was used, but not for the partial analysis for regions and zones. For the purposes of this study, the correlations between *totalinc* and *totfood*, and *totalinc* and *totexp*, are considered the most interesting. The correlation between *totalinc* and *totfood* is 0.48 for Costa Rica, with relatively little regional variation. The correlation between *totalinc* and *totexp* for the whole country is 0.73, again with very similar correlations across regions, ranging from 0.72 to 0.76.

Table 3-11: Correlations between the various income and expenditure variables, Costa Rica

	Total household income	Total per capita income	Household food expenditure	Food exp. away from home	Total household expenditure
Total household income	1.00				
Total income per capita	0.70	1.00			
Household food expenditure	0.48	0.21	1.00		
Food exp. away from home	0.43	0.25	0.27	1.00	
Total household expenditure	0.73	0.51	0.56	0.62	1.00

3.4. FOOD EXPENDITURE SHARES

Usually the interest in food demand analysis centers on drawing conclusions regarding food expenditure in relation to welfare levels. Absolute expenditure values are of limited value in this respect since they fail to take account of household size, characteristics of individual household members, income level, etc. Consequently, a more useful way of looking at food expenditure is by concentrating on food expenditure in relation to income. One such approach is the one originally developed by Engel (Deaton and Muellbauer, 1980a). Engel's observation was that poorer households spend a higher share of their total expenditure on food as compared to richer households (Engel's law). Engel also observed that the same tends to be true for large versus small households, at a given level of total expenditure. This suggests that the share of food (and perhaps of other commodities whose shares vary systematically with total expenditure as well) can be used as an indirect indication of welfare. Thus, two households with similar food shares must have similar incomes, irrespective of differences in household size. Hence, a comparison of their income at the same food share will yield an index of the cost of maintaining the larger relative to the smaller household (this is called the equivalence scale). This makes it interesting to investigate the percentage share of food expenditure in total household income or expenditure, and investigate whether this share differs between regions and zones.

To verify Engel's law in the case of Costa Rica, eight income strata were constructed, each of which included an equal number of households. Table 3-12 presents total food expenditure as a percentage of both total expenditure and total income. Both food expenditure percentages decline with income. Thus, Engel's law holds true, and a F-test was performed to assess whether the percentages differ significantly between the various income strata. The null hypothesis of no difference in percentage food expenditure between income strata is rejected for both measures of relative food expenditure (F-values of 98.3 and 103.4 for *foodexp/totexp* and *foodexp/totalinc*, respectively). Thus, the higher the income, the lower the percentage that is spent on food. For example, while the highest income stratum spends 17.4 per cent of total household income on food, the lowest income stratum spends 62.6 per cent. The two relative food expenditure measures can be expected to differ between regions and zones because of spatial differences in income. For example, since household income tends to be the highest in urban areas and in the Central region, food shares can be expected to be relatively low in these areas (assuming no spatial price differences). The opposite is true for rural areas and, *e.g.*, the Brunca and Chorotega regions.

Table 3-12: Relative total food expenditure by income stratum (¢)

	Household total income (¢) strata							
	< 7,999	7,999 - 12,326	12,327- 16,113	16,114- 20,594	20,595- 26,117	26,118- 34,698	34,699- 50,836	> 50,836
Food share 1	52.9	47.5	44.7	42.2	42.3	34.9	35.5	26.5
Food share 2	62.6	45.1	43.0	37.5	35.5	26.9	24.9	17.4

Notes:
- food share 1: total food expenditure as a percentage of total expenditure
- food share 2: total food expenditure as a percentage of total income

3.5. CONCLUSIONS

The statistical analyses in this chapter have demonstrated that models aimed at explaining food consumption patterns in Costa Rica need to explicitly take account of geographical location of households (in terms of planning regions and zones, *i.e.*, urban or rural location) as well as of their size. The number of households interviewed differs significantly between both regions and zones. While size does not exhibit significant differences between regions, rural households are significantly larger than those in urban areas. More important, however, is the existence of significant inter-household variation in most income and expenditure-related variables. Income (total and per capita) and expenditure variables (total consumption expenditure, total food expenditure, and expenditure on food away from home) are shown to significantly differ between households, depending on both size and geographical location. Finally, Engel's law, stating that the share of total income spent on food bears a negative relationship with total income level, was verified and found to hold true.

4. METHODOLOGY

4.1. MODEL SPECIFICATION

The principal aim of this study is to estimate Engel functions and to calculate related expenditure and price elasticities. Two relatively simple standard single demand functions from which such elasticities can be derived include the iso-elastic or double logarithmic function, and the semi-logarithmic function (Cramer, 1969). Other, more extended, specifications of Engel functions, including the double logarithmic quadratic (DLQ) model, are given by Wold and Jureen (1953), Aitchison and Brown (1957), and Prais and Houthakker (1971). The most common complete models used in the literature to calculate price and income or expenditure elasticities are the linear expenditure system (LES) and the almost ideal demand system (AIDS).

The LES, introduced for the first time by Klein and Rubin (1947), was popularized by Stone (1954b). In view of neo-classical demand theory and in order to not loose its linearity, the LES imposes three general restrictions on the demand structure, *i.e.*, additivity, homogeneity and symmetry[9]. Advantages of the LES include its compatibility with economic theory and relatively simple interpretation. On the other hand, the LES is rather restrictive; *e.g.*, it does not allow for inferior goods, implies that all goods are complements, and its linear Engel functions are not usually supported by empiricism (Sadoulet and de Janvry, 1995).

The AIDS represents another complete, theoretically plausible model which satisfies the general restrictions of demand systems. Described in Deaton and Muellbauer (1980a), it builds upon models originally developed by Working (1943) and Leser (1963) and does not impose the severe substitution limitations implied by additive demand models such as the LES (Deaton and Muellbauer, 1980b). Advantages of an AIDS system include its relative ease of estimation (linear estimation techniques can be employed) and the fact that it can be used to test for homogeneity and symmetry through linear restrictions on certain parameters. However, imposition of homogeneity, additivity, and symmetry conditions would render the AIDS restrictive, *i.e.*, would make the AIDS model inconsistent with most actually observed food consumption behavior (Wohlgenant, 1984). Both homogeneity and symmetry, basic to the assumptions of a linear budget constraint, are consistently rejected by the data (Deaton and Muellbauer, 1980a). Another drawback of the AIDS is the restriction that a luxury good cannot become a necessity and *vice versa*, irrespective of changes in income or expenditure levels.

It can be concluded that the imposition of the basic three restrictions of demand upon the LES and the relative inflexibility of the AIDS imposes strong restrictions on the data. In addition, food expenditure surveys may result in upwardly biased expenditure elasticity estimates for food staples and calorie-income relationships (Bouis, 1994). Such biased estimates for basic foods may

---

[9] Additivity (also called Engel aggregation) means that, in any period, the sum of the value of the demands for individual goods equals total expenditure, *i.e.*, the sum of income elasticities weighed by the expenditure shares equals one. Homogeneity of degree zero (also called 'absence of money illusion') means that when prices as well as income undergo a similar relative change, demand structure will not change, *i.e.*, the sum of the income elasticity of a good and its price elasticities (own and cross) equals zero. Symmetry means that the sum of the cross-price elasticities of demand and income elasticity is symmetric, for all products $i \neq j$.

in turn cause biased elasticity estimates for non-staples in case of estimation of complete demand systems. Combining the fact that the data used in this study guarantee a relatively large number of degrees of freedom (3,908 observations) with the aforementioned drawbacks of LES and AIDS, led to the choice of a single equation model to estimate the demand parameters. Even though single equation models may be less satisfactory from a theoretical point of view[10], their performance is not necessarily inferior to that of complete system models in terms of fit to past experience and ability to project in the future (Brown and Deaton, 1972).

As in Timmer (1981) and Lizano (1994), a DLQ single equation model was used. Since, in view of their systematic rejection by the data and to preserve the flexibility of the model, the basic restrictions of adding up, homogeneity and symmetry are not imposed on the DLQ equation, the resulting estimates will, in the strict sense, not conform to theory.

Based on the above discussion and taking into account the findings in the previous chapter, the following specification was estimated:

$$\ln \exp_i = \alpha_i + \beta_i \ln x + \gamma_i (\ln x)^2 + \delta_i \ln p_i + \varphi_i (\ln p \cdot \ln x) + \lambda_i \ln N + \kappa_i \ln CPI + \mu_i z + \sum_{m=1}^{5} v_{im} r_m \qquad (1)$$

where

$\exp_i$	per capita expenditure on category i (i = 1 to 24) (¢ per month)
x	per capita total expenditure per month (Colones)
p_i	price of good i (¢)
N	household size (number of members)
CPI	general monthly consumer price index
z	dummy for the zone where the household is situated (rural=0, urban=1)
r_m	dummy for the region where the household is situated (reference region: Brunca)

In this study, per capita total consumption expenditure instead of per capita income was used which is acceptable given a high correlation of 0.75 between the two. Furthermore, if there exists a measurement error in income, there will be a corresponding measurement error in consumption expenditure, and *vice versa*. Indeed, when expenditure and income elasticities were estimated for a number of different food categories, they turned out to be quite similar (Table 4.1). The implicit assumption made is that total consumption expenditure is weakly separable from non-consumption expenditure, meaning that the conditional ranking of various categories in consumption expenditure is independent of non-consumption expenditure (Appendix I). The logarithm of per capita total expenditure was used to minimize the effect of differences in household size between families and the resulting relation between household size and the size of total expenditure (Deaton, 1989b). *A-priori* it is expected that per capita total expenditure will have a positive effect on per capita expenditure on a particular category i (i = 1 to 24).

[10] Estimation of single demand functions creates the problem that predictions may not satisfy the budget constraint. Moreover, rendering them inadequate for use in complete models such as multimarkets and general equilibrium models (Sadoulet and de Janvry, 1995). In a simultaneous estimation of a food demand model, the adding up restriction would be satisfied only when total food expenditure instead of total consumption expenditure would be used. Geurts (1994), using single equation demand models, used total food expenditure as an independent variable and obtained implausibly high expenditure elasticities for all food categories. Jansen *et al.* (1996) found a simple approximation to transform these high expenditure elasticity estimates into acceptable values.

Table 4-1: Expenditure and income elasticities for fats, beans and meat, 1987-1988

	Beans		Butter & other fats		Meat	
	Exp. elast.	Inc. elast.	Exp. elast.	Inc. elast.	Exp. elast.	Inc. elast.
Quartile 1	0.24	0.21	0.55	0.52	1.45	1.36
Quartile 2	0.21	0.20	0.51	0.49	1.17	1.13
Quartile 3	0.20	0.19	0.49	0.47	0.99	1.01
Quartile 4	0.17	0.17	0.45	0.43	0.72	0.78

Most popular demand models are of rank two, *i.e.*, have expenditure (Engel) functions which are linear in the logarithm of total expenditure. However, some empirical studies have suggested that a more flexible specification is required (Musgrove, 1978; Timmer, 1981; Banks and Lewbel, 1992; Dobbelsteen and Kooreman 1993; Park *et al.*, 1996). Since both income and price elasticities tend to vary with income, especially in developing countries, the use of more flexible forms allows a commodity to be a necessity at some expenditure levels and a luxury or inferior good at other levels. Consequently, the expenditure equations in this study include a quadratic logarithmic expenditure term which results in Engel functions of rank three, allowing for the possibility that commodities are luxury, necessary or inferior goods at different levels of income. A negative quadratic total expenditure term should guarantee concave-shaped Engel curves. On the other hand, even though introducing flexibility in the Engel function with a quadratic term appears to be generally attractive, its usefulness always depends on the available data set. Attention must be paid to potential multicollinearity between the logarithmic expenditure term and its quadratic form which may lead to non-concave Engel curves (see also section 5.3).

Own-price is expected to exert a negative influence for price elastic commodities[11]. Even though the use of own-price as an explanatory variable in demand models based on cross-section data is somewhat controversial as prices often do not vary enough to calculate price elasticities, price variation in the NHIES was considerable and is a result of timing of interviews, transaction costs and poorly integrated markets. Another frequently encountered problem is that market prices are usually not directly available in cross-section data and must be approximated by unit values calculated by dividing expenditure by quantity. However, Deaton (1988, 1990) warns against using unit values as a proxy for market prices when estimating elasticities. Measurement errors in quantities consumed result in a spurious negative correlation with unit values. Moreover, since the latter reflect both price and quality, they will tend to vary less than price, which may result in an overestimation of the "true" price elasticities. Lizano (1994), using data from the NHIES, found that unit prices have enough variation to include in the specification and do not contain significant biases due to quality differences. Kreijns (1993) also found significant (α=5%) price differences between regions and zones. Therefore, in this study, unit values were used as a proxy for prices. The interaction term of per capita expenditure and the unit price of a good allows price elasticities to vary according to total expenditure level. A positive interaction term of own-price and incomeis plausible because expenditure on a normal good is usually less

[11] For detailed explanation see equation (8).

sensitive (resulting in lower absolute elasticity values) for price and expenditure changes at higher income levels.

The monthly consumer price index[12] is included for two reasons, the first of which is to pick up effects of other prices on the demand for good *i* where the share of the latter in total expenditure is assumed to be small. In addition, since the time of interview may influence the budget share of most food categories, it is important to take possible seasonal price differences into account. Unfortunately, CPI represents an average overall price index since the CPI for food products only was unavailable to the researchers; nevertheless, its coefficient can be expected to be positive and negative for substitutes and complementary goods, respectively (Henderson and Quandt, 1980). The second reason to include the CPI as an explanatory variable in the model is its traditional role of deflating nominal economic variables.

As already mentioned in section 2.2.2, average per capita consumption is calculated without using equivalent weights for the number of members. This drawback is partly corrected by using size as an explanatory variable. As discussed earlier in the previous chapter, inclusion of the size variable is also needed to correct for the relation between size and per capita total expenditure (or income). Exclusion of this variable is likely to lead to correlation between the per capita total expenditure variable and the error term. Per capita expenditure is expected to be negatively influenced by size, as larger households normally have lower per capita income as well as expenditure. Moreover, larger households may be more efficient in their use of foods (*i.e.*, less wastage due to economies of scale in food preparation, storage and consumption). On the other hand, for relatively poor households, the coefficient for size may be positive for staple foods, since the only way to survive for members of such households might be to increase their consumption of relatively cheap food items.

The effect of regional differences in food demand patterns are accounted for by dummy variables. The six different regions are represented by the inclusion of five dummies. Likewise, differences in food consumption patterns between the two zones (*i.e.*, urban and rural) are represented by one dummy variable.

4.2. MODEL ESTIMATION

The short time span of only eight consecutive days during which an individual household was interviewed four times resulted in a relatively large number of zero expenditure observations in the data. Thus, since the dependent variable contains both positive and zero values, the use of the Ordinary Least Squares (OLS) method to estimate equation (1) would be inappropriate. In case of substantial proportions of zero expenditure observations, the error term can no longer be expected to have a zero mean and applying OLS to the observed data could yield biased and inconsistent estimates (Maddala, 1992). Consequently, Tobit (Tobin, 1958; Greene, 1981) and Cragg specifications (Cragg, 1971; Haines *et al.*, 1988; Blisard and Blaylock, 1993; Burton *et al.*, 1994) instead of standard linear regression models, were used to estimate equation (1) for each of the 24 food product categories considered in this study.

[12] Calculated by DGEC as follows, for the period November 1987 -November 1988: 100, 102.2, 103.7, 107.7, 109.7, 111.7, 112.3, 113.8, 115.0, 116.1, 118.1, 121.7 and 123.2.

4.2.1. Tobit models

The Tobit model, first used by Tobin (1958) to deal with the non-consumption problem, is defined as follows (ignoring any non-linear terms for simplicity of exposition):

$$\exp_i^* = \beta_0 + \sum_{j=1}^{k} \beta_j x_{ij} + u_i \tag{2}$$

where $\exp_i^*$ is the expenditure per capita on good i, x denotes a vector of explanatory variables, and u_i is an error or disturbance term.

A Tobit model is derived from an underlying classical normal linear regression, in which $\exp_i^*$ is not directly observed. Starting from equation (2), Tobit models assume that $\exp_i^*$ is observed if $\exp_i^* > 0$, and is not observed otherwise. The observed $\exp_i$ is then defined as follows:

$$\exp_i = \begin{cases} \exp_i^* = \beta_0 + \sum_{j=1}^{k} b_j x_{ij} + u_i & \text{if } \exp_i^* > 0 \\ 0 & \text{if } \exp_i^* \leq 0 \end{cases} \tag{3}$$

The Tobit model is also known as the censored normal regression model, because some observations on $\exp_i^*$ (*i.e.*, those for which $\exp_i^* \leq 0$) are censored (Maddala, 1983). The maximum likelihood estimation method is used to estimate the coefficients of the Tobit model. OLS estimators are used as starting values for the algorithm which, in most cases, is Newton's iterative method (Olsen, 1978).

Since the Tobit model uses both non-zero and zero observations in the estimation process, it is the preferred model from a theoretical point of view. Nevertheless, it has a number of shortcomings. For example, even though the dependent variable $\exp_i^*$ can, in principle, take on negative values, they are not observed because of censoring. Thus, in a sense, part of the information in the sample is lost because negative values for $\exp_i^*$ are ignored. On the other hand, expenditure data cannot assume negative values, and the observed zero values are not due to censoring, but rather to the underlying purchasing decision-making process of individual consumers. Thus, in theory, the estimation procedure could be improved by modelling the decisions that produce the zero observations, rather than by using the Tobit model mechanically (Maddala, 1983). Another commonly encountered reason for zero observations in cross section expenditure data is the occurrence of infrequency-of-purchases, *i.e.*, certain products, though regularly consumed by the household, are not bought during the period covered by the survey (Blisard and Blaylock, 1993).

Another drawback of the Tobit model is that it assumes that all households are potential purchasers (*i.e.*, participate in the market) and would buy beyond certain 'threshold' levels of price and income. If relatively few households actually consume a particular product or most consumers purchase it infrequently, the Tobit model likely will distort the effect on expenditure of a change in prices and/or total expenditure. In the Tobit model, both the decision to consume and the quantity to consume, depend on one and the same set of coefficient estimates, while it has been shown that these decisions may be separate decisions that depend on different sets of variables, or on the same variables but with different parameter estimates (Haines *et al.*, 1988; Blisard and Blaylock, 1993; Burton *et al.*, 1994).

4.2.2. Cragg models

To account for zero expenditures, this analysis employs so-called 'double hurdle' models. These offer a useful extension of the Tobit approach since they permit separate analysis of the decisions whether, and how much, to consume. The Cragg specification can be considered as a simplified version of the double hurdle approach (Cragg, 1971; Haines *et al.*, 1988) and allows for two model interpretations: the 'market participation' model and the 'infrequency-of-purchase' model (Blisard and Blaylock, 1993). Such models are also known in the literature as generalizations of the Heckman procedure (Heien and Wessells, 1990; Heien and Durham, 1991).

The market-participation model, originally suggested by Cragg (1971), can be applied to food categories which are not consumed by every survey participant. A Probit regression estimates the probability of a household participating in the market, and for participating households, a consumption or expenditure equation is estimated. Zero expenditure indicates that the purchase was not made, either because of a relatively high price or because of low income.

Product categories that can be expected to be consumed by all households though bought at infrequent intervals, can be modelled with an 'infrequency-of-purchase' model which again is an extension of the original Cragg specification. In exactly the same fashion as for the market-participation model, the probability of observing a purchase is directly modelled in a Probit equation, and for those households who actually bought the product during the time of the survey, a consumption or expenditure equation is estimated. Observing a zero expenditure indicates that, even though the household does participate in the market for the product in question, it did not purchase the product during the period covered by the survey. The household may however, consume out of storage.

Given both interpretations of the same mathematical model, the researcher faces the question of which model interpretation applies. Cross-section data normally does neither contain information about whether or not a household ever consumes the product modelled nor, if consumption takes place, about its frequency of purchase. In this study, all demand equations were estimated using both Tobit and Cragg model specifications. The implicit restrictions in the Tobit specification are tested against the (unrestricted) Cragg specification. All storable items that are a basic part of the diet (*e.g.*, rice, beans) and therefore are likely to be consumed by all households (even if not necessarily purchased during the time of interrogation), were estimated with an infrequency-of-purchase model. Other items were estimated with the market-participation model.

The complete Cragg model consists of a Probit model plus a separate truncated regression model for the positive expenditures. Probit models (Greene, 1991; Maddala, 1992) assume that the basic regression model is specified as in (2), where $\exp_i^*$ is a 'latent' variable which is not observed, and u_i represents an error term. Observed is a dummy variable $\exp_i$ which is defined as follows:

$$\exp_i = \begin{cases} 1 & \text{if } \exp^* > 0 \\ 0 & \text{if otherwise} \end{cases} \tag{4}$$

All available observations are used for the Probit model, where the dependent variable assumes a value of either zero or one. In the infrequency-of-purchase version of the Cragg specification, $\exp_i = 1$ if a household purchases the product during the time of interrogation, while $\exp_i = 0$ if the household does not purchase the product during the time of interrogation. In the market-participation model version of the Cragg specification, $\exp_i = 1$ if the household ever buys the product, while $\exp_i = 0$ if the household does not participate in the market for that product.

If $\exp_i$ is observed (*i.e.*, $\exp_i > 0$), the βs in (2) can be estimated. Combining (2) and (4) yields

$$P_i = \text{Prob}\left(\exp_i = 1\right) = \text{Prob}\left[u_i > -\left(\beta_0 + \sum_{j=1}^{k} \beta_i x_{ij}\right)\right]$$
$$= 1 - F\left[-\left(\beta_0 + \sum_{j=1}^{k} \beta_i x_{ij}\right)\right]$$

where F is the cumulative distribution function (CDF) of u. If this CDF is symmetric, *i.e.*, 1 - F(-Z) = F(Z), we can write:

$$P_i = F\left(\beta_0 + \sum_{j=1}^{k} \beta_j x_{ij}\right) \quad (5)$$

If the errors u_i in (2) follow a normal distribution, the Probit model results.

To summarize, in the Cragg specification, a Probit model is used as an indicator of whether $\exp_i^*$ is positive or not, while a truncated regression model is employed for the nonlimit (positive) observations. Both Probit and the truncated regression estimate equation (1) with the same set of explanatory variables; the only difference is that Probit uses a dummy dependent variable while the truncated regression uses only observations with a positive value for $\exp_i$.

4.3. MODEL SELECTION

The Cragg model can be regarded as an extended version of the Tobit model where the probability of a nonlimit outcome is determined separately from the level of the nonlimit outcome. As described in the previous section, the Cragg model can simply be given by:

$$\text{Prob}\left[exp^* > 0\right] = \Phi\left(\gamma' z\right),$$
$$\text{Prob}\left[exp^* \leq 0\right] = 1 - \Phi\left(\gamma' z\right), \quad (6)$$
$$\text{if } \exp^* > 0, \text{ a truncated regression in } \beta' x$$

Here z and x are vectors of explanatory variables, and γ and β are vectors of unknown coefficients. Equations (6) represent a combination of the Probit model and the truncated regression model. The Tobit model results if it is assumed that $z = x$ and $\gamma = \beta$. Given the first assumption, the second is a testable restriction. The log-likelihood of the unrestricted model is simply the sum of those of the Probit model and the truncated regression model. This can be compared to the log-likelihood for the Tobit model, in order to determine the preferred model specification (Lin and Schmidt, 1983; Greene, 1991).

4.4. ELASTICITIES

Expenditure and price elasticities measure the relative change in per capita expenditure on good *i* due to a change in per capita total expenditure and in the own-price of good *i*, respectively. Coefficient estimates in a simple double logarithmic specification represent elasticities which are therefore constant at all expenditure levels. However, inclusion of quadratic expenditure and price-expenditure interaction terms in the DLQ model allows elasticities to vary according to total expenditure level. The derivation of price and expenditure elasticities is shown in equations (7) through (9).

Price elasticity estimates obtained from an expenditure equation need some correction before they can be interpreted as a price elasticity of demand. Expenditure on item *i* equals the price of *i* (p_i) multiplied with the quantity of *i* demanded (q_i), *i.e.*,

$$\ln(\exp_i) = \ln(p_i) + \ln(q_i)$$

$$\frac{\partial \ln(\exp_i)}{\partial \ln(p_i)} = 1 + \frac{\partial \ln(q_i)}{\partial \ln(p_i)}, \text{ where } \frac{\partial \ln(q_i)}{\partial \ln(p_i)} \text{ is the price elasticity of demand} \tag{7}$$

Thus, the price elasticity of demand is obtained by subtracting one from the calculated price elasticity of the expenditure equation.

On the other hand, expenditure ($\exp_i$) and income (x_i) elasticity estimates obtained from a demand or expenditure equation are similar, as long as the price of *i* is assumed to be independent of expenditure/income:

$$\frac{\partial \ln(\exp_i)}{\partial \ln(x_i)} = \frac{\partial \ln(p_i)}{\partial \ln(x_i)} + \frac{\partial \ln(q_i)}{\partial \ln(x_i)}, \text{ where } \frac{\partial \ln(q_i)}{\partial \ln(x_i)} \text{ is the income elasticity of demand, and}$$
$$\frac{\partial \ln(p_i)}{\partial \ln(x_i)} \text{ is assumed to be zero} \tag{8}$$

The demand elasticities from expenditure equation (1) are as follows:

$$\ln \exp_i = \alpha_i + \beta_i \ln x + \gamma_i (\ln x)^2 + \delta_i \ln p_i + \varphi_i (\ln p \cdot \ln x) + \lambda_i \ln N + \kappa_i \ln cpi + \mu_i z + \sum_{m=1}^{5} \nu_{im} r_m$$

Expenditure elasticity, η

$$\eta = \frac{\partial \exp / \exp}{\partial x / x} = \beta + 2\gamma \ln x + \varphi \ln p$$

Price elasticity of demand, e

$$e = \frac{\partial \exp / \exp}{\partial p / p} - 1 = \delta + \varphi \ln x - 1$$

(9)

When multicollinearity problems preclude the inclusion of the interaction term (ln*p*·ln*x*) in expenditure equation (1), the resulting expenditure elasticity estimate becomes independent from the own-price variable, whereas the price elasticity estimate becomes independent from per capita total expenditure.

Expenditure and price elasticities are calculated by income quartile, using average per capita expenditure and average own-price for each quartile. A t-test[13] is used to determine whether the elasticity estimates are significantly different from zero (Cramer, 1986; Lizano, 1994). Statistically it is possible that price elasticity estimates are significantly different from zero without even the individual own-price variable coefficient estimates in equation (1) being significant.

13

If e is an elasticity as a function g of two variables θ_1 and θ_2

$$e = g(\theta), \qquad \theta = (\theta_1, \theta_2)$$

Then $\mathrm{var}\, e = G V\left(\hat{\theta}\right) G^T$, $\quad G = \left[\frac{\partial g(\theta)}{\partial \theta_1}, \frac{\partial g(\theta)}{\partial \theta_2}\right]$, V = covariance matrix

Test statistic $t_e = \dfrac{e}{\sqrt{\mathrm{var}\, e}}$

In the case of the income and price elasticity, $\sqrt{\mathrm{var}\, e}$ can be calculated as follows:

$$\sqrt{\mathrm{var}\,\eta} = \sqrt{\mathrm{var}\,\beta + 4(\ln x)^2 \mathrm{var}\,\gamma + (\ln p)^2 \mathrm{var}\,\varphi + 4(\ln x)\mathrm{cov}\,\beta\gamma + 2(\ln p)\mathrm{cov}\,\beta\varphi + 4(\ln x \ln p)\,\mathrm{cov}\,\gamma\varphi}$$

$$\sqrt{\mathrm{var}\,\varepsilon} = \sqrt{\mathrm{var}\,\delta + (\ln x)^2 \mathrm{var}\,\varphi + 2 \ln x \,\mathrm{cov}\,\delta\varphi}.$$

Reliable estimates of expenditure and price elasticities provide indispensable information for national food policy making (Pinstrup-Andersen *et al.*, 1976; Lizano, 1994). Expenditure elasticities allow a classification of food groups into necessary, luxury and inferior goods, with $\eta < 1$, $\eta > 1$ and $\eta < 0$, respectively (Varian, 1978). Equation (9) explicitly allows for a food category to be a luxury good at relatively low per capita total expenditure levels, though a necessary good at high per capita total expenditure levels. The reliability of the expenditure elasticity (η), depends on three parameter estimates (*i.e.*, β, γ and φ) and as well as the average of $\ln x$ and $\ln p$. The reliability of the price elasticity, e, depends on two parameter estimates (*i.e.*, δ and φ) as well as the average of $\ln x$.

When estimating simple double logarithmic specifications, it is usually expected that the coefficients for own price are negative, resulting in negative own-price elasticity estimates. From equation (9), however, it is obvious that, in case a price-expenditure interaction term is included in the model, the coefficient for own price (δ) does no longer have to be negative to obtain a negative own price elasticity estimate. In most cases, the expenditure effect (φ) can be expected to be non-negative, indicating that the price elasticity increases with total expenditure (or, in other words, that demand becomes more price inelastic at higher total expenditure levels). In case of a zero estimate for δ, the price elasticity can be calculated as $e = \delta - 1$. Thus, as long as $\delta < 1$, $e < 0$. If $0 < \delta < 1$ or if $\delta < 0$, demand is price inelastic and price elastic, respectively. In case of a positive φ, demand is price elastic if $\delta < -\varphi \cdot \ln x$, while demand is price inelastic if
$-\varphi \cdot \ln x < \delta < 1 - \varphi \cdot \ln x$.

5. EMPIRICAL RESULTS

5.1. INTRODUCTION

Using specification (1) with 3,908 observations, expenditure equations were estimated for all food categories listed in Appendix II. Even though the use of the Tobit model is widespread in the analysis of household budget data, in this study each expenditure equation was estimated twice, *i.e.*, using both Tobit and Cragg model specifications. The restrictions implied in Tobit model compared to those of the Cragg model were tested using the Log Likelihood Ratio[14] statistic.

In spite of the typical difficulties associated with the use of cross-sectional market price data (see section 4.1), it was nevertheless attempted to obtain significant price coefficient estimates. Potential spatial differences between regions and zones were modelled by the inclusion of appropriate binary variables. The model specification also included a variable which represents household size.

5.2. LIMITATIONS OF ESTIMATION RESULTS

Before presenting the results of the Tobit and Cragg model estimations in sections 5.3 and 5.4, this section discusses some aspects that are important to keep in mind when interpreting the results of this study. While some of these aspects are valid for all food categories, others apply to only a few of them.

The first aspect relates to infrequency-of-purchases. Regularly consumed goods which are coincidentally not bought in the period covered by the survey result in zero observations, even though in reality households do consume them. Unlike the Tobit model which cannot deal with the infrequency-of-purchase phenomenon, the infrequency-of-purchase model (section 4.2.2) explicitly was developed to tackle this problem. The infrequency-of-purchase model can be expected to perform well for storable items that form a basic part of the diet and therefore can be expected to be consumed by all households.

The shorter the time span covered by the survey, the larger the problem of infrequently bought products. The longer the period for which the household has reported its expenditures, the higher will be the share of infrequently purchased goods (Dobbelsteen and Kooreman, 1993). Since in the NHIES survey all purchases are reported for a relatively short average period of one week, the problem of infrequently bought products can be considered more or less equal for all households. On the other hand, the relatively large sample size (3,908 observations) should guarantee some minimum coverage for each product.

Second, it is conceivable that a household's expenditure on a certain food category during the survey period happens to be substantially higher or lower than its long-term average, resulting in an a-typical per capita expenditure level of that product category. Aggregating products into

[14] The Likelihood Ratio (LR) test is a general large-sample test based on the maximum likelihood estimation method. The Chi-squared test statistic λ can be calculated as follows: $\lambda = 2 * (\ln L_{probit} + \ln L_{truncated} - \ln L_{tobit})$, with degrees of freedom equal to the number of restrictions (*i.e.*, equal to the number of explanatory variables in this study) (Greene, 1991; Maddala, 1992).

larger categories will diminish this problem, but comes at a cost of loss of homogeneity within product categories.

Third, as with the infrequency-of-purchase phenomenon, a Tobit model specification is not able to capture non-market-participation. As a consequence, a Cragg-type model was used also for products that cannot be expected to be consumed by everybody.

The Probit equation in a market-participation model theoretically represents the probability that a household participates in a particular market, implicitly assuming that the cumulative probability of the frequency of purchases equals one. In other words, it is assumed that the sample period is long enough to observe all households replenish their supplies, except those choosing not to consume because of relatively high price or low income. This assumption will probably not completely hold, and therefore the Probit function in the non-market-participation model may represent not only non-market-participation but also (at least to some unknown degree) the infrequency-of-purchase phenomenon.

A fifth important aspect of the estimation results relates to the fact that expenditure elasticities estimates are obtained for 'average' households. The latter are implicitly assumed to be more or less representative for relatively large groups of households which may, however, still be relatively heterogeneous in terms of their consumption patterns and other socio-economic characteristics.

A sixth aspect consists of the fact that a part of total food consumption, particularly in the rural areas, is not bought in the market but rather home-produced with a value that was imputed by the survey investigators. Even the best imputation procedures are unlikely to exactly reflect the 'true' shadow prices of the products in question for the households. Thus, there likely exists an imputation error that is common to not only dependent, but also independent variables (per capita total expenditure was also corrected for the value of home produced products). The effect of this imputation error is equivalent to standard simultaneity bias, which can be addressed by using instrumental variables or two-stage least squares estimation methods (Deaton, 1988). However, since neither size nor direction of this bias are known in advance, such techniques will be difficult to implement for the Engel function specification as used in this study.

Another potential problem in relation to consumption of home-produced products might be that the survey information regarding such consumption behavior is not entirely satisfactory. On the other hand, even though the consumption of home-produced products may not be insignificant (particularly so in the rural areas), Lizano (1994) could not identify a significant dummy variable representing home consumption in the demand equations. In case home consumption is partly recorded as part of purchased consumption, the resulting average unit price might be biased.

Seventh, despite the fact that certain categories of products are more likely to be consumed away from home than others, the variable representing total expenditure on food away from home does not distinguish between different products. The fact that consumption away from home is not included in the expenditure on individual products may represent another (unknown) source of bias in the corresponding elasticity estimates.

Finally, the availability of products may vary across regions and zones; *e.g.*, typically a wider variety of products is available in urban than in rural areas. Average per capita expenditure per individual product is likely be lower the higher the number of different products available, with obvious consequences for the ultimate expenditure elasticity estimates. Generally, the latter are likely to be upwardly biased because the relative change in the expenditure of a product category due to a relative change in per capita total expenditure is likely to be larger when the initial expenditure on that category is lower. This may partially invalidate the use of expenditure elasticity estimates that are not geographic specific.

5.3. EMPIRICAL FINDINGS

The infrequency-of-purchase model was applied to maize, bread, sugar, rice, beans, meat, butter and other fats, roots and tubers, coffee, and potato. These products constitute basic parts of Costa Rican diet and are assumed to be consumed by all households. Thus, for these products the Probit results yield information about the probability of observing a purchase. All other food categories were estimated with a market-participation model in which the Probit results represent information about whether households participate in a market or not.

As argued in the previous section, Cragg-type model specifications are often found superior to a Tobit specification. To test this now common finding with the NHIES data for Costa Rica, both model specifications were employed to estimate expenditure equations for all 24 food categories, though Tobit estimation results are reported only for the following four major food categories: maize, bread, sugar, and fresh vegetables. The results are given in Tables 5.1 to 5.4.

A-priori the specification of expenditure equation (1) may result in multicollinearity problems which may be resolved by excluding the quadratic expenditure term as well as the interaction effect of own-price and income. However, re-estimation of equation (1) for a number of product categories without these two variables had no marked effect on the estimates of the remaining coefficients, despite the fact that some of the correlation coefficients between the expenditure variable and its quadratic term were as high as 0.95. As a result, both the quadratic expenditure term and the interaction effect of own-price and income were retained in the model.

5.3.1. Comparison between Tobit and Cragg model results

5.3.1.1. Maize

Maize, rice and beans, which before 1987 were subject to pricing policies of the MEIC and the *Consejo Nacional de Producción* (National Production Council or CNP; Corrales, 1981; Stewart, 1987; Jansen *et al.*, 1996), remain the most important staples in the Costa Rican diet. The analysis regarding government policies towards staple foods in Costa Rica is a fairly complicated affair, with the effects on producers, consumers and state revenues varying widely, both by individual product and across different years (Quirós *et al.*, 1987).

Table 5.1 gives estimation results for maize and maize products, with about 48 per cent of all households reporting at least one purchase. The Cragg specification (in this case an infrequency-of-purchase model) was tested against the Tobit specification, yielding a Likelihood Ratio test statistic of 593.81, *i.e.*, the Tobit specification was strongly rejected in favor of the Cragg model[15].

According to the Tobit results, both per capita total expenditure and the consumer price index (CPI) have a positive influence on per capita expenditure on maize, whereas own-price and size exert a significant negative influence. In agreement with Meza and Rodriguez (1993),

[15] The critical Chi-square value with 13 degrees of freedom is 27.7 at the one percent level of significance.

Table 5-1: Estimation results for maize and maize products

	Tobit model		Cragg model			
			Probit equation		Truncated equation	
Variable	Coefficient	Stand. error	Coefficient	Stand. error	Coefficient	Stand. error
Intercept	-9.227*	2.341	-12.687*	5.068	-3.839	2.985
Tot exp. cap	0.955*	0.371	2.738*	0.757	0.737	0.470
(Tot exp cap)^2	-0.050*	0.022	-0.163*	0.045	-0.012	0.024
Price	-0.555*	0.181	-0.610*	0.351	-0.911*	0.439
Price * Exp	-0.086*	0.022	-0.103*	0.043	0.095*	0.054
Zone	-0.242*	0.051	-0.054	0.115	-0.461*	0.052
Household size	-0.336*	0.049	-0.159	0.107	-0.518*	0.052
CPI	0.711*	0.372	-0.213	0.841	0.254	0.377
Central	-0.042	0.077	0.277*	0.167	-0.136*	0.078
Chorotega	0.273*	0.087	0.142	0.191	0.345*	0.089
Pacífico	0.024	0.092	-0.143	0.187	-0.048	0.094
Huetar Norte	0.246*	0.089	0.628*	0.199	0.061	0.089
Huetar Atl.	0.186*	0.092	0.418*	0.195	-0.043	0.095
Likelihood	-2999.86		-347.30		-2355.65	
	Elasticities				Elasticities	
	Expenditure	Price			Expenditure	Price
Quartile I	0.531	-2.159			0.261	-1.239
Quartile II	0.430	-2.231			0.261	-1.166
Quartile III	0.375	-2.277			0.250	-1.117
Quartile IV	0.286	-2.346			0.241	-1.043

* significantly different from zero at the ten percent level according to the standard t-test

households in urban areas have lower per capita expenditure on maize than those in rural areas (the reference), probably because of larger availability of other products in urban areas (such as industrially processed *tortillas*) and higher average per capita income and total expenditure. Households in the Chorotega, Huetar Norte and Huetar Atlántico regions have significant higher per capita expenditure on maize compared to those in Brunca (the reference region).

The Cragg model shows slightly different results. The zonal dummy, size, CPI, Chorotega and Pacífico all do not influence the probability of observing a maize purchase. While per capita total expenditure has a positive significant effect on the probability of observing a maize purchase, own-price exerts a negative influence. Households in the Central, Huetar Norte and Huetar Atlántico regions are more likely to buy maize than those in the Brunca region. The truncated regression results suggest that own-price, zone, size and Central exert a negative influence on per capita expenditure of maize, while households in Chorotega have higher per capita expenditure than those in Brunca. Even though CPI is not significant, bread is widely considered as a substitute for maize *tortillas*.

The change in sign that occurs between the Probit model and the truncated equation for the Central region variable suggests that the Tobit specification is incorrect. According to the latter, households in the Central region do not have a different buying behavior than those in

Brunca; however, the Cragg specification clearly indicates that households in the Central region buy more often, though each time lower quantities, than the ones located in Brunca.

For a necessity such as maize, the Tobit estimates for expenditure and price elasticities are improbably high in absolute value. The Cragg model results in significantly lower estimates, even though they still are on the high side. Upwardly biased expenditure elasticity estimates for food staples are a typical phenomenon with expenditure surveys (Bouis, 1994). Cragg expenditure elasticities hardly vary with increasing income or expenditure level, while richer households seem to be less sensitive to price changes than suggested by the Tobit results. With the exception of the price elasticity in the fourth quartile, all estimates are significantly different from zero. The fact that certain maize products are relatively easily substituted by other products (*e.g.*, bread for *tortillas*) might partially explain the relatively high price elasticity estimates.

5.3.1.2.Bread

Bread, even though a basic food product in Costa Rica, is not subject to government price controls. A total of 3,055 sample households (≈78% of the total sample) acquired bread during the survey period, which can therefore be analyzed with an infrequency-of-purchase model. The results (Table 5.2) indicate that the Tobit specification is strongly rejected by the Cragg specification (Likelihood Ratio test value of 3168). The Tobit results confirm *a-priori* expectations regarding the signs of the coefficients of the total expenditure and own-price variables. The CPI has a significant and positive influence on per capita expenditure on bread, suggesting that bread can act as a substitute for some other products (particularly maize *tortillas*). Contrary to *a-priori* expectations, household size exerts a positive influence on per capita expenditure on bread. As in Meza and Rodriguez (1993), households in the urban zone have higher per capita expenditure on bread than households in the rural zone, while households in the Central, Chorotega, and Huetar Atlántico regions have higher per capita expenditure than households in Brunca, though households in Huetar Norte have (marginally) lower per capita expenditure

The Probit model shows that per capita total expenditure has a positive influence on the probability of observing a bread purchase. Own-price, however, does not seem to influence this probability. Also household size, urban location, and Chorotega and Pacífico positively influence the probability of observing a purchase of bread. According to the truncated regression, own-price has a negative influence on per capita expenditure on bread, while per capita total expenditure has the expected opposite influence, as does the CPI. Households in the urban zones or in the Central and Huetar Atlántico regions have higher per capita expenditure on bread than reference households in rural zones and Brunca, respectively. As far as the rural-urban difference is concerned, this may be due to people in rural areas consuming more *tortillas* instead of bread. Shortcomings of the Tobit model appear from the change in the sign of the estimated coefficient of household size in the Cragg model. Larger households show a higher probability of a purchase but their purchases tend to be smaller. The Tobit results, on the other hand, suggest that larger households have higher per capita expenditure on bread.

Table 5-2: Estimation results for bread

	Tobit model		Cragg model			
			Probit equation		Truncated equation	
Variable	Coefficient	Stand. error	Coefficient	Stand. error	Coefficient	Stand. error
Intercept	-18.212*	1.875	-14.851*	4.549	-6.852*	1.384
Tot exp. cap	2.590*	0.289	1.890*	0.621	1.448*	0.222
(Tot exp cap)^2	-0.127*	0.017	-0.101*	0.039	-0.063*	0.013
Price	-0.958*	0.145	-0.870	0.563	-0.245*	0.150
Price * Exp	0.015*	0.018	-0.107	0.071	0.028	0.019
Zone	0.325*	0.043	0.392*	0.121	0.198*	0.029
Household size	0.129*	0.040	0.642*	0.094	-0.294*	0.029
CPI	1.193*	0.316	0.909	0.797	0.484*	0.220
Central	0.347*	0.064	-0.065	0.160	0.319*	0.045
Chorotega	0.138*	0.072	0.279*	0.150	0.005	0.052
Pacífico	0.227	0.075	0.392*	0.160	0.080	0.054
Huetar Norte	-0.032*	0.076	-0.116	0.158	-0.023	0.056
Huetar Atl.	0.234*	0.074	0.229	0.164	0.108*	0.052
Likelihood	-5357.19		-462.13		-3310.94	
	Elasticities				**Elasticities**	
	Expenditure	Price			Expenditure	Price
Quartile I	0.770	-1.851			0.490	-1.045
Quartile II	0.556	-1.838			0.393	-1.023
Quartile III	0.422	-1.830			0.326	-1.009
Quartile IV	0.217	-1.817			0.229	-0.987

• significantly different from zero at the ten percent level according to the standard t-test

The expenditure elasticities resulting from the Tobit model have acceptable values. Lizano (1994), also using a Tobit specification, found that bread is an inferior good for the highest income quartile, claiming that this result is plausible given that average per capita consumption of bread decreases between the third and the fourth income quartile. Tobit price elasticities do not vary much with increasing total expenditure or income, but overall seem quite high. Lizano (1994) found price elasticities of between -0.4 and -0.5 which, at least for the lowest two income quartiles, seem to be on the low side (in absolute value terms). The Cragg model results indicate that consumption of bread is less sensitive to changes in total expenditure and own-price than suggested by the Tobit results. The Cragg price elasticity estimates suggest that bread leans more towards a luxury item than expected, but expenditure elasticity values contradict this notion. Nevertheless, since they result from expenditure survey data rather than from food intake data, the latter may again be somewhat upwardly biased (Bouis, 1994). In this respect it is also worth noting that the own-price variable coefficient estimates were not significantly different from zero.

5.3.1.3. Sugar

A total of 2,723 households, or almost 70 per cent of the sample, bought sugar during the time of interrogation. Domestic sugar supply as well as sugar trade is the monopoly of *the Liga Agrícola e Industrial de la Caña de Azucar* (Sugar Cane Agriculture and Industrial Board). Sugar producers in Costa Rica are protected, at the expense of consumers. Nevertheless, average consumption per capita per year is very high, estimated at nearly 60 kg (Lizano, 1994). Virtually everyone in Costa Rica consumes sugar which makes the infrequency-of-purchase model the most suitable specification. Estimation results for sugar are given in Table 5.3. The Likelihood Ratio test of the Cragg specification against the Tobit specification was 670.52, *i.e.*, the Tobit model was again rejected. In the latter, both own-price and per capita total expenditure influence per capita expenditure on sugar in the expected directions. CPI has a significant positive influence on the demand for sugar which goes against the commonly held notion of sugar as a complementary good. Household size has a negative significant coefficient, implying that, according to the Tobit model, larger households have lower per capita expenditure on sugar. Households in the urban zones have lower per capita expenditure on sugar than households in the rural zones, while households in Chorotega and (even though to a much lesser extent) Huetar Norte have higher per expenditure on sugar than households in the (reference) Brunca region.

In the Probit equation of the Cragg model, only the interaction term price*total expenditure and the zone variable has a significant (negative) influence on the probability of observing a purchase of sugar. In the truncated equation, per capita total expenditure has a significant positive influence on per capita expenditure on sugar, while own-price is not significant. Household size has a significant negative effect on per capita expenditure on sugar; its coefficient estimate is almost the same as in the Tobit equation. Unlike the Tobit results, the CPI is no longer significant. Households in urban areas have lower per capita expenditure on sugar than households in rural areas. On the other hand, and in agreement with consumption data reported in Meza and Rodriguez (1993), households in Chorotega and Huetar Norte exhibit higher expenditure on sugar than households in Brunca.

Sugar is one of the basic food items in Costa Rica and is therefore expected to have relatively low (in absolute value terms) expenditure and own-price elasticities. Tobit and Cragg expenditure elasticity estimates are very similar (even though they are about double those found by Lizano (1994) using a simple OLS estimation procedure), but price elasticity estimates differ significantly between the two model specifications. According to the Tobit model, per capita expenditure on sugar is very sensitive to price changes, with a price elasticity of approximately -2.35. On the other hand, price elasticity estimates resulting from the Cragg model are much more in the acceptable range, *i.e.*, they are much lower in absolute value and decline with rising income level. As in the case of bread, even though the own-price variable coefficient estimates were not significantly different from zero, the price elasticity estimates, as scalars, were significant. Nevertheless, such estimates warrant careful interpretation. Lizano (1994) reported much lower (in absolute value) price elasticity estimates which increased (in absolute value) rather than decreased with rising income.

Table 5-3: Estimation results for sugar

	Tobit model		Cragg model			
			Probit equation		Truncated equation	
Variable	Coefficient	Stand. error	Coefficient	Stand. error	Coefficient	Stand. error
Intercept	-12.718*	1.579	9.837	17.382	-6.200*	2.805
Tot exp. cap	1.459*	0.229	-2.517	2.120	1.969*	0.344
(Tot exp cap)^2	-0.078*	0.013	0.153	0.130	-0.079*	0.012
Price	-1.107*	0.195	0.143	1.071	-0.510	0.681
Price * Exp	-0.028	0.023	-0.326*	0.153	0.112	0.081
Zone	-0.265*	0.033	-1.351*	0.563	-0.271*	0.030
Household size	-0.305*	0.030	-0.621	0.433	-0.321*	0.028
CPI	1.053*	0.233	-0.451	3.312	0.103	0.220
Central	-0.016	0.047	0.439	0.780	0.029	0.044
Chorotega	0.128*	0.052	-0.678	0.781	0.158*	0.048
Pacífico	0.018	0.055	-0.875	0.777	0.061	0.051
Huetar Norte	0.090*	0.055	-0.173	1.183	0.151*	0.051
Huetar Atl.	0.074	0.010	-0.461	0.784	0.073	0.051
Likelihood	-3185.84		-23.14		-2827.44	
	Elasticities				**Elasticities**	
	Expenditure	Price			Expenditure	Price
Quartile I	0.464	-2.305			0.459	-0.721
Quartile II	0.333	-2.329			0.330	-0.630
Quartile III	0.250	-2.344			0.247	-0.571
Quartile IV	0.124	-2.367			0.124	-0.484

* significantly different from zero at the ten percent level according to the standard t-test

5.3.1.4. Fresh vegetables

Although almost three-quarters of all households purchased products from the category fresh vegetables during the interview period, it is assumed that these products are not consumed by everyone. Due to their perishable nature, fresh vegetables need to be bought regularly, also by families who own a refrigerator; consequently, households that did not buy them during the survey period were assumed to not normally be in the market for fresh vegetables. Thus, in this case the Cragg model is assumed to represent a market-participation model rather than an infrequency-of-purchase model.

Table 5.4 presents the estimation results for fresh vegetables. The Likelihood Ratio test of the market participation model against the Tobit model was 1426, *i.e.*, the Tobit model was also rejected for fresh vegetables. In the Tobit model, per capita total expenditure, the zonal dummy and the consumer price index variable all exert a positive significant influence on per capita expenditure on fresh vegetables. On the other hand, the own-price*total expenditure interaction term and, to a lesser extent, household size have a significant negative influence on per capita expenditure on fresh vegetables. The latter does not seem to differ between regions.

Table 5-4: Estimation results for fresh vegetables

	Tobit model		Cragg model			
			Probit equation		Truncated equation	
Variable	Coefficient	Stand. error	Coefficient	Stand. error	Coefficient	Stand. error
Intercept	-16.649*	1.837	-20.594*	7.167	-8.179*	1.892
Tot exp. cap	1.865*	0.287	2.065*	1.189	1.481*	0.300
(Tot exp cap)^2	-0.092*	0.017	-0.125*	0.074	-0.060*	0.016
Price	-0.162	0.139	-0.206	0.466	0.207	0.257
Price * Exp	-0.116*	0.017	-0.171*	0.060	-0.037	0.031
Zone	0.231*	0.040	0.242	0.163	0.187*	0.035
Household size	-0.098*	0.039	0.093	0.137	-0.317*	0.036
CPI	1.441*	0.297	2.058*	1.112	0.673*	0.263
Central	-0.083	0.061	0.053	0.219	-0.065	0.054
Chorotega	0.105	0.068	0.399*	0.235	-0.023	0.060
Pacífico	0.113	0.071	0.080	0.251	-0.018	0.063
Huetar Norte	-0.064	0.071	0.421*	0.243	-0.141*	0.064
Huetar Atl.	0.072	0.070	0.147	0.240	-0.023	0.063
Likelihood	-4496.07		-182.42		-3550.72	
	Elasticities				**Elasticities**	
	Expenditure	Price			Expenditure	Price
Quartile I	0.974	-1.976			0.761	-1.052
Quartile II	0.807	-2.074			0.664	-1.080
Quartile III	0.710	-2.135			0.601	-1.100
Quartile IV	0.558	-2.229			0.507	-1.128

* significantly different from zero at the ten percent level according to the standard t-test

The Probit model results show that per capita total expenditure as well as the consumer price index variable exert a positive and significant influence on the probability of participating in the market or observing a purchase. Per capita total expenditure squared and the interaction term of own-price*total expenditure both exert a negative influence on that probability. Households located in Chorotega or Huetar Norte have a higher probability of being in the market or observing a purchase than reference households in the Brunca region. According to the truncated equation, per capita total expenditure as well as the consumer price index variable positively affect per capita expenditure on fresh vegetables, *i.e.*, fresh vegetables may act as a substitute for other products. Household size exerts a negative influence while own-price does not have a significant influence. Not surprisingly, and in accordance with vegetable consumption data in Meza and Rodriguez (1993), households in urban areas have higher per capita expenditure on fresh vegetables than households in the reference rural areas, while households in Huetar Norte have lower per capita expenditure reference households in Brunca, possibly determined by availability factors.

From the values of the expenditure elasticity estimates it becomes clear that fresh vegetables have more of a luxury good character than maize, bread or sugar. Tobit expenditure elasticity estimates range from 0.97 for the poorest income quartile to 0.56 for the richest income quartile. This compares to Cragg expenditure elasticity estimates that are between 0.76 to 0.51.

Price elasticities for relatively luxurious products can be expected to exceed those for more basic goods (in absolute value terms). Own-price elasticity estimates from the Tobit model are considered as too high, while those resulting from the Cragg model seem much more reasonable. The fact that the own-price variable coefficient estimates were statistically not different from zero might offer an explanation for the similarity of price elasticity estimates between income quartiles.

To conclude, the implicit restrictions imposed by a Tobit model specification, nested within a more general Cragg specification, were overwhelmingly rejected for all four food categories considered. Thus, in contrast to what is being claimed in Lizano (1994, pp. 171-72), the results discussed above reinforce the inappropriateness of a single-stage specification such as the Tobit model which is not able to recognize that frequency of purchases or market participation on the one hand, and consumption levels on the other hand, may be driven by different sets of explanatory variables, or by similar variables but with different effects. A double stage model such as the Cragg specification is clearly superior to the Tobit model. In the remainder of this paper, discussion of estimation results will be largely limited to those based on Cragg models. Estimation results based on Cragg models for the other food categories are given in Appendix VII.

5.3.2. Elasticity estimates

Table 5.5 presents an overview of expenditure- and price elasticity estimates for all food categories that were part of this study. Elasticities were calculated by income quartile; both expenditure elasticities and price elasticities are expected to decline (in absolute value) with rising income or total expenditure.

Most elasticities behave as expected, declining in absolute value with rising income, even though a few remain basically unchanged across expenditure categories, while some food categories exhibit increasing elasticity values (in absolute terms) as income goes up. Increasing expenditure elasticity estimates were found for confectionery products (a heterogeneous food category which includes luxury breads, cakes, pastry etc.), other cereals and flour, conserved horticultural products, non-alcoholic beverages, processed milk products, and cheese. Except in the case of processed milk products, coefficient estimates for the expenditure variable and its squared term were non-significant for these food categories. However, dropping the quadratic expenditure term and the interaction term of own-price*income (because of possible multicollinearity) did not yield any improvement. Obtaining robust coefficient estimates and corresponding elasticities is also hampered for food product categories that are relatively heterogeneous. Finally, in the case of the conserved horticultural products and processed milk products food categories, less than 7 per cent of all households actually purchased these products during the survey period which makes the estimation results less reliable.

Rice, meat, confectionery and fresh vegetables have own-price elasticities that slightly increase (in absolute value) with rising income. Whereas the latter two categories show a minimal increase with non-significant price coefficient estimates, for the rice and meat categories significant coefficient estimates were obtained for the price variables, even though they were of

Table 5-5: Expenditure and price elasticities obtained from Cragg model estimation, by income quartile (Q)

Product	Expenditure elasticities				Price elasticities			
	QI	QII	QIII	QIV	QI	QII	QIII	QIV
Maize	0.26*	0.26*	0.25*	0.24*	-1.24*	-1.16*	-1.12*	-1.04
Bread	0.49*	0.39*	0.33*	0.23*	-1.05**	-1.02	-1.01	-0.99
Sugar	0.46*	0.33*	0.25*	0.12*	-0.72*	-0.63*	-0.57*	-0.48*
Fresh vegetables	0.76*	0.66*	0.60*	0.51*	-1.05	-1.08*	-1.10*	-1.13*
Rice	0.41*	0.31*	0.24*	0.14*	-0.53*	-0.63*	-0.69*	-0.78*
Beans	0.23*	0.20*	0.17*	0.14*	-0.89	-0.83	-0.78	-0.71
Meat	0.93*	0.80*	0.69*	0.54*	-0.53*	-0.59*	-0.64*	-0.70*
Butter&fats	0.51*	0.43*	0.37*	0.30*	-1.62*	-1.51*	-1.43*	-1.33*
Roots&tubers	0.49*	0.41*	0.35*	0.26*	-0.68*	-0.64*	-0.60*	-0.55*
Coffee	0.33*	0.28*	0.24*	0.23*	-0.68*	-0.69*	-0.70*	-0.71*
Potato	0.43*	0.36*	0.30*	0.23*	-0.58*	-0.56*	-0.55*	-0.53*
Confectionery	0.46*	0.48*	0.49*	0.51*	-1.06	-1.08*	-1.10*	-1.13*
Pastas	0.29*	0.22*	0.17*	0.10**	-0.89	-0.81*	-0.76*	-0.67*
Other cereals	0.23*	0.26*	0.29*	0.34**	-0.92	-0.86*	-0.81*	-0.74*
Fish	0.52*	0.51*	0.50*	0.48*	-1.20*	-1.15*	-1.11*	-1.05
Edible oil	1.26*	0.91*	0.80*	0.19	-1.58*	-1.14	-0.81	-0.22*
Conserved hort. prod.	0.37	0.48*	0.58*	0.72*	-0.91	-0.89	-0.87	-0.84
Fresh fruits	0.74*	0.70*	0.66*	0.61*	-0.71*	-0.70*	-0.70*	-0.70*
Orange	0.51*	0.51*	0.50*	0.49*	-0.82	-0.80*	-0.78*	-0.76*
Non- alcoholic beverages	0.52*	0.55*	0.57*	0.60*	-0.93	-0.93	-0.93	-0.93
Tobacco products	0.31*	0.25*	0.20*	0.14**	-0.75*	-0.72*	-0.69*	-0.67*
Non-processed milk products	0.52*	0.42*	0.36*	0.25*	-0.99	-0.82*	-0.69*	-0.51*
Processed milk products	0.02	0.20	0.40*	0.66*	-1.33	-1.29	-1.25*	-1.19
Cheese	0.39*	0.42*	0.44*	0.47*	-0.80	-0.79*	-0.79*	-0.78*

* (**) significantly different from zero at the five (ten) percent level according to the t-test; see also footnote 14

the wrong sign. Dropping the interaction term of own-price*income did not improve the results and consequently this interaction term was kept in the model.

The next two sections will briefly discuss the remaining food categories, starting with those to which the 'infrequency-of purchase' model interpretation of the Cragg specification applies, followed by food categories for which the 'market participation' model is appropriate.

5.3.3. Infrequency-of-purchase models

5.3.3.1. Rice

In view of its importance in the Costa Rican diet, it is expected that per capita expenditure on rice will be relatively little affected by changes in per capita total expenditure or in the price of rice. On the other hand, Senauer (1990) found, for several developing countries, that rice consumption of low-income households is relatively price and income responsive. An overview of government trade policies *vis-à-vis* rice is given in Lizano (1994), asserting that government rice policies have protected producers while taxing consumers.

The fact that basic staples can be safely assumed to be consumed by all households, and taking into account that rice can be stored relatively easily, imply that its demand structure should be analyzed with an infrequency-of-purchase model. Rice was bought by approximately 70 per cent of all sample households during the time of the survey. None of the coefficient estimates in the Probit equation was statistically significant (Table A7.1, Appendix VII). Rather than implying that that the probability of observing a purchase is not affected by any explanatory variable included in the equation, this result may be caused by the presence of multicollinearity resulting in high standard errors.

The truncated equation indicates that per capita total expenditure has a significant positive effect on per capita rice expenditure. Combined with the positive own-price effect, this results in a price inelastic demand for rice, confirming *a-priori* expectations for a staple product. Household members in urban areas consume less rice than those in rural areas which might be explained by the larger availability of substitutes (*e.g.*, bread) or because households in urban areas are relatively richer and therefore consume other products. These explanations might also be valid for the lower per capita expenditure on rice in the Central and, to a lesser extent, Huetar Norte regions compared to the reference region of Brunca. Household size has the expected significant negative effect on per capita rice expenditure, while prices of other products exert a positive effect, indicating that rice may substitute for some other (dearer) products. Indeed, MEIC (1996) reports a cross-price elasticity of rice and potato of 0.11.

Expenditure elasticities are relatively low and decline with rising income, from 0.41 for the lowest income quartile to 0.14 for the top quartile. These estimates are consistent with the negative relationship between between income level and rice consumption as observed in Meza and Rodriguez (1993) and compare favorably with Lizano (1994) who, using a DLQ model estimated by simple OLS, obtained unrealistically low expenditure elasticity estimates ranging from 0.15 for the lowest to 0.02 for the highest income quartile. Rice was reported as an inferior good in MEIC (1996), a highly unlikely result. Price elasticities are negative but, contrary to expectations, are higher in absolute value for richer households; this result is probably caused by the wrong sign (negative) of the estimated coefficient for the interaction term of own-price and total expenditure. Only the price elasticity value for the richest quartile (-0.78) agrees with the one reported in Stewart (1987). On the other hand, Lizano (1994) obtained much lower (in absolute value) expenditure elasticity estimates, ranging from -0.37 for the lowest to -0.29 for the highest income category. MEIC (1996) reports price elasticities of -0.34 (short term) and -0.44 (long term).

5.3.3.2. *Beans*

Together with rice, beans (black beans in particular) probably constitute the most important food product in Costa Rica; indeed, rice and beans are often eaten together. According to Meza and Rodriguez (1993), rice and beans together account for some 30 and 34% of respectively total caloric and protein intake of Costa Ricans, while beans constitute the major source of protein in rural areas. Consequently, also the beans category can be estimated with the infrequency-of-purchase model (about 60 per cent of sample households bought beans during the survey period), while its elasticity estimates should be similar to those found for rice. As for rice, Lizano (1994) maintains that bean producers in Costa Rica are being protected; even though this does not seem to result in higher consumer prices for black beans, imports of (cheaper) red beans are subject to various tariff measures.

Both the Probit and the truncated equation contain just a few significant coefficients (Table A7.2, Appendix VII). Own-price has a significant negative effect on the probability of observing a purchase of beans, while the price of other products has a positive effect on this probability, as does living in the Chorotega region.

Contrary to the Probit results, per capita total expenditure does have a positive significant effect in the truncated equation; thus, even though it does not influence the probability of observing a purchase, per capita total expenditure does have an effect on the level of per capita expenditure on beans. On the other hand, own-price does influence the probability of a bean purchase but not the expenditure level. These results imply that, as a result of an increase in its own price, bean purchases become lower in frequency but expenditure of each purchase increases, *i.e.*, the net effect of a rise in the own-price of beans on per capita expenditure on beans is probably small. Per capita expenditure on beans is relatively lower in urban areas and in the Central region, probably due to higher per capita income and larger availability of substitute products. These results are supported by the per capita consumption data given in Meza and Rodriguez (1993).

Price- and expenditure elasticity estimates for beans are quite similar to those obtained for rice. Expenditure elasticities decline from 0.23 for the relatively poor to 0.14 for richer households. Expenditure elasticities for beans obtained by Lizano (1994) can be considered unrealistically low, ranging between 0.05 and -0.002, again pointing towards the inappropriateness of single decision models and simple OLS procedures for the analysis of household budgeting data. Price elasticities vary from -0.89 to -0.71 which can be considered as a strong price effect for a necessity. It should be noted that these relative high absolute price elasticity estimates did not significantly differ from zero. Earlier estimates by Céspedes (1973) resulted in values of around -0.10 which may be considered to be on the low side, however. Price elasticity estimates in Lizano (1994) seemed more reasonable (between -0.53 and -0.36), despite the use of a restricted model.

5.3.3.3. *Meat*

Meat constitutes another important product in the Costa Rican food basket; more than 75 per cent of all households bought meat during the survey period. Together with liberal portions of rice and beans, a typical Costa Rican meal usually includes some meat as well. With the exception of chicken, both price control and trade barriers in the meat market are minimal (Lizano, 1994). High market participation, wide and easy availability of meat, and a strong meat-consumption tradition all worked in favor of an infrequency-of-purchase model. About 80% of the total meat consumption in Costa Rica consists of beef and chicken (Meza and Rodriguez, 1993).

The probability of observing a meat purchase is only influenced by the price level of other products (positive effect) and the interaction term of own-price and per capita total expenditure (negative effect) (Table A7.3, Appendix VII).

In the truncated equation, per capita total expenditure as well as own-price positively affect per capita meat expenditure. The combination of a positive of own-price variable coefficient and a negative influence of the interaction term produces a price inelastic demand. Household size exerts a negative effect on per capita meat expenditure, while the latter is somewhat higher in urban than in rural areas. Per capita meat expenditure in Chorotega and Huetar Atlántica significantly exceeds that in the reference region of Brunca, perhaps due to the importance of a stronger meat consumption tradition in these areas. The latter results are consistent with meat consumption data reported in Meza and Rodriguez (1993). The significant positive coefficient of the CPI in the Probit equation, combined with the absence of an effect of this variable on the level of meat expenditure, imply that a rising CPI causes the probability of observing a meat purchase to increase and the quantity per purchase to decrease slightly, probably resulting in a small effect on per capita meat consumption.

In spite of the fact that meat is commonly viewed as a staple product, expenditure elasticities are relatively high, decreasing from 0.93 for the poorest household quartile to 0.54 for the richest quartile. This may partially be explained by the heterogeneous character of the meat category which contains both common cuts as well as luxury meat products. Lizano (1994), using a Tobit procedure, found implausibly high income elasticities for the two lowest income quartiles (both exceeding two) which declined to just below one for the highest income quartile. Even though price elasticities have the expected negative sign, rich households appear to be more sensitive to price changes than poor households, though the difference in the estimated values is not dramatic. This may be caused by the quality difference phenomenon, *i.e.*, richer households can be expected to consume different types of meat than poorer households. Lizano (1994), again based on a Tobit, reported somewhat implausible own-price elasticity estimates of -3.25 for the lowest income category and a positive elasticity of 0.46 for the highest income category.

5.3.3.4. Butter and other fats

Most products in this category belong to the basic food basket of Costa Rican consumers, rendering the infrequency-of-purchase model again the appropriate specification. Seventy-five per cent of all households bought at least one of the products belonging to this food category during the survey period.

Even though the individual effects of per capita total expenditure and own-price on the probability of observing a purchase are statistically zero, the interaction term exerts a significant negative effect (Table A7.4, Appendix VII). Household size has a positive influence on observing a purchase, *i.e.*, larger households buy more often. Households in Pacífico have a higher buying frequency than households in the Brunca reference region.

Total per capita expenditure has a positive influence on per capita expenditure of butter and other fats, which effect tapers off at higher levels of expenditure (income) as indicated by the negative coefficient of per capita expenditure squared. Own-price negatively affects per capita expenditure pointing to a price elastic food category, while the interaction term has a positive effect. Finally, household size exerts a negative effect on per capita expenditure. Combined with the results of the Probit equation, this implies that, even though larger households buy more often, their total expenditure is less than that of smaller households. Per capita expenditure does not differ between regions or zones, a result which is supported by the per capita consumption data given in Meza and Rodriguez (1993).

Expenditure elasticities decrease from 0.51 to 0.30 with rising income, while price elasticity results indicate that richer households are slightly less sensitive to price changes. Generally, both expenditure and price elasticity estimates seem to be on the high side for such common products as butter and other fats. A possible explanation might be that these products are easily substituted by other, more luxury, products, and are therefore relatively sensitive to own-price changes, independent of income. Even though strictly not fully comparable with the butter and other fats category in this study, Lizano (1994) reported that demand for shortening products is much less sensitive to both income and own price. Expenditure elasticities ranged from 0.24 (for the lowest income quartile) to 0.08 (highest quartile), while price elasticities were between -0.60 and -0.42.

5.3.3.5. *Roots and tubers*

Roots and tubers are products belonging to the basic food basket in Costa Rica and, consequently, were purchased by a high proportion of households (62 per cent) during the survey period. Even though the infrequency-of-purchase model seems to be the most appropriate model to estimate this category, experience in Geurts (1994) learned that this category presents estimation difficulties, most likely due to its heterogeneity.

The Probit equation does not yield any significant coefficients, probably due to homogeneity in purchase frequency and the presence of multicollinearity which is, however, not a problem in the expenditure equation (Table A7.5, Appendix VII). Total per capita expenditure has a significant positive influence on per capita expenditure on roots and tubers, while its squared term has a negative effect. The CPI exerts a negative effect which result is hard to explain; indeed, one might have expected a positive coefficient in view of the commonly held notion that poor consumers often resort to roots and tubers when other staple foods (*e.g.*, rice) become more expensive. Members of large households spend less on roots and tubers than members of small households. Households in rural areas have slightly higher per capita expenditure on roots and tubers than urban households. Compared to households in Brunca, members of households located in the Pacífico and Chorotega regions spend less on roots and tubers expenditure, while households in the Central and Huetar Norte regions spend more. This is not surprising given the geographical distribution of roots and tubers production which is concentrated in these areas.

Expenditure elasticities are low and well within the expected range for a necessity. Even though price elasticity estimates decline (in absolute value) with rising income as expected, they must be used carefully because of the non-significance of the underlying price coefficients.

5.3.3.6. *Coffee*

Coffee is a common product with traditional value consumed by virtually each household in Costa Rica. The domestic market for coffee is Costa Rica is regulated through a quota, while coffee exports are taxed. Lizano (1994) claims that these measures result in Costa Ricans drinking cheap coffee but of low quality. About 63 per cent of all households reported a coffee purchase during the survey period, again rendering the infrequency of purchase model appropriate.

The probability of observing a coffee purchase is strongly influenced by its own-price, with the expected negative and positive effects of the own-price variable and the interaction term, respectively (Table A7.6, Appendix VII).

On the other hand, the price coefficient (positive) points at price inelasticity. Combining both price effects in the Cragg model leads to the conclusion that the effect of a rise in the price of coffee would be moderate, since households would buy less frequently but spend more in each individual purchase. Per capita total expenditure positively influences per capita coffee expenditure while its squared term has a plausible negative effect. CPI has a positive effect (*i.e.*, an increase in the general price level would result in an increase in per capita coffee expenditure, suggesting that coffee is a substitute for other products[16]), while household size has a negative effect. Household members living in urban areas and in the Huetar Atlántico region spend less on coffee compared to reference households in rural areas and Brunca, respectively. As far as the rural-urban difference is concerned, this may be due to urban households substituting other drinks such as tea, soft drinks, etc.

Estimated values for expenditure elasticities reflect the widespread habit of coffee consumption, with relatively low expenditure elasticities that decrease only slowly with rising income (from 0.33 for the lowest to 0.23 for the highest income quartile). Lizano (1994) found even lower expenditure elasticities (below 0.2). Price elasticity estimates are very similar for all income quartiles (about -0.70) and are among some of the lowest values (in absolute value) found in this study; price elasticities in Lizano (1994) were even slightly lower in absolute terms (between -0.5 and -0.6).

5.3.3.7. *Potato*

Potato is the final food category in this study that was estimated with an infrequency-of-purchase model. Justification is found in the considerable importance and widespread use of potatoes, as evidenced by the fact that almost 57 per cent of all households purchased potatoes of any kind during the survey period. Even though the Costa Rican potato market is protected by a tariff, the degree to which this tariff protects producers and hurts consumers seems moderate since potato production seems to be fairly efficient (Lizano, 1994).

As was the case for the roots and tubers category, the Probit equation for potatoes suffers from high standard errors and statistically insignificant coefficients (Table A7.7, Appendix VII). However, the truncated equation presents no such problems, indicating that per capita expenditure on potato is positively affected by per capita total expenditure and negatively by its squared term. Household size exerts its usual negative influence on per capita expenditure. Per capita potato expenditure in urban areas is lower than in rural areas, but at the same time the estimation results also suggest that household members in the Central and Huetar Norte regions spend more on potato than household members in Brunca. Since the Central and (to a lesser extent) the Huetar Norte regions are much more urbanized than the Brunca region, these results seem somewhat contradictory, even though a possible explanation may be found in concentration

[16] Lizano (1994), in an otherwise largely unsuccessful attempt to estimate cross-price elasticities, found that milk and coffee are complements.

of production in these areas and concurrent consumption habits. Finally, households in the Pacífico region incur lower per capita expenditure on potato than households in Brunca.

Elasticity estimates resemble those obtained for the roots and tubers category, even though they are about 10% lower (in absolute values) on the average. Both expenditure and price elasticities reported in Lizano (1994) showed a similar pattern though they were somewhat lower in absolute value.

5.3.3.8. Summary of infrequency-of-purchase model results

Tables 5.6 and 5.7 summarize the estimation results for the infrequency-of-purchase models discussed above, listing the signs of the significant coefficient estimates obtained for the Probit equations and the expenditure equations, respectively.

Table 5-6: Sign of significant* coefficients in the Probit equation of the infrequency-of-purchase model

Category	lnx	$(\ln x)^2$	lnp	lnp·lnx	z	lnN	lncpi	Cent	Chor	Pac	Nort	Atl.
Maize	+	-	-	-				+			+	
Bread	+	-			+	+			+	+		
Sugar				-	-							
Rice												
Beans			-				+		+			
Meat				-			+					
Butter&fats				-		+				+		
Roots&tubers												
Coffee			-	+								
Potato												

* significantly different from zero at the ten percent level according to the standard t-test

Table 5-7: Sign of significant* coefficients in the expenditure equation of the infrequency-of-purchase model

Category	lnx	$(\ln x)^2$	lnp	lnp·lnx	z	lnN	lncpi	Cent	Chor	Pac	Nort	Atl.
Maize			-	+	-	-		-	+			
Bread	+	-	-		+	-	+	+				+
Sugar	+	-			-	-			+		+	
Rice	+	-	+		-	-	+	-			-	
Beans	+				-	-		-				
Meat	+	-	+	-	+	-			+			+
Butter&fats	+	-	-			-						
Roots&tubers	+	-			-	-	-	+	-	-	+	
Coffee	+	-			-	-	+					-
Potato	+	-			-	-	-	+		-	+	

* significantly different from zero at the ten percent level according to the standard t-test

Table 5.6 shows many empty cells, pointing at a low number of significant coefficients of the variables that determine the probability of observing a purchase. Only for maize and bread a significant (positive, though declining with rising total expenditure) effect of per capita total expenditure was found. Own-price exerts a significant effect (negative) only for maize, beans and coffee. This effect becomes stronger and weaker with rising income for maize and coffee, respectively. Large urban households buy bread more often, though urban households buy sugar less often than rural households. Large households also buy butter and related products more often. The price level of other products (positively) influences only the buying frequency of beans and meat. The effect of location on buying frequency showed no consistent pattern.

The expenditure equation of the infrequency-of-purchase model led to much more significant results. With the exception of maize for which no direct significant effect could be detected, per capita total expenditure has a positive influence (which, however, declines with increasing income levels) on expenditure levels of all 10 food categories considered in Table 5.7. The results regarding the influence of own-price are less clear-cut, however; several coefficient estimates are statistically insignificant, and while the positive signs for rice and meat point at a price inelastic demand, the negative signs of the own-price variable coefficient in the case of maize, bread and butter&fats result in a relatively elastic demand for these product groups. Larger households have lower per capita expenditures than smaller households. Per capita expenditure on bread and meat is higher in urban than in rural areas (possibly due to a denser distribution network), though the reverse holds for most other food categories. Judging from the sign of the significant coefficient estimates for the general price level variable, bread, rice, and coffee are relatively easy substitutes of other products. The results for the regional dummy variables present a mixed picture which may partially reflect regional food preferences and product availability.

5.3.4. Market participation models

5.3.4.1. Confectionery

This product group consists of a relatively wide variety of food items including certain types of bread, pastry, pies, cakes, etc. About 37 per cent of the sample household bought at least one of the products included in this category during the survey period. Since not every consumer participates in the market for such products, their demand structure should be analyzed with a market-participation model. However, estimation of both the participation equation and the expenditure equation resulted in only few significant coefficients (Table A7.8, Appendix VII). Besides the above-mentioned large variety of different products that are included in this category, a probable explanation may also be found in the heterogeneity of individual products, *i.e.*, the individual items (*e.g.*, pastries) can be of a common or luxury type.

The interaction term of price and per capita total expenditure has a negative influence on the probability of a household being in the market. Also the CPI exerts a negative influence on this probability, meaning that an increasing general price level decreases the probability of a household being in the market for confectioneries. Finally, households in the Central and Atlántica regions have a higher probability of participating in the market for confectioneries than reference households in Brunca. As mentioned before in section 5.2, it might be that the Probit equation, in view of the relatively short time of interrogation, not only explains market participation behavior, but partly picks up the probability of observing a confectionery purchase as well.

Household size is the only variable with a significant coefficient in the expenditure equation, exerting its common negative influence on per capita pastry expenditure.

Due to the large number of non-significant coefficients, elasticities hardly vary between income quartile. Average expenditure and price elasticity values are about 0.48 and -1.10, respectively. The former can be considered as somewhat low for a food category which contains many luxury items, while the latter is of an acceptable magnitude.

5.3.4.2. Pastas

During the course of the survey, less than 30 per cent of sample households had bought products belonging to this food category which demand structure is therefore analyzed with a market-participation model. Only the CPI had a fairly strong and significant negative influence on the probability of a household being in the market for pastas (Table A7.9, Appendix VII). High standard errors for the coefficient estimates of the remaining variables might point towards a multicollinearity problem, even though multicollinearity is not a problem in the expenditure equation.

Total per capita expenditure as well as the CPI exert a significant positive effect on per capita pasta expenditure, *i.e.*, pastas can substitute for other products (*e.g.*, rice, potato) when these get relatively expensive. Household size exerts its expected negative influence, while urban households as well as households in Chorotega and Pacífico have lower per capita expenditure than reference households in rural areas and Brunca, respectively. Regarding the latter results, no immediate satisfactory explanation was found.

Expenditure elasticities sharply decline with increasing income, from 0.28 for the poorest income quartile to only 0.10 for the richest 25 per cent of households. Non-significant price coefficient estimates call for careful interpretation of price elasticity estimates which vary between -0.89 and -0.67.

5.3.4.3. Other cereals and flour

Other cereals and flour turned out to be less common than might be expected, with only 25 per cent of sample households purchasing one or more products from this category during the survey period. Even though, *a-priori*, the frequency of buying other cereals and flour can be expected to be relatively low, not every household will consume these, and therefore the market-participation model was used to analyze their demand.

It was technically not possible to estimate the Probit equation because of a singular Hessian matrix during the iterative estimation procedure. On the other hand, estimation of the truncated equation did not present any problem.

Total per capita expenditure did not yield a significant influence on per capita expenditure on this product category (Table A7.10, Appendix VII). However, own-price, household size and urban location all exerted significant negative effects. Per capita expenditure on other cereals and flour in the Central, Chorotega and Huetar Norte regions significantly exceeds that in Brunca.

Elasticity estimates suggest that, compared to poorer households, per capita expenditure on other cereals and flour of relatively richer households is more sensitive to expenditure changes. However, this counter-intuitive result is not robust since the underlying expenditure coefficient estimates were not significant. As expected, price elasticities decrease (in absolute values) with rising income.

5.3.4.4. Fish

Forty-three per cent of all households purchased fish products during the survey period, complicating a clear-cut interpretation of the Probit equation in the Cragg model. Most likely, the Probit will reflect both the probability of observing a purchase and the probability of market participation. Total per capita expenditure does not have an effect on the binary dependent variable in the Probit equation, but market participation depends strongly on own-price which exerts a significant negative influence (Table A7.11, Appendix VII). Thus, an increase in the price of fish products decreases the probability of observing a fish purchase or even makes a household leave the market altogether. Larger households are more likely to make a purchase, while households in Chorotega and Pacífico are less likely to do so than households in Brunca.

Unlike its probability, per capita total expenditure positively affects the level of per capita expenditure on fish. The effect of household size in the truncated equation is opposite that in the Probit. Finally, households in the Huetar Atlántico and Chorotega regions have significantly higher per capita fish expenditure than households in Brunca.

Expenditure elasticities differ little by income, oscillating around 0.5. Price elasticities indicate that fish is a price-elastic commodity across the entire income spectrum.

5.3.4.5. Edible oil

The majority of Costa Rican households uses butter or other fats for cooking, leaving the use of edible oil to special occasions and to the relatively richer, more health-conscious segments of the population. Less than 1 per cent of all sample households purchased edible oil during the survey period, and even though this figure certainly underestimates the percentage of households that actually consume this product due to its easy storability, the results of the Cragg model should be given a market-participation interpretation.

The probability that a household ever buys edible oil is negatively affected by the CPI, *i.e.*, a rising general price level may induce consumers to revert back to cheaper fats for cooking and as such will decrease the probability of being in the market for edible oil (Table A7.12, Appendix VII).

Per capita expenditure on edible oil is positively influenced by per capita total expenditure, while own-price exerts a negative effect. The quadratic expenditure term and the interaction term have opposite effects; the negative sign of the former dampens the effect of income on the expenditure on edible oil, whereas the positive sign of the latter forces the price elasticity to decrease (in absolute terms) with rising income. Compared to small households, large households have lower per capita expenditure of edible oil, whereas the latter is lower in the Pacífico region than in Brunca.

Expenditure elasticity estimates indicate that edible oil is a luxury good for low income groups but a necessity for high income consumers. Similarly, for low income groups, edible oil is a price-elastic good which, however, becomes price-inelastic at higher income levels. However, in view of the relatively low number of households who actually purchased edible oil, these estimates should be interpreted with caution.

5.3.4.6. *Conserved horticultural products*

Products belonging this category are not commonly consumed in Costa Rica because of the wide availability of relatively cheaper fresh vegetables and fruits virtually throughout the year. This is reflected in the fact that only 274 households (or only 7 per cent of the total sample) bought products from this category during the survey period, making market-participation the most appropriate interpretation of the Cragg model. When interpreting the results in Table A7.13 (Appendix VII), it should be kept in mind that this category is rather heterogeneous which made it relatively difficult to obtain robust coefficient and elasticity estimates.

Own-price has a strong negative effect on the probability of a household being in the market, while the interaction term of price and total expenditure exerts a significant positive effect, indicating that the negative price effect is less at higher income levels. The general price level (CPI) has a negative effect on the probability of market participation.

Per capita expenditure on conserved horticultural products is influenced neither by per capita total expenditure nor by own-price. This result may be a reflection of the heterogeneous character of this product category, since one would expect that only relatively richer households consume from this category and that consumption levels would be strongly dependent on own-price. In per capita terms, large households spend less on conserved horticultural products than do small households, while expenditure on this category is higher in rural than in urban areas (an unexpected and counterintuitive result) and lower in Huetar Norte than in Brunca.

In addition to the heterogeneous character of this product category, the inability of the model to detect a significant influence of total expenditure and own-price makes the calculated elasticities less reliable. Expenditure elasticity estimates range from 0.37 for the lowest to 0.72 for the highest income category, while price elasticity estimates vary from -0.91 to -0.84. Since only relatively rich households can be expected to be in the market for conserved horticultural products, expenditure estimates for the lower income quartiles may be less meaningful, while the finding that they increase with rising income may not be so worrisome.

5.3.4.7. *Fresh fruits*

Fresh fruits are common in Costa Rica and widely available throughout the country. However, product diversity within this group and a considerable level of consumption from own production may compromise estimation results. Only 48 per cent of the sample households bought at least one product belonging to this category during the survey period.

Even though the results of the Probit estimation were expected to reflect both market-participation and frequency-of-purchase effects, none of the coefficients were significantly different from zero, possibly as a result of the heterogeneous character of this product category (Table A7.14, Appendix VII).

The expenditure equation yielded better results. In agreement with data presented in Meza and Rodriguez (1993), total per capita expenditure and zone positively affect per capita fresh fruit expenditure (urban households can be expected to have less access to fruits out of own production), though own-price hardly has an influence. Both household size and CPI negatively affect per capita expenditure. While the former result is plausible, the latter result can only be explained by product heterogeneity or by complementary products within this product category. Households located in the Pacífico region have lower per capita fresh fruit expenditure than reference households in Brunca, possibly due to the time-of-interview effect.

Both price and expenditure elasticity estimates are relatively stable across income quartiles. The former oscillate around -0.70, while the latter decrease slightly from 0.74 for the highest to 0.61 for the lowest income quartile.

5.3.4.8. *Orange*

Even though orange constitutes one of the products in the category fresh fruits, its demand structure was also analyzed separately because of its all-around presence in Costa Rica. Since only 20 per cent of sample households purchased oranges during the survey period (even though it can be reasonably expected that every household consumed oranges, *i.e.*, most consumption takes place out of own production), the Cragg model carries a market-participation interpretation.

Not surprisingly, both own-price and CPI have a negative effect on the probability of a household being in the market for oranges (Table A7.15, Appendix VII). Furthermore, as expected, households in urban areas are much more likely to participate in the market for oranges than rural households since particularly the latter typically consume out of own production.

Relatively abundant and often free availability of oranges offers a likely explanation for the non-significant coefficient estimates of total expenditure variables and the own-price, although the latter is significant in the Probit equation. Both household size and CPI exert a negative influence on per capita orange expenditure. A satisfactory explanation for the negative influence of CPI is lacking since one would expect individual fruit items to be substitutes rather than complementary goods. Households located in Huetar Atlántico have lower per capita orange expenditure than reference households in Brunca; again this may be a matter of availability of the fruit during the time of interview.

Similar to the findings for the fresh fruit category, neither price- nor expenditure elasticities vary much between income categories. Expenditure elasticities are about 0.5, while own-price elasticity estimates vary between -0.82 and -0.76.

5.3.4.9. *Non-alcoholic beverages*

This product category also contains a large variety of products, some of which may be considered as luxury and others as necessary goods, again complicating model interpretation as well as leading to less robust estimation results. Approximately 30 per cent of sample households purchased one or more products belonging to this category during the survey period. Even though the Probit equation will mostly refer to the probability of being in the market, some influence of the probability of observing a purchase is not inconceivable.

Whereas the Probit equation failed to converge, the expenditure equation yielded only two statistically significant coefficient estimates (Table A7.16, Appendix VII). The household size variable exerted its familiar negative influence on per capita expenditure, while households in the Pacífico region incur significantly higher expenditure on non-alcoholic beverages than households in Brunca.

Neither expenditure nor price elasticity estimates varied much between income levels which is not surprising given the non-significant price and expenditure coefficients in the expenditure equation. In view of its heterogeneity, an average price elasticity estimate of nearly one is acceptable for this product category.

5.3.4.10. Tobacco products

About 25 per cent of all households consumed tobacco products during the survey period. Assuming that smokers buy tobacco products at least once a week leads to a market-participation interpretation of the Probit equation since the effect of infrequency-of-purchase would be negligible.

The probability that a household participates in the market for tobacco products is strongly and negatively influenced by the price of tobacco products which effect diminishes with increasing income (Table A7.17, Appendix VII).

Total per capita expenditure has a positive effect on per capita expenditure on tobacco products, while household size exerts its usual negative effect. Households in urban areas have lower per capita expenditure on tobacco products than households in rural areas (perhaps a matter of education and extension), while households in the Central region spend significantly more on tobacco products than households in Brunca.

Tobacco carries the characteristics of a necessary good, with fairly low expenditure elasticities that vary from 0.31 for the poorest to 0.14 for the richest income quartile. Per capita expenditure on tobacco products is more sensitive to price changes than to changes in total expenditure; price elasticities vary between -0.75 (poorest households) to -0.67 (richest households).

5.3.4.11. Non-processed milk products

This product category includes both fresh milk as well as (nearly) non-processed dairy products. Regulation in the fresh milk market is relatively little, with only the price of liquid milk with 2% fat regulated. On the other hand, since imports of powdered milk are subject to a tariff, milk producers are subsidized and milk consumers would benefit from imported milk (Lizano, 1994). Approximately 66 per cent of sample households purchased at least one product from this category during the survey period. Due to the perishable nature of the products included in this category, it can reasonably be expected that all households who ever buy these kind of products actually did so during the survey period, thus justifying a market-participation interpretation of the Cragg model results.

However, relatively high standard errors rendered all coefficients in the Probit equation insignificant, unlike in the expenditure equation where almost all coefficients were significant (Table A7.18, Appendix VII). The positive effect of total expenditure on per capita expenditure on non-processed milk products decreases at higher income levels. Own-price has a negative influence on per capita expenditure which effect becomes less strong at higher income levels. Prices of other products positively influence per capita expenditure on non-processed milk products, *i.e.*, non-processed milk products may act as substitutes for other products. Household size exerts its usual negative effect on per capita expenditure. Households in urban areas have lower per capita expenditure on non-processed milk products than households in rural areas (perhaps reflecting larger autoconsumption in rural areas, even though imputed prices used to value autoconsumption can be expected to be below market prices), while, perhaps not surprisingly in view of the concentration of milk production in these areas and in agreement with Meza and Rodriguez (1993), households in the Huetar Norte region incur higher per capita expenditure than reference households in Brunca.

Expenditure elasticities decrease from 0.52 to 0.25 with rising income, suggesting that households in the lowest expenditure quartile are twice as sensitive to income changes than households in the highest expenditure quartile. Own-price elasticity is -0.99 for the lowest quartile and -0.51 for the highest quartile, indicative of the near-luxury character of non-processed milk products for poorer households. Both expenditure and price elasticity estimates reported in Lizano (1994) for the milk category and based on simple OLS estimation, are similar to the estimates found in this study for the non-processed milk category.

5.3.4.12. *Processed milk products*

Processed milk products (*e.g.*, condensed milk) are rather uncommon in Costa Rica and generally belong to the luxury product category. Less than 5 per cent of sample households purchased these products during the survey period. Generally, luxury goods are bought rather infrequently by a limited segment of the population, meaning that the Probit equation will reflect both the infrequency-of-purchase phenomenon and market-participation behavior.

The low proportion of actual buyers caused estimation problems in the Probit equation reflected in high standard errors (Table A7.19, Appendix VII). Nevertheless, some significant coefficients were obtained, indicating that the probability of observing a purchase of a processed milk products is positively influenced by income, though less so at higher income levels; and that own price exerts its usual negative influence which effect also becomes less strong at higher income levels.

The expenditure equation also encountered some serious estimation problems. Per capita total expenditure has a negative influence on per capita expenditure of processed milk products which goes against economic theory. Household size has a negative effect on per capita expenditure. The estimation results obtained for this category were considered insufficiently robust for confidence in the elasticity estimates. Lizano (1994), using a Tobit specification, obtained plausible income elasticity estimates (1.84, 1.42, 1.06 and 0.36, for the lowest to the highest income category), even though her price elasticities seem on the high side (in absolute terms), ranging from nearly -3.0 for the lowest to -2.0 for the highest income category.

5.3.4.13. *Cheese*

This category includes all kinds of different cheeses (except for cream cheese which is included in the processed milk products category), some of which have a necessity character while others are true luxury products. However, consumption of white cheese is the most widespread (Meza and Rodriguez, 1993). The heterogeneous character of this product category can be expected to complicate interpretation of the estimation results. Approximately 30 per cent of sample households consumed products from this category during the survey period. A market-participation model was estimated for this category.

The Probit equation contained no significant coefficient estimates, due to high standard errors possibly caused by multicollinearity. In the expenditure equation, CPI has a positive influence on per capita cheese expenditure (suggesting that cheese may act as a substitute for other products), while the household size variable carries its usual negative sign. In agreement with Meza and Rodriguez (1993), urban households have lower per capita cheese expenditure than households in rural areas (possibly caused by larger consumption of home produced cheese as well as substitution of cheese for meat in rural areas), while households in the Chorotega and Huetar Norte regions spend more on cheese than reference households in Brunca.

In view of the heterogeneity of this product category, elasticity estimates in Table A7.20 (Appendix VII) should be interpreted carefully, the more so since the coefficient estimates of neither own-price nor total expenditure were significant in the expenditure equation. Expenditure elasticity estimates varied from 0.39 for the lowest to 0.47 for the highest income quartile; price elasticity estimates were virtually the same for all quartiles (approximately -0.79).

5.3.4.14. Summary of market participation model results

As in the case of infrequency-of-purchase models (Table 5.6), also the Cragg market participation model could not always separate out the effect of each individual variable in the model on the probability of observing a purchase, thus resulting in a relatively large number of empty cells in Table 5.8. A significant effect of per capita total expenditure was found only for the tobacco products, fresh vegetables and processed milk products categories, with the effect diminishing with rising income in both latter cases. The own-price variable assumes larger importance in market participation models than in infrequency-of-purchase models, suggesting that households simply drop out of the market in case prices exceed certain levels. The mostly negative coefficient of the price*income interaction variable indicates that rich households pull out later than poorer households. Even though the same effect might be expected for some other product groups as well, it was only in the case of oranges that participation of urban households in the market significantly exceeded that of rural households. Similarly, the positive effect of household size on the probability of market participation was limited to the fish product group. The general price level, as a proxy for the prices of other products, lowers the probability of market participation for five out of the fourteen product groups that were analyzed with the market participation model. Again, the effect of location (region/zone) on this probability showed no consistent pattern and would be difficult to interpret anyway.

Similar to the results obtained for the infrequency-of-purchase model (Table 5.7), and disregarding the processed milk products category which encountered serious estimation problems, per capita total expenditure exerts a positive influence on the level of per capita expenditure of an individual product group in 7 out of the 14 groups considered. For the remaining 6 product groups no significant effect could be found (Table 5.9). Own-price has a significant negative influence on per capita expenditure in only 3 out of the 14 cases, with the effect declining at with rising income. Larger households consistently have significantly lower per capita expenditure than smaller households. With the exception of fresh vegetables and fruits on which urban households spend significantly more than rural households, the latter incur higher per capita expenditure for most other products. The results obtained for the general price level variable are somewhat difficult to interpret, suggesting that fresh vegetables, pasta products, milk and cheese have readily available substitutes, whereas fresh fruits (including oranges) are products with complementary ties to other products. As in the case of the infrequency-of-purchase models, the results for the regional dummy variables present a mixed picture which may partially reflect regional food preferences and availability.

Table 5.8: Sign of significant* coefficients in the Probit equation of the market participation model

Category	lnx	$(\ln x)^2$	lnp	lnp·lnx	z	lnN	lncpi	Cent	Chor	Pac	Nort	Atl.
Fresh vegetables	+	-		-			+		+		+	
Confectionery				-			-	+				+
Pastas							-					
Oth.cereals&flour												
Fish			-	+		+			-	-		
Edible oil							-					
Cons. hort. prod.			-	+			-					
Fresh fruits												
Orange			-		+		-					
N. alc. bev.												
Tobacco prod.			-	+								
N.proc.milk prod.												
Proc. milk prod.	+	-	-	+								
Cheese												

* significantly different from zero at the ten percent level according to the standard t-test

Table 5.9: Sign of significant* coefficients in the expenditure equation of the market participation model

Category	lnx	$(\ln x)^2$	lnp	lnp·lnx	z	lnN	lncpi	Cent	Chor	Pac	Nort	Atl.
Fresh vegetables	+	-			+	-	+				-	
Confectionery						-						
Pastas	+	-			-	-	+		-	-		
Oth.cereals&flour			-	+	-	-		+	+		+	
Fish	+					-			+			+
Edible oil	+	-	-	+		-				-		
Cons. hort. prod.					-	-					-	
Fresh fruits	+				+	-	-			-		
Orange						-	-					-
N. alc. bev.						-				+		
Tobacco prod.	+				-	-		+				
N.proc.milk prod.	+	-	-	+	-	-	+				+	
Proc. milk prod.	-	+				-						
Cheese					-	-	+		+		+	

* significantly different from zero at the ten percent level according to the standard t-test

6. SUMMARY AND CONCLUSIONS

This paper analyzed the structure of domestic food demand in Costa Rica at the level of the household, given prices, income, location, and household size. Using data from the 1987/88 National Household Income and Expenditure Survey for approximately 3,900 households spread over the entire country, Engel functions were estimated for a total of 24 different food product categories. Rather than the Tobit specification which is commonly used to take account of zero purchases, Cragg-type double hurdle models were employed to estimate expenditure and price elasticities. In this way, both the infrequency-of-purchase phenomenon and marketing participation behavior were captured, allowing the decision whether or not to purchase an item from a particular food category to be independent of the decision regarding the quantity purchased. The elasticity estimates obtained in this study can be considered superior to those reported in other studies which results are either implausible (MEIC, 1996) or imprecise (Lizano, 1994).

Cragg-type double hurdle models consist of a combination of a Probit specification which is used to identify the factors that explain the purchasing decision, and a truncated regression equation to determine the factors that influence quantities bought. The estimated model specification had monthly household per capita expenditure on a particular food category as its dependent variable, while independent variables included total monthly per capita consumption expenditure (as a proxy for per capita income), own-price, household size, the general price level, and binary variables for household location (including rural or urban and any of six planning regions). Both expenditure and price elasticity estimates were allowed to vary by income quartile through the incorporation of two additional explanatory variables in the model, *i.e.*, a quadratic expenditure term and an own-price* total expenditure interaction variable. Whereas the inclusion of income and price related variables in the model was largely based on economic theory, incorporation of dummy variables for location of the households was justified by statistical analyses which revealed significant differences in income, expenditure pattern, and household size between planning regions as well as between urban and rural areas.

The results provide strong statistical support in favor of the Cragg model (and against the Tobit specification), *i.e.*, the decisions whether and how much to consume should be analyzed separately since they are not determined by the same set of variables. Recognition of this fact leads to significantly improved elasticity estimates; indeed, compared to elasticities obtained from the Tobit model which were usually much higher than expected *a-priori*, estimates resulting from the Cragg model were much more within the expected range. In addition, the Cragg model outperformed the Tobit model in the sense that both expenditure and price elasticities (the latter in absolute terms) usually decreased with rising income which was not always the case with the Tobit results.

Out of the total of 24 food product categories analyzed, for 10 an infrequency-of-purchase interpretation was given to the Probit equation of the Cragg model. These are products which can be considered as being consumed by virtually the entire Costa Rican population, *i.e.*, maize, bread, sugar, rice, beans, meat, butter and other fats, roots and tubers, coffee, and potato. For the remaining 14 product categories for which not all consumers can *a-priori* be expected to be in the market, a market participation interpretation of the Probit in the Cragg model was deemed the most appropriate. These product categories included fresh vegetables, confectionery, pastas, other cereals and flour, fish, vegetable oil, conserved fruits and vegetables, fresh fruits, oranges, non-alcoholic beverages, tobacco products, processed milk products, non-processed milk products, and cheese. Even though the technical specifications of the infrequency-of-purchase and the market participation interpretation of the Cragg model is the same, explicit recognition of the distinction between the two is important in view of a correct interpretation of the Probit equation results.

It was found that household size consistently exerts a negative influence on an individual product group's expenditure, *i.e.*, larger households tend to incur lower per capita expenditure than smaller households. Nevertheless, more detailed information about household composition in terms of age, sex, education, professional status etc. (Sadoulet and de Janvry, 1995) would have sharpened these results as well as enabled analysis of intra-household food allocation.

At given income levels, food expenditure patterns in Costa Rica differ significantly between rural and urban areas. With the exception of fresh vegetables, bread and fresh fruits (for which urban households spend more than rural households) and confectionery, fish, edible oil, oranges, non-alcoholic beverages, and processed milk products (for which categories no significant difference between rural and urban expenditure could be detected), rural households consistently incur higher expenditure for the selected food items than urban households. Whereas on the one hand, this may be a counterintuitive result since one would expect rural households to have cheaper access to such staples as grains, roots and tubers, and milk products, the finding seems quite logical for some other product categories which are delivered mostly from the largely urbanized Central Valley (*e.g.*, meat, sugar, butter and fats, coffee, pastas, conserved products, tobacco products, processed milk products). Moreover, this finding is consistent with the analysis in Jansen *et al.* (1996) which finds that the scarcity of regulated rural markets leads to the inefficient (and costly) situation in which products produced outside the Central Valley flow through the national wholesale market in Heredia (located in the Central Valley) before they are redistributed again in their areas of origin.

An attempt was made to determine the nature of each food product group (in terms of substitute or complementary goods) by including the general price level as a proxy variable for the price of other commodities. A significant coefficient was obtained for 10 out of the 24 product categories, indicating that bread, rice, coffee, pastas, non-processed milk products and cheese have substitute characteristics; whereas roots and tubers, potato, fresh fruits and oranges are complements. Inclusion of the general price index variable in the model also may pick up part of the effect of possible seasonal price differences.

Regional binary variables, representing the six planning zones as distinguished by the government, were included in the model mainly to avoid misspecification. Even though the resulting coefficient estimates for the five regional dummies included in the model lack a clear-cut interpretation, in general they represent a mix of regional food preferences and product availability.

Expenditure elasticity estimates all turned out to be positive across the entire income spectrum, *i.e.*, all food product categories can be considered as normal (rather than inferior) goods (Varian, 1978). With the exception of meat which expenditure elasticity varies between 0.55 for the highest and nearly one for the lowest income quartile (implying a constant expenditure share of meat for the latter quartile), expenditure elasticity estimates for the product categories analyzed with the infrequency-of-purchase model all were smaller than 0.5, *i.e.*, expenditure on each of these product categories increases less than 0.5% for each percentage point increase in total expenditure (or income). Thus, all these food product categories can be regarded as necessities (Varian, 1978). Expenditure on beans in particular is very insensitive to income, increasing only between 0.14 and 0.23% for each percentage point increase in the latter. Without exception, expenditure elasticity estimates for all 10 food product categories estimated with the infrequency-of-purchase model showed an inverse relationship with income. Given the staple food character of most of these product categories, these relatively low expenditure elasticities which decrease with increasing income do not come as a surprise.

Expenditure elasticity estimates for product categories analyzed with the market participation model were considered less robust than those that were analyzed with the infrequency-of-purchase model. This was caused mainly by the much more heterogeneous character of these product categories which led to multicollinearity problems and complicated the interpretation of some of the results. For example, statistically insignificant coefficient estimates for the expenditure variable in the Engel equation meant that, for some product categories that were analyzed with the market participation model (*e.g.*, other cereals and flour, conserved horticultural products, non-alcoholic beverages, processed milk products, cheese), expenditure elasticity estimates showed a positive, rather than the expected inverse, relationship with income, while for other product categories (*e.g.*, confectionery) expenditure elasticities showed only minimal variation across income quartiles. The latter was also the case (though this time with a statistically firm base) for fish, fresh fruits, and oranges. Perhaps somewhat contrary to *a-priori* expectations, expenditure elasticity estimates for the product categories estimated with the market participation model did not generally exceed those found for product categories analyzed with the infrequency-of-purchase model. Only edible oil could be designated as a luxury item (*i.e.*, expenditure elasticity larger than one), and then only for the lowest income quartile.

Demand turned out to be price elastic (*i.e.*, absolute price elasticity estimates that exceed one) across all income categories for 6 product categories (maize, fresh vegetables, butter and fats, confectionery, fish, and processed milk products) out of the total of 24 categories analyzed in this study. In addition, a price elastic demand for at least one income category was found in the case of bread and edible oil. Demand for non-processed milk products is nearly price-elastic for the poorest income quartile. Furthermore, a few product categories classify as nearly-price-elastic across the entire income spectrum, including conserved horticultural products, non-alcoholic beverages, and cheese. The magnitude of the price elasticity estimates did not seem to consistently differ between product categories estimated with the infrequency-of-purchase model on the one hand, and those estimated with the market participation model on the other hand.

Whereas the high price elasticities for maize lack an obvious explanation, the high elasticities found for butter and fats are probably due to relatively easy substitution by edible oil. Similarly, the finding of an increasingly price-sensitive demand for rice at higher income levels seems unlikely. Price elasticity estimates for beans were also considered to be on the high side but were statistically not significant. Price elasticities for processed milk, even though quite high in absolute value, were considered unreliable due to the wrong sign of the income variable coefficient in the Engel equation.

The potential areas of use of the results of a demand study such as this one in policy making are basically threefold. One is to identify effective policy interventions, or to design targeted commodity research programs, aimed at improving the nutritional status of particular individuals, households, or individuals within households (Pinstrup-Andersen *et al.*, 1976; Garcia and Pinstrup-Andersen, 1987). A second important area of policy intervention for which detailed information about the structure of food demand is needed concerns the design of cost-effective food subsidy strategies (Timmer *et al.*, 1983) or evaluate existing food subsidy programs (Stewart, 1987; Park *et al.*, 1996). Finally, adequate information about the demand structure is necessary for sectoral and macroeconomic policy analysis, both in the short and the long runs (Sadoulet and de Janvry, 1995). For example, Lizano (1994) has shown that, given her set of own-price and expenditure elasticities, liberalization of food markets in Cost Rica would mean that, for most food products, people would consume more and spend less across the entire income spectrum.

Ideally, household budgeting surveys should be conducted about every ten years, to capture adjustments in consumption patterns resulting from changes in household distribution and composition, preference schemes, and changes in economic conditions and policy. At the same time, however, these factors are subject to structural change only in the relatively long term, and it may therefore be concluded that the elasticity estimates from this study are, probably, still valid today. Even though the estimated models are valid only within certain ranges of prices and incomes, effects of changes in these variables can, most probably, be adequately captured by the estimated models since expenditure elasticities were estimated by income quartile and price elasticities reflect household reactions on seasonal variation in prices. Expenditure elasticities by income quartile can be used to estimate the consequences of movements between income groups. The estimated price elasticities tend to be valid as long as seasonal variation in prices is larger than the annual change in prices.

Finally, it should be recognized that the years 1987-88 marked the beginning of the structural adjustment program (SAP) in Costa Rica. Even though the degree to which this may have led to a structural break and the resulting consequences for the forecasting ability of the models are unclear, the introduction of the SAP during survey period may have some implications for the validity of some of the elasticity estimates for policy making purposes. Traditionally, government policy measures have concentrated on the staple foods maize, rice, beans and sugar. With the exception of maize and its own price, consumption of these foods turned out to be relatively price- and income-inelastic. Despite the fact that, a result of the SAP, the CNP significantly reduced its maize purchases during the survey period (even though these were completely eliminated only by 1995; Murillo and Mora, 1996), the consumer price of maize stayed constant during the period.

REFERENCES

Aitchison, J., and J.A.C. Brown (1957). *The Lognormal Distribution*. Cambridge University Press, Cambridge.

Anonymous (1995). Análisis del Estado Nutricional de la Población Costarricense 1993-1994. Ministerio de Salud, Departamento de nutrición y atención integral, sección vigilancia nutricional, San José, Costa Rica.

Baldares, J. de (1984). *La Distribución del Ingreso y los Sueldos en Costa Rica*. Editorial Costa Rica. San José, Costa Rica.

Banks, J., and A. Lewbel (1992). Quadratic Engel Curves, Welfare Measurement and Consumer Demand. Working paper, Institute for Fiscal Studies, London.

Behrman, J.R., and A. Deolalikar (1990). The Intra-household Demand for Nutrients in Rural South India: Individual Estimates, Fixed Effects and Permanent Income. *Journal of Human Resources*, vol. 24, no. 4, pp. 665-697.

Blisard, N., and J. Blaylock (1993). Distinguishing Between Market Participation and Infrequency of Purchase Models of Butter Demand. *American Journal of Agricultural Economics,* vol. 75, pp. 314-220.

Bouis, H.E. (1994). The Effect of Income on Demand for Food in Poor Countries: Are our Food Consumption Databases giving us Reliable Estimates? *Journal of Development Economics*, vol. 44, pp. 199-226.

Brown, J.A.C., and A.S. Deaton (1972). Surveys in Applied Economics: Models of Consumer Behavior. *Economic Journal*, vol. 82, pp. 1145-1236.

Burton, M., M. Tomlinson, and T. Young (1994). Consumers' Decisions Whether or not to Purchase Meat: A Double Hurdle Analysis of Single Adult Households. *Journal of Agricultural Economics*. vol. 45, no. 2, pp. 202-212.

Céspedes, V. (1973). *Costa Rica: La Distribución del Ingreso y Consumo de Algunos Alimentos*. Serie Economía y Estadística, No. 45. Universidad de Costa Rica, San José, Costa Rica.

Corrales, J. (1981). *De la Pobreza a la Abundancia en Costa Rica*. Universidad Autónoma de Centro América, San José, Costa Rica.

Cox, T.L., and M.K. Wohlgenant (1986). Prices and Quality Effects in Cross-Sectional Demand Analysis. *American Journal of Agricultural Economics*, vol. 68, pp. 908-919.

Cragg, J. G. (1971). Some Statistical Models for Limited Dependent Variables with Application to the Demand for Durable Goods. *Econometrica*, vol. 39, no. ??? pp. 829-44.

Cramer, J.S. (1969). *Empirical Econometrics*. North Holland, Amsterdam.

Cramer, J.S. (1986). *Econometric applications of Maximum Likelihood Methods*. Cambridge University Press, Cambridge.

Churchill, G.A. (1991). *Marketing Research and Methodological Foundations*. The Dryden Press, Orlando, U.S.A.

Deaton, A. (1988). Quality, Quantity and Spatial Variation of Price. *American Economic Review*, vol. 70, no. 3, pp. 418-431.

Deaton, A. (1989a). Looking for Boy-Girl Discrimination in Household Expenditure Data. *World Bank Economic Review*, vol. 3, no. 1, pp. 1-15.

Deaton, A. (1989b). Household Survey Data and Pricing Policies in LDCs. *World Bank Economic Review*, vol. 3, no. 2, pp. 183-210.

Deaton, A. (1990). Price Elasticities from Survey Data: Extensions and Indonesian Results. *Journal of Econometrics*, vol. 44, pp. 282-309.

Deaton, A. and J. Muellbauer (1980a). *Economics and Consumer Behavior*. Cambridge University Press, Cambridge, U.K..

Deaton, A. and J. Muellbauer (1980b). An Almost Ideal Demand System. *The American Economic Review*, vol. 70, no. 3, pp. 312-326.

DGEC (Dirección General de Estadística y Censos, Ministerio de Economía y Comercio) (1987). *Censo de Población 1984*. San José, Costa Rica.

DGEC (Dirección General de Estadística y Censos, Ministerio de Economía y Comercio) (1988). *Metodología. Encuesta Nacional de Ingresos y Gastos de los Hogares*, Informe No. 2, San José, Costa Rica.

DGEC (Dirección General de Estadística y Censos, Ministerio de Economía y Comercio) (1990). *Avance de Resultados. Encuesta Nacional de Ingresos y Gastos de los Hogares*, Informe No. 1, San José, Costa Rica.

DGEC (Dirección General de Estadística y Censos, Ministerio de Economía y Comercio) (1995). *Canasta Básica de Alimentos*. San José, Costa Rica.

Dobbelsteen, S. (1996). *Intra-Household Allocation of Resources; A Micro-econometric Analysis*. PhD. Thesis, Wageningen Agricultural University, Wageningen, the Netherlands.

Garcia, M., and P. Pinstrup-Andersen (1987). *The Pilot Food Price Subsidy Scheme in the Philippines: Its Impact on Income, Food Consumption, and Nutritional Status*. Monograph no. 61, International Food Policy Research Institute, Washington, D.C., U.S.A.

Greene, W. H. (1981). On the Asymptotic Bias of the Ordinary Least Squares Estimators of the Tobit Model. *Econometrica*, vol. 49, no. 2, pp. 505-13.

Greene, W.H. (1991). *Limdep Version 6.0 User's Manual and Reference Guide*. Econometric Software, Inc., New York, U.S.A.

Geurts, J.A.M.M. (1994). Inter Household Allocation of Food: A case Study for Costa Rica. Unpublished M.Sc. thesis, Department of Marketing and Marketing Research, Wageningen Agricultural University, Wageningen, the Netherlands.

Haines, P., D.K. Guilkey, and B. M. Popkin (1988) Modeling Food Consumption Decisions as a Two-Step Process. *American Journal of Agricultural Economics*, vol. 70, no. 3, pp. 543-552.

Heien, D., and C. Durham (1991). A test of Habit Formation Hypothesis Using Household Data. *Review of Economics and Statistics*, vol. 73, pp. 198-199.

Heien, D., and C.R. Wessells (1990). Demand Systems Estimation with Micro-Data: A Censored Regression Approach. *Journal of Business and Economic Statistics*, vol. 8, pp. 365-371.

Henderson, J.M., and R.E. Quandt (1980). *Microeconomic Theory: A Mathematical Approach*. Third Edition, MacGraw-Hill, New York, U.S.A.

Hoekstra, S. (1993). An Export Marketing Plan for Exporters of Roots and Tubers, Plantain and Palm Heart in the Atlantic Zone of Costa Rica. Atlantic Zone Program (CATIE/UAW/MAG), Field Report no. 103, Turrialba, Costa Rica.

Houthakker, H.S., and L.D. Taylor (1966). *Consumer Demand in the United States, 1929-1970*. Harvard University Press, Cambridge, MA, U.S.A.

ILO (1992). *Statistical Sources and Methods: Household Income and Expenditure Surveys*. Volume 6, International Labor Organization, Geneva, Switzerland.

Jansen, H.G.P., and A. van Tilburg (with J. Belt and S. Hoekstra) (1996). Agricultural Marketing in the Atlantic Zone of Costa Rica: A Production, Consumption and Trade Study of Agricultural Commodities Produced by Small and Medium-Scale Farmers. *Serie Técnica*, Informe Técnico No. 271, CATIE, Turrialba, Costa Rica.

Kreijns, M.S. (1993). Domestic Demand for Agricultural Products in Costa Rica: A Study for Eight Products. Atlantic Zone Program (CATIE/UAW/MAG), Field Report no. 72, Turrialba, Costa Rica.

Kruseman, G. R. Ruben, and H. Hengsdijk (1994). Agrarian Structure and Land Use in the Atlantic Zone of Costa Rica. DLV Report No. 3, Wageningen Agricultural University, Wageningen, the Netherlands.

Klein, L.R. and H. Rubin (1947). A Constant-Utility Index of the Cost of Living. *Review of Economic Studies,* vol. 15, pp. 84-87.

Leser, C.E.V. (1963). Forms of Engel Functions. *Econometrica,* vol. 31, pp. 694-703.

Lin, T.F., and P. Schmidt (1983). A Test of the Tobit Specification Against an Alternative Suggested by Cragg. *Review of Economics and Statistics*, vol. 65, pp. 174-177.

Lizano, E. (1994). The Impact of Policy Reform on Food Consumption in Costa Rica. Ph.D thesis, Fletcher School of Law and Diplomacy, Tufts University, U.S.A.

Logtesteijn, M. van (1992). Intermediate Trade in Cattle, Fruits, Roots, and Tubers in the Atlantic Zone in Costa Rica. Atlantic Zone Program (CATIE/UAW/MAG), Field Report no. 104, Turrialba, Costa Rica.

Maddala, G.S. (1983). *Limited and Qualitative Dependent Variables in Economics*. Cambridge University Press, Cambridge, U.K.

Maddala, G.S. (1992). *Introduction to Econometrics*, Second Edition. MacMillan Publishing Company, New York, U.S.A.

MEIC (1996). Estudio del Mercado del Arroz. Ministry of Economics, Industry and Commerce, San José, Costa Rica.

Meza, N., and Rodriguez, N. (1993). II Encuesta nacional sobre Consumo Aparente de Alimentos, 1991: Análisis de Tendencias en el Consumo de Alimentos, 1989-91. Ministry of Health, San José, Costa Rica.

Murillo, R.M., and J.C. Mora (1996). *Situación y Perspectivas de los Granos Básicos en Costa Rica*. Unpublished consultants' report, Basic Grains Project, Interamerican Institute for Cooperation in Agriculture (IICA), Coronado, Costa Rica.

Musgrove, P. (1978). *Consumer Behavior in Latin America Income and Spending of Families in Ten Andean Cities*. The Brookings Institution, Washington, D.C., U.S.A.

Norusis, N.J. (1993). *SPSS for Windows, Base System Users Guide Release 6.0.* SPSS Inc, Chicago, Illinois, U.S.A.

Olsen, R. (1978). Note on the Uniqueness of the Maximum Likelihood Estimator of the Tobit Model. *Econometrica,* vol. 46, pp. 1211-1215.

Park, J.L., R.B. Holcomb, K. Curry Raper, and O. Capps, Jr. (1996). A Demand Systems Analysis of Food Commodities by U.S. Households Segmented by Income. *American Journal of Agricultural Economics*, vol. 78, pp. 290-300.

Pinstrup-Andersen, P., N.R. de Londoño, and E. Hoover (1976). The Impact of Increasing Food Supply on Human Nutrition: Implications for Commodity Priorities in Agricultural Research. *American Journal of Agricultural Economics*, vol. 58, pp. 131-142.

Portier, P. (1994). Marketing Research for Agricultural Produce Cultivated by Small Farmers in the Atlantic Zone of Costa Rica. Atlantic Zone Program (CATIE/UAW/MAG), Field Report no. 105, Turrialba, Costa Rica.

Prais, S.J., and H.S. Houthakker (1971). *The Analysis of Family Budgets*. Cambridge University Press, Cambridge.

Quirós, J., A. Di Mare, T. Vargas, V. Céspedes, J. Corrales, and M. Baldares (1987). *La Política de Precios en Costa Rica*. Counsel-Ciapa, United States Agency for International Development (AID), San José, Costa Rica.

Sadoulet, E., and A. de Janvry (1995). *Quantitative Development Policy Analysis*. Johns Hopkins University Press, Baltimore, U.S.A.

Sen, A.K., and S. Sengupta (1983). Malnutrition of Rural Children and the Sex Bias. *Economic and Political Weekly*, vol. 18, pp. 855-864.

Senauer, B., M. Garcia, and E. Jacinto (1988). Determinants of the Intra-household Allocation of Food in the Rural Philippines. *American Journal of Agricultural Economics*, vol. 70, pp. 170-180.

Senauer, B. (1990). Household Behaviour and Nutrition in Developing Countries. *Food Policy*, vol. 15, pp. 408-417.

Schipper, R.A., D.M. Jansen, and J.J. Stoorvogel (1995). Sub-regional linear programming models in land use analysis: a case study for the Neguev settlement, Costa Rica. *Netherlands Journal of Agricultural Science*, vol. 43, no. 1, pp. 83-109.

Stewart, R. (1987). Food pricing policy and its effects in Costa Rica. The case of rice and beans. *Food Policy*, vol. 2, pp. 264-272.

Stone, J.R.N. (1954a). *The Measurement of Consumers' Expenditure and Behaviour in the United Kingdom,* 1920-1938, vol. 1, Cambridge University Press, Cambridge.

Stone, J.R.N. (1954b). Linear Expenditure Systems and Demand Analysis: an Application to the Pattern of British Demand. *Economic Journal,* vol. 64, pp. 511-27.

Stoorvogel, J.J., R.A. Schipper, and D.M. Jansen (1995). USTED: a methodology for a quantitative analysis of land use scenarios. *Netherlands Journal of Agricultural Science*, vol. 43, no. 1, pp. 5-18.

Tedford, J.R., O. Capps, Jr., and J. Havlicek, Jr. (1986). Adult Equivalent Scales Once More - A Development Approach. *American Journal of Agricultural Economics*, vol. 68, pp. 322-333.

Thomas, D. (1990). Intrahousehold Resource Allocation, An Inferential Approach. *Journal of Human Resources*, vol. 24, pp. 635-664.

Timmer, P. (1981). Is there Curvature in the Slutsky Matrix*? Review of Economics and Statistics*, vol. 63, pp. 395-402.

Timmer, P., W. Falcon, and S. Pearson (1983). *Food Policy Analysis*. Johns Hopkins University Press, Baltimore, U.S.A.

Tobin, J. (1958), Estimation of the Relationships for Limited Dependent Variables. *Econometrica,* vol. 26, no. 1, pp. 24-36.

United Nations, Eurostat, International Monetary Fund, Organization for Economic Cooperation and Development, and World Bank (1993*). System of National Accounts 1993, Series F, No. 2, Rev. 4*. New York, and Washington, D.C., U.S.A., and Paris, France.

Varian, H.R. (1978). *Microeconomic Analysis*. W.W. Norton & Company, New York, U.S.A.

Wohlgenant, M.K. (1984). Conceptual and Functional Form Issues in Estimating Demand Elasticities for Food. *American Journal of Agricultural Economics*, vol. 66, pp. 211-215.

Wold, H., and L. Jureen (1953). *Demand Analysis*. Wiley, New York, U.S.A.

Working, H. (1943). Statistical Laws of Family Expenditure. *Journal of the American Statistical Association*, vol. 38, pp. 43-56.

World Bank (1994). World Bank data on Diskette. STARS Software Version 3.0, International Economics Department, Washington, D.C., U.S.A.

APPENDIX

Appendix I: Definition of Household Income and Expenditure

IA. Total gross household income consists of the following four components (DGEC, 1988):

1. **Main income**, defined as income in cash and/or in kind obtained by household members from employment, either as employees or from self-employment:
   a) Income from work as an employee, including all income in cash and in kind:
      - Income in cash: defined as income earned by each of the wage earners in the household in the form of wages and salaries, overtime payments, commissions, tips, end-of-year bonuses, premiums, holiday allowances, other allowances, bonuses, and any other cash payments.
      - Income in kind: defined as the goods received by the members of the household as compensation for any work done, valued at local retail market prices. Income in kind also includes the estimated value of meals and rent of the dwelling given as part of remuneration.

   b) Income from independent work (own-account work): defined as income in cash from own-account work or from work as an employer, including the value of home-grown and home-produced goods as well as goods received free of charge, and consumed by the household.
      - Income in cash for own-account work and for work as an employer: defined as income in cash received from agricultural, industrial and commercial activities, from free-lance activities, or as independent workers.
      - Income in kind: defined as the retail value of goods produced by the members of the household consumed at home. Includes the value of the goods taken from establishments (generally a small business) for own consumption.

2. **Property income**, defined as income in cash resulting from the possession of financial assets and/or the ownership of real estate (land, buildings, etc.) and/or other assets, including:
   a) Rent from land, houses, buildings and other fixed assets.
   b) Interest on fixed term investments (bonds, certificates of deposit, etc.).
   c) Interest on saving accounts.
   d) Dividends from shares.
   e) Income from copyrights, brand names and patents.
   f) Profits.
   g) Income resulting from membership in producer cooperatives, defined as profits received by members of producer cooperatives (agricultural, livestock, industrial) as a way of distributing cooperative profits.
   h) Rents attributable to the use of one's own dwelling, estimated as the amount of rent that would have to be paid by the household if it would rent the dwelling.

3. **Regular transfers and other benefits received**, defined as income received regularly by one or more members of the household without compensation. This type of income includes:
   a) Income in cash in the form of regular transfers, including old age benefits and other pensions, subsidies, food allowances, help from other households, study grants from national or foreign institutions, and cash transfers received regularly either from within the country or from abroad.
   b) The estimated value of the rent for a dwelling provided by other households or institutions, defined as the amount of rent that normally would have to be paid for the dwelling occupied, which, however, is provided for free by another household or institution.

4. **Other income**, defined as the income in cash or in kind received by household members as occasional transfers from institutions, firms or individuals. Examples of this income component include inheritances, lottery prizes, remittances that are not received regularly, gifts, indemnity payments from insurance policies, life insurance, etc. This type of income tends to vary substantially through time.

IB. Total household expenditure can be divided in consumption expenditure and non-consumption expenditure (DGEC, 1988). Both include monetary outlays as well as imputed values of expenditures that do not involve cash outlays, such as consumption of home-produced goods, goods received in kind, etc.

Consumption expenditure can be divided into expenditures for food, drinks, and tobacco products; clothing and footwear; housing; furniture and other household goods; medical and health services; transportation; education; and other expenditures, including expenditures on food consumed away from home, holidays, personal care items, etc.

Non-consumption expenditure includes, among other items, social security payments, direct taxes, interest payments, payments to non-profit organizations, insurance payments, and home-improvement payments.

The concept of consumption used in the survey is that of purchased consumption, *i.e.*, the total value of goods and services acquired during the reference period, no matter whether the household has actually paid for every item or not.

Appendix II: Description of Food Product Categories

Table A2: Food product categories used in the estimation of food demand models

Name of product category	Contents of product category
maize	regular maize flour, broken maize grains, sweet maize, maize for popcorn, malt (maize drink), maize dough, maize cake, refined maize flour
bread	French bread, regular loaf, square loaf, hamburger buns, hot dog buns, sweet bread, brown bread, other types of bread
sugar	regular sugar, sugar cubes, powdered sugar, brown sugar, white sugar, other types of sugar
fresh vegetables	white beet, garlic, artichokes, white celery, green celery, lentil, mature pumpkin, green pumpkin, eggplant, water cress, broccoli, onions, chayote, sweet pepper, hot pepper, cauliflower, coriander, maize cobs, spinach, small bananas, mushrooms, lettuce, mustard, cucumber, parsley, mature plantain, green plantain, leek, radish, red beet, green cabbage, tomato, green beans, carrot, squash
rice	rice of any kind
beans	black beans, white beans, ready-to-eat beans, bean paste, red beans, soft beans, beans not further specified
meat	any kind of beef, pork, chicken, birds
butter and other fats	pig fat, vegetable fat, butter, margarine
roots and tubers	sweet potato, winged yam, eddoe, white potato, tannia, cassava, other roots and tubers
coffee	coffee beans, milled coffee, instant coffee
potato	any kind of potato
confectionery	biscuits, cookies, crackers, pies, cakes, tarts, other confectionery
pastas	pasta of any kind
other cereals and flour	oats, barley, breakfast cereal, wheat flour, instant flour, groat flour, sago starch
fish	any kind of fish and seafood, fresh and conserved
edible oil	maize oil, olive oil, soya oil, vegetable oil, edible oil not further specified

Table A2 contd.

Name of product category	Contents of product category
conserved horticultural products	conserved onion, conserved hot pepper, conserved maize cobs, conserved asparagus, conserved mushrooms, conserved sweet maize, conserved palm heart, conserved gherkin, conserved peas, conserved beans, conserved mixed vegetables, conserved carrot, other conserved vegetables, dried almonds, dried hazelnut, dried banana, dried plums, preserved fruits, dried macadamia, dried cashew, peanuts, other nuts, dried grapes, other dried fruits, conserved cherries, conserved fruit cocktail, conserved cashew, conserved apricot, conserved palm heart, conserved pineapple, other conserved fruits
fresh fruits	avocado, banana, carambola, cherries, plums, coconut, peach, raspberry, strawberry, grapefruit, passion fruit, soursop, guava, Spanish plum, lemon, genip, mandarin, mango, apple, cashew, apricot, melon, mulberry, orange, papaya, palm heart, pineapple, water melon, tamarind, grapes, other fresh fruits
orange	any kind of orange
non-alcoholic beverages	mineral water, purified water, milk-based sweet drinks, orange juice, other fruit juices, vegetable-based juices, soft drinks, other non-alcoholic drinks
tobacco products	tobacco and cigarettes
non-processed milk products	sour milk, evaporated milk, fresh milk, other milk, butter
processed milk products	concentrated milk, powdered milk, pasteurized and sterilized milk, cream cheese
cheese	any type of cheese except cream cheese

Appendix III: Summary Statistics of Variables used in Regression Analysis

Table A3: Descriptive statistics of explanatory variables

Variable	Mean	Std Dev	Minimum	Maximum	Observ.
Per capita total monthly expenditure	4,966.69	6,382.66	163	120848	3,908
Ln (per capita total monthly expenditure)	8.11	0.87	5.09	11.70	3,908
Ln (per capita total monthly expenditure)^2	66.58	14.18	25.93	136.94	3,908
Total household income per month	24,227.57	23,098.52	125	308100	3,908
Number of household members	4.65	2.25	1	20	3,908
Ln (number of household members)	1.41	0.54	0.00	3.00	3,908
Dummy zone (1=urban, 0=rural)	0.40	0.49	0.00	1.00	3,908
Ln (per capita maize expenditure)	2.07	1.05	-1.79	6.60	1,882
Ln (price of maize)	-3.09	0.54	-6.03	1.36	1,882
Ln (price of maize)*ln (per capita total exp.)	-25.47	4.64	-42.81	13.20	1,882
Ln (per capita bread expenditure)	2.89	0.86	-0.56	5.86	3,055
Ln (price of bread)	-2.45	0.92	-6.81	1.44	3,055
Ln (price of bread)*ln (per capita total exp.)	-20.16	7.72	-57.79	13.68	3,055
Ln (per capita sugar expenditure)	3.08	0.78	-2.20	5.98	2,723
Ln (price of sugar)	-3.50	0.19	-5.65	-1.48	2,723
Ln (price of sugar) * ln (per capita total exp.)	-28.43	3.33	-53.70	-12.66	2,723
Ln (per capita fresh vegetables expenditure)	2.98	1.05	-1.25	-1.25	2,904
Ln (price of fresh vegetables)	-3.29	0.61	-6.91	1.61	2,904
Ln (price of veg.) * ln (per capita total exp.)	-27.10	5.49	-64.08	12.24	2,904
Ln (per capita rice expenditure)	3.56	0.80	0.29	6.34	2,710
Ln (price of rice)	-3.31	0.22	-5.56	-1.017	2,710
Ln (price of rice) * ln (per capita total exp.)	-26.72	3.04	-42.24	8.57	2,710
Ln (per capita beans expenditure)	2.90	0.82	-1.39	6.99	2,301
Ln (price of beans)	-3.08	0.21	-5.40	-1.51	2,301
Ln(price of beans) * ln (per capita total exp.)	-25.04	2.90	-44.43	-12.15	2,301
Ln (per capita meat expenditure)	4.22	0.99	-0.85	7.15	3,023
Ln (price of meat)	-1.83	0.34	-4.86	0.29	3,023
Ln (price of meat) * ln (per capita total exp.)	-15.04	2.84	-46.71	2.65	3,023
Ln (per capita butter & other fats exp.)	2.86	0.86	-0.69	6.15	2,925
Ln (price of butter & other fats)	-2.68	0.39	-5.18	1.69	2,925
Ln (price of fats) * ln (per capita total exp.)	-21.71	3.40	-41.83	12.97	2,925
Ln (per capita roots & tubers expenditure)	2.55	0.89	-1.39	5.75	2,432
Ln (price of roots & tubers)	-3.45	0.40	-6.28	-2.12	2,432
Ln(price of roots & tub) * ln(per cap. tot. exp)	-28.49	4.27	-49.90	16.06	2,432
Ln (per capita coffee expenditure)	2.52	0.85	-0.69	5.60	2,491
Ln (price of coffee)	-2.54	0.31	4.69	0.92	2,491
Ln (price of coffee) * ln (per capita tot. exp.)	-20.58	3.24	40.04	9.66	2,491
Ln (per capita potato expenditure)	2.44	0.82	-1.39	5.42	2,212
Ln (price of potato)	-3.33	0.34	-4.92	-1.02	2,212
Ln (price of potato) * ln (per capita tot. exp.)	-27.60	3.97	-42.85	-8.91	2,212
Ln (per capita confectionery expenditure)	2.06	1.08	-2.20	5.39	1,446
Ln (price of confectionery)	-1.60	0.86	-6.32	1.61	1,446
Ln(price of confect.) * ln (per capita tot. exp.)	-13.68	7.34	-54.23	14.84	1,446
Ln (per capita pasta expenditure)	1.94	1.04	-2.40	5.14	1,146
Ln (price of pasta)	-2.40	0.34	-4.89	-0.56	1,146
Ln (price of pasta) * ln (per capita total exp.)	-19.74	3.25	-36.52	-4.25	1,146

Table A3 contd.

Variable	Mean	Std Dev	Minimum	Maximum	No obs.
Ln (per cap. exp. on other cereals and flour)	2.15	1.14	-2.20	5.64	989
Ln (price of other cereals and flour)	-2.90	1.00	-4.74	-0.22	989
Ln(price of other cereals & flour) * ln (per capita total expenditure)	-23.65	8.03	-44.43	-1.77	989
Ln (per capita fish expenditure)	3.09	1.00	-1.39	6.81	1,694
Ln (price of fish)	-1.33	0.40	-5.04	0.74	1,694
Ln (price of fish) * ln (per capita total exp.)	-11.13	3.48	-49.85	5.95	1,694
Ln (per capita edible oil expenditure)	2.75	1.43	-1.95	6.22	256
Ln (price of edible oil)	-2.17	0.47	-3.61	-0.31	256
Ln (price of oil) * ln (per capita total exp.)	-18.97	4.14	-31.92	-2.52	256
Ln (per cap. cons. horticultural prod. exp.)	1.91	1.33	-1.79	5.93	274
Ln (price of conserved horticultural products)	-1.96	0.83	-5.48	0.87	274
Ln (price of conserved horticultural products) * ln (per capita total expenditure)	-16.78	6.91	-44.51	8.55	274
Ln (per capita fresh fruits expenditure)	2.38	1.31	-1.61	6.22	1,876
Ln (price of fresh fruits)	-3.62	0.72	-6.91	1.00	1,876
Ln (price of fruits) * ln (per capita tot. exp.)	-30.36	6.37	-66.30	9.01	1,876
Ln (per capita orange expenditure)	1.77	1.19	-2.40	5.86	773
Ln (price of orange)	-3.76	0.67	-6.04	2.81	773
Ln (price of orange) * ln (per capita tot. exp.)	-31.94	6.23	-51.68	24.17	773
Ln (per capita non-alcoholic drinks exp.)	2.48	1.26	-2.20	6.104	1,178
Ln (price of non-alcoholic drinks)	-2.81	0.44	-6.91	-0.03	1,178
Ln (price of non alc) * ln (per capita tot. exp.)	-23.86	4.38	-53.40	-0.29	1,178
Ln (per capita tobacco expenditure)	3.32	1.35	-1.95	6.86	944
Ln (price of tobacco products)	-3.45	0.95	-6.91	0.89	944
Ln(price of tobacco products) * ln (per capita total expenditure)	-28.49	8.05	-63.14	8.76	944
Ln (per cap. non-proc. Milk products exp.)	3.33	0.98	-0.79	6.10	2,586
Ln (price of non-processed milk products)	-3.76	0.36	-6.05	-1.22	2,586
Ln (price of non-processed milk products) * ln (per capita total expenditure)	-30.95	3.68	-47.06	-8.94	2,586
Ln (per capita processed milk products exp.)	1.81	1.22	-1.50	4.43	180
Ln (price of processed milk products)	-1.87	0.48	-4.21	-4.21	180
Ln(price of proc milk) * ln (per cap. tot. exp.)	-15.96	4.61	-37.50	-5.30	180
Ln (per capita cheese expenditure)	2.70	1.10	-1.71	6.09	1,169
Ln (price of cheese)	-1.88	0.40	-6.22	-0.41	1,169
Ln (price of cheese) * ln (per capita tot. exp.)	-15.82	3.41	-51.90	-3.52	1,169

Appendix IV: Distribution of Household Size across Regions and Zones

Table A4: Regional and zonal percentage distribution of household size

	Household size (number of members)						
	1	2	3	4	5	6	>6
Region							
Central	4.2	11.7	16.6	22.0	19.1	12.7	13.8
Chorotega	5.6	9.3	16.6	19.3	17.0	10.3	21.9
Pacífico	6.9	9.9	20.3	20.3	17.0	11.0	14.6
Brunca	5.6	7.1	14.6	20.1	15.5	14.8	22.2
Huetar Atlántico	6.3	11.1	13.7	22.7	17.2	12.3	16.6
Huetar Norte	5.0	8.2	15.7	22.6	15.9	12.3	20.3
Zone							
Urban	5.6	12.2	16.9	23.5	19.0	11.1	11.7
Rural	5.1	8.4	15.9	19.7	16.2	13.2	21.4

Appendix V: Distribution of Income Categories across Regions and Zones

Table A5: Percentage distribution of household across income categories*, by region and zone

	REGION						ZONE		
Row Pct *Column Pct* INCOME CATEGORY	Central	Pacífico	Chorot.	Brunca	Atlántico	Norte	Urban	Rural	Row total
< 7,999	40.9 8.0	8.9 21.0	18.5 26.2	15.2 21.0	10.7 15.5	5.9 15.7	21.5 5.3	78.5 20.0	12.5
7,999 - 12,327	44.0 8.7	7.8 18.5	14.9 21.2	17.0 23.7	9.5 13.9	6.8 18.4	32.4 8.0	67.6 17.4	12.6
12,327 - 16,114	61.5 12.1	5.2 12.3	10.0 14.1	9.8 13.6	8.4 12.2	5.0 13.5	45.4 11.1	54.6 13.9	12.5
16,114 - 20,595	64.2 12.6	6.1 14.5	5.7 8.0	8.8 12.3	9.9 14.4	5.3 14.2	52.3 12.8	47.7 12.2	12.5
20,595 - 26,118	66.8 13.1	4.5 10.7	7.5 10.6	8.1 11.2	9.4 13.7	3.7 9.9	54.3 13.3	45.7 11.7	12.5
26,118 - 34,669	72.1 14.2	4.5 10.7	4.3 6.0	6.3 8.7	8.7 12.6	4.2 11.2	59.7 14.6	40.3 10.3	12.5
34,699 - 50,836	76.0 14.9	3.6 8.6	5.6 7.9	4.2 5.8	7.3 10.6	3.4 9.1	68.6 16.8	31.4 8.0	12.5
> 50,836	83.7 16.4	1.6 3.7	4.2 5.9	2.7 3.7	4.8 7.0	3.0 8.0	74.7 18.2	25.3 6.5	12.5
Column Total	2487 63.6	207 5.3	346 8.8	352 9.0	336 8.6	181 4.6	1997 51.1	1911 48.9	3908 100.0

* All income categories contain an equal number of households

Appendix VI: Income and Expenditure Correlations by Region and Zone

Table A6.1: Income and expenditure correlations for the urban zone (n = 1576)

	FOODOUT*	TOTALINC	TOTEXP	FOODEXP
TOTALINC**	.4459			
TOTEXP***	.5814	.7277		
FOODEXP****	.2394	.4410	.5727	
INCCAP*****	.2643	.6607	.4702	.1561

* FOODOUT = household's monthly expenditure on food away from home
** TOTALINC = monthly income of the household
*** TOTEXP = household's monthly expenditure on all consumption goods
**** FOODEXP = household's monthly expenditure on food
***** INCCAP = monthly per capita income of the household

Table A6.2: Income and expenditure correlations for the rural zone (n=2334)

	FOODOUT	TOTALINC	TOTEXP	FOODEXP
TOTALINC	.3522			
TOTEXP	.3318	.6423		
FOODEXP	.2303	.4901	.5508	
INCCAP	.2094	.7243	.4535	.2200

Table A6.3: Income and expenditure correlations for the Central region (n = 1275)

	FOODOUT	TOTALINC	TOTEXP	FOODEXP
TOTALINC	.4398			
TOTEXP	.5827	.7335		
FOODEXP	.2712	.4606	.5693	
INCCAP	.2219	.6763	.4829	.1642

Table A6.4: Income and expenditure correlations for the Chorotega region (n = 571)

	FOODOUT	TOTALINC	TOTEXP	FOODEXP
TOTALINC	.3592			
TOTEXP	.4681	.7415		
FOODEXP	.2555	.4799	.6481	
INCCAP	.2958	.7525	.5888	.2669

Table A6.5: Income and expenditure correlations for the Pacífico region (n = 507)

	FOODOUT	TOTALINC	TOTEXP	FOODEXP
TOTALINC	.4263			
TOTEXP	.2190	.4069		
FOODEXP	.1994	.5016	.3865	
INCCAP	.3501	.6488	.2838	.2560

Table A6.6: Income and expenditure correlations for the Brunca region (n = 567)

	FOODOUT	TOTALINC	TOTEXP	FOODEXP
TOTALINC	.3605			
TOTEXP	.4334	.7242		
FOODEXP	.2323	.4577	.7051	
INCCAP	.3524	.7038	.5540	.2144

Table A6.7: Income and expenditure correlations for the Huetar Atlántico region (n = 512)

	FOODOUT	TOTALINC	TOTEXP	FOODEXP
TOTALINC	.4146			
TOTEXP	.4472	.7312		
FOODEXP	.1734	.4749	.7321	
INCCAP	.1853	.6303	.3465	.1209

Table A6.8: Income and expenditure correlations for the Huetar Norte region (n = 478)

	FOODOUT	TOTALINC	TOTEXP	FOODEXP
TOTALINC	.3226			
TOTEXP	.3518	.7505		
FOODEXP	.1678	.4963	.5810	
INCCAP	.3068	.7521	.5641	.2347

Appendix VII: Estimation Results obtained from the Cragg Model

Table A7.1: Estimation results for rice

Variable	Cragg model			
	Probit equation		Truncated equation	
	Coefficient	Stand. error	Coefficient	Stand. error
Intercept	-12.490	4380.017	-3.654	2.960
Total per capita exp.	0.794	774.008	0.920*	0.397
(Total per capita exp.)^2	-0.044	45.641	-0.064*	0.014
Price	-0.314	808.021	1.287*	0.689
Price * total per capita exp.	-1.051	96.223	-0.116	0.083
Zone	0.093	96.554	-0.259*	0.033
Household size	0.361	110.203	-0.257*	0.030
CPI	-1.419	690.578	1.209*	0.242
Central	9.707	473.099	-0.313*	0.046
Chorotega	-0.279	477.214	-0.027	0.050
Pacífico	0.228	659.311	0.046	0.055
Huetar Norte	1.155	526.486	-0.123*	0.054
Huetar Atlántico	0.567	660.899	0.010	0.054
Likelihood	-0.00		-3001.89	
			Elasticities	
			Expenditure	Price
Quartile I			0.411	-0.534
Quartile II			0.307	-0.632
Quartile III			0.236	-0.690
Quartile IV			0.136	-0.778

* significantly different from zero at the ten percent level according to the standard t-test

Table A7.2: Estimation results for beans

Variable	Cragg model: Probit equation Coefficient	Probit equation Stand. error	Truncated equation Coefficient	Truncated equation Stand. error
Intercept	-26.868*	9.203	-1.884	2.897
Total per capita exp.	1.481	1.277	0.815*	0.400
(Total per capita exp.)^2	-0.070	0.069	-0.023	0.015
Price	-2.975*	0.933	-0.491	0.750
Price * total per capita exp.	0.116	0.107	0.085	0.089
Zone	0.017	0.215	-0.241*	0.036
Household size	-0.254	0.212	-0.370*	0.034
CPI	3.441*	1.541	0.216	0.248
Central	-0.174	0.313	-0.143*	0.051
Chorotega	0.760*	0.447	0.033	0.055
Pacífico	0.167	0.405	-0.085	0.060
Huetar Norte	0.711	0.469	-0.069	0.060
Huetar Atlántico	0.227	0.395	-0.022	0.060
Likelihood	-94.861		-2518.83	
			Elasticities	
			Expenditure	Price
Quartile I			0.229	-0.890
Quartile II			0.195	-0.825
Quartile III			0.171	-0.780
Quartile IV			0.140	-0.714

* significantly different from zero at the ten percent level according to the standard t-test

Table A7.3: Estimation results for meat

Variable	Cragg model: Probit equation Coefficient	Probit equation Stand. error	Truncated equation Coefficient	Truncated equation Stand. error
Intercept	-19.517	12.612	-5.195*	1.723
Total per capita exp.	-0.422	1.432	2.098*	0.288
(Total per capita exp.)^2	0.030	0.086	-0.093*	0.015
Price	2.342	1.908	1.058*	0.391
Price * total per capita exp.	-0.834*	0.267	-0.082*	0.048
Zone	0.208	0.337	0.079*	0.031
Household size	-0.359	0.248	-0.234*	0.031
CPI	3.971*	2.340	-0.124	0.226
Central	-0.067	0.450	-0.065	0.046
Chorotega	-0.717	0.513	0.195*	0.052
Pacífico	-0.165	0.525	-0.075	0.055
Huetar Norte	-0.096	0.547	0.085	0.055
Huetar Atlántico	0.564	0.477	0.164*	0.052
Likelihood	-46.05		-3417.08	
			Elasticities	
			Expenditure	Price
Quartile I			0.934	-0.532
Quartile II			0.797	-0.590
Quartile III			0.694	-0.637
Quartile IV			0.545	-0.697

* significantly different from zero at the ten percent level according to the standard t-test

Table A7.4: Estimation results for butter and other fats

Variable	Cragg model: Probit equation – Coefficient	Probit equation – Stand. error	Truncated equation – Coefficient	Truncated equation – Stand. error
Intercept	-6.135	14.131	-9.760*	2.063
Total per capita exp.	0.021	1.743	1.739*	0.320
(Total per capita exp.)^2	-0.003	0.108	-0.059*	0.015
Price	2.135	1.308	-1.611*	0.402
Price * total per capita exp.	-0.678*	0.180	0.140*	0.047
Zone	0.590	0.378	-0.027	0.032
Household size	0.789*	0.396	-0.331*	0.031
CPI	0.355	2.623	0.348	0.226
Central	0.139	0.656	0.055	0.046
Chorotega	0.185	0.764	0.077	0.051
Pacífico	1.119*	0.656	0.064	0.053
Huetar Norte	0.303	0.776	-0.020	0.054
Huetar Atlántico	0.448	0.647	0.024	0.054
Likelihood	-33.54		-3256.05	
			Elasticities	
			Expenditure	Price
Quartile I			0.507	-1.622
Quartile II			0.425	-1.511
Quartile III			0.369	-1.437
Quartile IV			0.297	-1.329

* significantly different from zero at the ten percent level according to the standard t-test

Table A7.5: Estimation results for roots and tubers

	Cragg model			
	Probit equation		Truncated equation	
Variable	Coefficient	Stand. error	Coefficient	Stand. error
Intercept	-10.549	4220.0	-0.932	2.044
Total per capita exp.	0.452	717.2	1.518*	0.307
(Total per capita exp.)^2	-0.025	44.24	-0.056*	0.016
Price	-3.283	417.0	-0.134	0.371
Price * total per capita exp.	-0.148	50.62	0.064	0.045
Zone	0.127	96.82	-0.081*	0.034
Household size	0.048	89.66	-0.464*	0.034
CPI	0.642	641.5	-0.660*	0.245
Central	-0.390	120.4	0.138*	0.050
Chorotega	-0.549	285.3	-0.109*	0.059
Pacífico	-0.093	101.2	-0.113*	0.060
Huetar Norte	-1.235	429.3	0.153*	0.057
Huetar Atlántico	-0.189	117.3	-0.036	0.060
Likelihood	-0.000		-2620.752	
			Elasticities	
			Expenditure	Price
Quartile I			0.491	-0.681
Quartile II			0.411	-0.636
Quartile III			0.348	-0.601
Quartile IV			0.260	-0.551

* significantly different from zero at the ten percent level according to the standard t-test

Table A7.6: Estimation results for coffee

	Cragg model			
	Probit equation		Truncated equation	
Variable	Coefficient	Stand. error	Coefficient	Stand. error
Intercept	-45.645	54.930	-6.918*	1.937
Total per capita exp.	3.449	8.612	0.772*	0.262
(Total per capita exp.)^2	-0.129	0.423	-0.035*	0.014
Price	-20.458*	7.757	0.467	0.391
Price * total per capita exp.	1.753*	0.717	-0.019	0.047
Zone	0.387	0.923	-0.246*	0.033
Household size	-0.448	0.606	-0.590*	0.030
CPI	4.431	5.993	1.564*	0.254
Central	0.911	2.688	0.016	0.047
Chorotega	0.692	3.031	-0.072	0.052
Pacífico	-0.314	3.481	-0.075	0.056
Huetar Norte	0.654	2.931	-0.017	0.055
Huetar Atlántico	-0.054	3.684	-0.107*	0.056
Likelihood	-9.836		-2640.48	
			Elasticities	
			Expenditure	Price
Quartile I			0.330	-0.680
Quartile II			0.275	-0.691
Quartile III			0.240	-0.696
Quartile IV			0.228	-0.711

* significantly different from zero at the ten percent level according to the standard t-test

Table A7.7: Estimation results for potato

	Cragg model			
	Probit equation		Truncated equation	
Variable	Coefficient	Stand. error	Coefficient	Stand. error
Intercept	46.774	12690	0.647	2.096
Total per capita exp.	0.634	758.398	1.222*	0.299
(Total per capita exp.)^2	-0.025	46.092	-0.050*	0.015
Price	2.820	520.098	0.239	0.478
Price * Total per capita exp.	-1.309	64.332	0.025	0.057
Zone	-3.715	655.111	-0.123*	0.031
Household size	0.115	114.789	-0.513*	0.032
CPI	-12.152	2595.011	-0.550*	0.232
Central	0.811	550.702	0.099*	0.048
Chorotega	0.239	587.499	-0.080	0.056
Pacífico	0.156	635.877	-0.150*	0.056
Huetar Norte	-1.361	931.896	0.132*	0.055
Huetar Atlántico	0.187	620.678	0.048	0.057
Likelihood	-0.00		-2153.58	
			Elasticities	
			Expenditure	Price
Quartile I			0.429	-0.578
Quartile II			0.358	-0.560
Quartile III			0.305	-0.547
Quartile IV			0.227	-0.526

* significantly different from zero at the ten percent level according to the standard t-test

Table A7.8: Estimation results for confectionery

Variable	Cragg model			
	Probit equation		Truncated equation	
	Coefficient	Stand. error	Coefficient	Stand. error
Intercept	1.235	3.449	-0.117	2.490
Total per capita exp.	0.475	0.558	0.219	0.423
(Total per capita exp.)^2	-0.015	0.034	0.013	0.024
Price	0.173	0.552	0.199	0.285
Price * total per capita exp.	-0.273*	0.069	-0.036	0.034
Zone	-0.020	0.077	0.013	0.052
Household size	0.036	0.072	-0.474*	0.053
CPI	-1.225*	0.566	0.003	0.373
Central	0.262*	0.177	0.076	0.080
Chorotega	-0.169	0.139	0.009	0.095
Pacífico	0.106	0.135	-0.144	0.099
Huetar Norte	-0.116	0.145	-0.095	0.098
Huetar Atlántico	0.335*	0.130	-0.138	0.091
Likelihood	-768.87		-1654.23	
			Elasticities	
			Expenditure	Price
Quartile I			0.460	-1.057
Quartile II			0.477	-1.081
Quartile III			0.491	-1.100
Quartile IV			0.512	-1.130

* significantly different from zero at the ten percent level according to the standard t-test

Table A7.9: Estimation results for pastas

Variable	Cragg model			
	Probit equation		Truncated equation	
	Coefficient	Stand. error	Coefficient	Stand. error
Intercept	-94.291	315.901	-11.175*	3.222
Total per capita exp.	29.377	24.142	1.238*	0.508
(Total per capita exp.)^2	-1.753	1.448	-0.048*	0.026
Price	-52.552	746.203	-0.662	0.709
Price * total per capita exp.	3.532	73.014	0.108	0.087
Zone	3.641	58.542	-0.225*	0.056
Household size	0.250	0.555	-0.551*	0.056
CPI	-8.029*	4.751	1.673*	0.412
Central	-0.099	300.195	0.048	0.078
Chorotega	3.444	294.097	-0.277*	0.101
Pacífico	-0.591	489.512	-0.263*	0.098
Huetar Norte	-0.327	521.895	-0.071	0.090
Huetar Atlántico	3.861	294.101	-0.151	0.095
Likelihood	-16.67		-1203.43	
			Elasticities	
			Expenditure	Price
Quartile I			0.285	-0.887
Quartile II			0.222	-0.813
Quartile III			0.168	-0.755
Quartile IV			0.097	-0.672

* significantly different from zero at the ten percent level according to the standard t-test

Table A7.16: Estimation results for non-alcoholic beverages

Variable	Cragg model: Probit equation Coefficient	Stand. error	Truncated equation Coefficient	Stand. error
Intercept			0.230	3.388
Total per capita exp.			0.243	0.541
(Total per capita exp.)^2			0.019	0.030
Price			0.094	0.639
Price * total per capita exp.			-0.003	0.075
Zone			0.045	0.063
Household size			-0.514*	0.066
CPI			-0.043	0.456
Central			-0.051	0.102
Chorotega			0.191	0.117
Pacífico			0.264*	0.116
Huetar Norte			-0.003	0.128
Huetar Atlántico			0.113	0.110
Likelihood			-1454.13	
			Elasticities	
			Expenditure	Price
Quartile I			0.519	-0.926
Quartile II			0.545	-0.928
Quartile III			0.565	-0.930
Quartile IV			0.595	-0.932

* significantly different from zero at the ten percent level according to the standard t-test

** singular Hessian during Newton iterations

Table A7.17: Estimation results for tobacco products

Variable	Cragg model			
	Probit equation		Truncated equation	
	Coefficient	Stand. error	Coefficient	Stand. error
Intercept	-31.146	36.124	-3.721	3.569
Total per capita exp.	4.218	5.167	1.096*	0.549
(Total per capita exp.)^2	-0.180	0.266	-0.044	0.030
Price	-12.496*	4.699	-0.069	0.398
Price * total per capita exp.	0.996*	0.438	0.045	0.048
Zone	-1.052	0.783	-0.163*	0.069
Household size	-0.238	0.444	-0.719*	0.069
CPI	1.064	5.728	0.657	0.505
Central	-0.361	1.210	0.227*	0.108
Chorotega	-0.840	2.893	-0.022	0.128
Pacífico	1.141	1.027	0.143	0.127
Huetar Norte	0.061	1.050	0.147	0.140
Huetar Atlántico	-1.645	7.047	0.174	0.121
Likelihood	-11.69		-1219.06	
			Elasticities	
			Expenditure	Price
Quartile I			0.311	-0.751
Quartile II			0.246	-0.718
Quartile III			0.202	-0.694
Quartile IV			0.135	-0.667

* significantly different from zero at the ten percent level according to the standard t-test

Table A7.18: Estimation results for non-processed milk products

Variable	Cragg model			
	Probit equation		Truncated equation	
	Coefficient	Stand. error	Coefficient	Stand. error
Intercept	-50.149	7344.111	-13.641*	2.733
Total per capita exp.	0.989	629.566	2.521*	0.421
(Total per capita exp.)^2	-0.052	38.432	-0.077*	0.018
Price	-9.606	680.056	-1.670*	0.471
Price * total per capita exp.	0.227	82.473	0.235*	0.058
Zone	-0.563	161.085	-0.084*	0.039
Household size	0.054	77.530	-0.332*	0.039
CPI	8.301	1351.014	0.617*	0.281
Central	0.619	258.301	0.037	0.057
Chorotega	0.705	257.356	-0.072	0.067
Pacífico	-3.198	1065.012	0.088	0.069
Huetar Norte	-1.400	1863.988	0.292*	0.071
Huetar Atlántico	0.535	261.499	0.027	0.067
Likelihood	-0.000		-3279.29	
			Elasticities	
			Expenditure	Price
Quartile I			0.520	-0.994
Quartile II			0.420	-0.818
Quartile III			0.363	-0.694
Quartile IV			0.255	-0.513

* significantly different from zero at the ten percent level according to the standard t-test

Table A7.19: Estimation results for processed milk products

Variable	Cragg model			
	Probit equation		Truncated equation	
	Coefficient	Stand. error	Coefficient	Stand. error
Intercept	-45729*	15480	3.315	0.486
Total per capita exp.	10090*	3416	-2.285*	-2.209
(Total per capita exp.)^2	-557.051*	188.512	0.166*	2.284
Price	5686.099*	1949.101	-0.831	-0.579
Price * total per capita exp.	460.792*	160.098	0.069	0.416
Zone	4.220	47.981	-0.199	-1.480
Household size	-1.781	4.861	-0.440*	-3.086
CPI	7.304	15.221	1.375	1.366
Central	-1.212	134.098	-0.138	-0.690
Chorotega	-2.451	135.213	-0.269	-0.965
Pacífico	0.049	157.524	-0.358	-1.344
Huetar Norte	1.317	159.100	-0.317	-1.293
Huetar Atlántico	2.574	93.261	0.043	0.204
Likelihood	-2.25		-175.11	
			Elasticities	
			Expenditure	Price
Quartile I			-0.024	-1.332
Quartile II			0.200	-1.286
Quartile III			0.395	-1.245
Quartile IV			0.663	-1.187

* significantly different from zero at the ten percent level according to the standard t-test

Table A7.20: Estimation results for cheese

Variable	Cragg model: Probit equation Coefficient	Probit equation Stand. error	Truncated equation Coefficient	Truncated equation Stand. error
Intercept	-359.331	411.524	-1.537	3.215
Total per capita exp.	91.377	89.732	0.146	0.544
(Total per capita exp.)^2	-5.163	5.112	0.019	0.027
Price	-8.716	178.512	0.135	0.674
Price * total per capita exp.	-3.164	20.061	0.009	0.078
Zone	-0.323	0.693	-0.201*	0.051
Household size	1.169	1.045	-0.514*	0.052
CPI	-11.179	7.703	0.627*	0.376
Central	3.242	142.612	0.024	0.091
Chorotega	4.053	142.604	0.292*	0.103
Pacífico	0.848	165.310	0.000	0.102
Huetar Norte	0.553	158.297	0.245*	0.112
Huetar Atlántico	-0.318	176.003	-0.013	0.100
Likelihood	-9.22		-1298.54	
			Elasticities	
			Expenditure	Price
Quartile I			0.391	-0.799
Quartile II			0.420	-0.792
Quartile III			0.440	-0.787
Quartile IV			0.471	-0.779

* significantly different from zero at the ten percent level according to the standard t-test