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"ELASTICITIES?
CLARO QUE SI!

An analysis of the domestic Costan Rican food demand

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THE REPOSA PROJECT

The Research Program on Sustainability in Agriculture (REPOSA) is a cooperation between Wageningen Agricultural University (WAU), the Center for Research and Education in Tropical Agriculture (CATIE), and the Costa Rican Ministry of Agriculture and Livestock (MAG). In addition, REPOSA has signed memoranda of understanding with numerous academic, governmental, international and non-governmental organizations in Costa Rica.
The overall objective of REPOSA is the development of an interdisciplinary methodology for land use evaluation at various levels of aggregation. The methodology, based on a modular approach to the integration of different models and data bases, is denominated *USTED* (*Uso Sostenible de Tierras En el Desarrollo*; Sustainable Land Use in Development).
REPOSA provides research and practical training facilities for students from WAU as well as from other Dutch and regional educational institutions.
REPOSA's research results are actively disseminated through scientific publications, internal reports, students' thesis, and presentations at national and international conferences and symposia. Demonstrations are conducted regularly to familiarize interested researchers and organizations from both within and outside Costa Rica with the *USTED* methodology.
REPOSA is financed entirely by WAU under its Sustainable Land Use in the Tropics program, sub-program Sustainable Land Use in Central America. It operates mainly out of Guápiles where it is located on the experimental station *Los Diamantes* of MAG.

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REPOSA (*Research Program on Sustainability in Agriculture*, o sea Programa de Investigación sobre la Sostenibilidad en la Agricultura) es una cooperación entre la Universidad Agrícola de Wageningen, Holanda (UAW), el Centro Agronómico Trópical de Investigación y Enseñanza (CATIE) y el Ministerio de Agricultura y Ganadería de Costa Rica (MAG). Además REPOSA ha firmado cartas de entendimiento con organizaciones académicas, gubernamentales, internacionales y non-gubernamentales en Costa Rica.
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REPOSA es financiado por la UAW bajo su Programa del Uso Sostenible de la Tierra en los Areas Trópicos. La sede de REPOSA está ubicada en la Estación Experimental Los Diamantes del MAG en Guápiles.

Preface

With pleasure I have worked the last three months on this research, an analysis of the Costa Rican demand regarding important food products (product groups). This research broadened my knowledge and it made me realize again how interesting consumer behavior can be.

First of all I would like to thank Dr. Aad van Tilburg and Dr. Hans G.P. Jansen for giving me the opportunity to fulfill an interesting traineeship in a very beautiful country. Especially I would like to thank Hans Jansen for his support and comments during my traineeship here in Costa Rica.

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Arja Leonie van der Valk
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Chapter 1

1.1 Introduction

Food consumption provides the living of the human being. The basic objective of the theory of consumer behaviour is to explain how a rational consumer chooses what to consume when confronted with various prices and a limited income [1]. Food consumption patterns are very interesting and also indispensable for national food policy. In Costa Rica relatively little information is available concerning the structure of domestic food demand. Recently study was carried out by Geurts et al. (1997) analysing the buying behaviour of Costa Rican consumers regarding major food product categories. The aim of that study was to estimate Engel functions and to calculate related expenditure and price elasticities.

This research is a specified continuation on the study of Geurts et al. (1997). Expenditure and own-price elasticities are estimated for different agricultural products (product groups), based on the same methodology used in the survey of Geurts et al. (1997). In this chapter the used data, the methodology and model estimation will be discussed as well as the expenditure and own-price elasticities.

1.2 Data

Food consumption patterns in Costa Rica are analysed using household budget data from the 1987-88 National Household Income an Expenditure Survey. Data contained general characteristics of the household and of the members in the household; inventory of purchased food products; daily expenditure of the household; budget of the household; agricuitural production and (only for rural households) infrastructure of the residential area [2].

Two data sets, 'Hogar.txt' and 'Biernes.txt', were used to analyse the food demand in Costa Rica. The 'Hogar.txt' data set contained 3910 records, each record represented one family and their income and expenditures. Appendix A gives more detailed information about this data set.
The 'Biernes.txt' data set compromised 27,896 records with five variables related to the family variable. Each record represented a family and the quantity and value of their purchased products. If a family purchased, for example, seven different products, seven different records for that family are given in the 'Biernes.txt'. The specification of these variables is given in appendix B. The products are divided in 19 different products (product groups).

For the analysis of the food demand in Costa Rica, it was necessary to match the two data sets with each other in such a way that one record represents a family, their characteristics, their income and expenditures, and the quantity and value of their purchased products. This file-matching was done by a writing a computer program, in the computer language Pascal.

This program is given in appendix C. The result of running this program was a file of 3910 records, with a maximum of 88 purchased products per family record. All these different products had to be grouped in different product groups as explained in appendix B.Because of an error in the data set, 3908 observations are used in the estimation of the elasticities. Five products could not be analysed, due to missing values. In appendix B these products are underlined. These missing values rejected one product group, 'Macadamia', resulting in 18 different product groups left to be analysed.

1.3 Methodology

The Engel curve analysis is based on cross-sectional data from households.
As mentioned before, in this research the same methodology as in Geurts et al. (1997) was used to estimate the expenditure and price elasticities.
In order to provide a clear view of the used methodology, the models with their needed (explanatory) variables as well as a brief summary of the models are given.

- Expenditure equation : A double Logarithmic Quadratic Single Equation Model

$$\ln exp_i = \alpha_i + \beta_i \ln x + \gamma_i (\ln x)^2 + \delta_i \ln p_i + \varphi_i (\ln p.\ln x) + \lambda_i \ln N + K_i \ln CPI + \mu_i Z + \sum v_{im} r_m$$

exp_i	=	per capita expenditure on category i (i= 1 to 19) (¢ per month)
x	=	per capita total expenditure per month (¢)
p_i	=	price of good i (¢)
N	=	household size (number of members)
CPI	=	general monthly consumer price index (November 1987 = 100)
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)

- A-priori is expected that per capita total expenditure will have a positive effect on per capita expenditure on a particular category [3].
- Inclusion of a quadratic logarithmic expenditure term allows for commodities to be luxury, necessity or inferior goods at different levels of income [3].
- Own - price is expected to exert a negative influence for price-elastic categories [3].
- The interaction term of per capita expenditure with unit price allows price elasticities to vary according to total expenditure levels [3].
- General monthly consumer price index is included to pick up effects of other prices on the demand for a particular category where the share of the latter in total expenditure is to be small and because of its traditional role of deflating nominal economic variables [3].
- Per capita consumption is expected to be negatively influenced by household size, as larger households normally have lower per capita income as well as expenditure and may be more efficient in their use of foods [3].
- The effect of geographical differences in food demand patterns is accounted for by dummy variables. The six regions are represented by the inclusion of five dummies and the two zones are represented by one dummy variable [3].

1.4 Model estimation

The Tobit (Tobin, 1958) and Cragg (Cragg, 1971 ; Haines et al,. 1988) specifications are used to estimate the expenditure equation for each of the 18 products (product groups), using maximising likelihood techniques. In section 4.2 of Geurts et al. (1997) an extended explanation of the used models is given, therefore only a summary of the most important characteristics of both models is given.

1.4.1 The Tobit model

The Tobit mode is a censored regression model, that uses all (non-zero and zero) observations in the estimation process.

z_i = y_i if $y_i > 0$
= 0 otherwise
y_i = $f(x'b) + u_i$
= expenditure on food item i

With the Tobit model all households are considered to be potential purchasers (participate in the market) and are expected to buy beyond certain threshold levels of price (low) and income (high). In reality this does not always hold because there are consumers that never buy food item i.

1.4.2 The Cragg model

The Cragg model is a Double-Hurdle model, that distinguishes two sub-models:

- A Probit regression model, that uses all observations in the estimation process. The Probit regression estimates the probability of a household participating in the market *(the market- participation model)* or the probability of observing a purchase *(the infrequency of purchase model)* thus explaining the purchasing decision.

  z_i = 1 if $y_i > 0$
  = 0 otherwise
  y_i = $f(x'b) + u_i$
  = expenditure on food item i

- A Truncated regression model, using only all non-zero observations in the estimated process (i.e. meaning those households who actually bought the product during the time of the survey).

  y_i = $f(x'b) + u_i$
  = expenditure on food item i

To choose between the Tobit and Cragg model, a Likelihood Ratio (LR) test is used involving the calculation of a Chi-squared test statistic (λ):

$$\lambda = 2 \cdot (\ln L_{probit} + \ln L_{truncated} - \ln L_{tobit})$$

λ : Chi - squared test statistic
lnL : Log-Likelihood
v : degrees of freedom, equal to the number of restrictions or the number of explanatory variables in the model (Line and Schmidt, 1983)[3]

In this research seven products are considered to be a basic part of the diet in Costa Rica (rice, beans, beef, maize, sugar, coffee and potato) and therefore are likely to be consumed by all households. This indicates that the infrequency of purchase model will be used for those products (product groups). The remaining eleven products are given a market-participation model interpretation. Table 1.1 gives an review of the products (product groups) interpreted by a market-participation model or by an infrequency of purchase model.

Cragg model *The infrequency of purchase model*	*Gragg model* *The market- participation model*
Rice	Products de Milk
Beans	Products de Palm oil
Beef	Onion
Maize	Plantain
Sugar	Palm heart
Coffee	Banana
Potato	Mango
	Melon
	Orange
	Pineapple
	Cassava

Table 1.1: Review of products (product groups) analysed by the infrequency-of-purchase model and by the market-participation model

1.5 Elasticities

Section 4.4 of Geurts et al. (1997) describes very clearly the characteristics of the elasticities, so a brief summary of the most important characteristics of the expenditure and own-price elasticity is sufficient.

1.5.1 Expenditure elasticities

Expenditure elasticities measure the relative change in per capita expenditure of a particular good due to a change in per capita total expenditure. The expenditure elasticity depends on income (-) and own price (+): the expenditure elasticity is higher for lower incomes and higher prices.
Expenditure elasticities (η) are obtained as follows from the expenditure equation:

$$\eta = \beta + 2\gamma \ln x + \delta \ln p$$

Goods can be categorised according to the signs and magnitudes of the elasticities as follows [4]:

Normal good: $\eta_i > 0$ ($\eta_i > 1$ luxury ; $0 < \eta_i < 1$ necessity)
Neutral good: $\eta_i = 0$
Inferior good: $\eta_i < 0$

1.5.2 Own-price elasticities

Own-price elasticities measure the relative change in per capita expenditure on good I due to a change in the own-price of good i. The own-price elasticity depends on income (+) : lower price elasticities with higher incomes.

Own-price elasticities (ε) are as follows obtained from the expenditure equation:

$$\varepsilon = \delta + \varphi \ln x - 1$$

Goods can be categorised according to the signs and magnitudes of the elasticities as follows [4]:

Non - Giffen good: $\varepsilon_i < 0$ ($\varepsilon_i < -1$ elastic; $\varepsilon_i > -1$ inelastic)
Giffen good: $\varepsilon_i > 0$

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. To calculate expenditure- and price elasticities by income quartile, respectively average per capita expenditure and average own-price for each quartile were used.
A t-test is used to determine whether the elasticity estimates are statistically different from zero. For price elasticity estimates to be statistically different from zero, individual own-price coefficient estimates need not be significant [3]. Table 1.2 shows an overview of expenditure - and price elasticities for the 18 food categories analysed in this study.

* (**) significantly different from zero at the five (ten) percent level according to the t-test, see also section 5.2 and 5.3.2 of Geurts et al. (1997)

	Expenditure elasticities by total expenditure quartile (=Q)				*Price elasticities by total expenditure quartile (=Q)*			
Products	*QI*	*QII*	*QIII*	*QIV*	*QI*	*QII*	*QIII*	*QIV*
Rice	0.427*	0.288*	0.214*	0.123*	-0.878*	-0.867*	-0.861*	-0.823*
Maize	0.304*	0.265*	0.238*	0.213*	-1.009*	-0.944*	-0.916*	-0.875*
Beef	0.701*	0.570*	0.516*	0.430*	-0.880*	-0.895*	-0.901*	-0.911*
Beans	0.195*	0.170*	0.158*	0.141	-0.889*	-0.888*	-0.887*	-0.886*
Sugar	0.468*	0.314*	0.239*	0.142*	-1.032*	-0.999*	-0.983*	-0.962*
Milk	0.722*	0.571*	0.505*	0.416*	-0.895*	-0.882*	-0.876*	-0.868*
Palm oil	0.519*	0.419*	0.366*	0.304*	-1.158*	-1.087*	-1.051*	-1.006*
Onion	0.456*	0.361*	0.326*	0.270*	-0.819*	-0.846*	-0.856*	-0.872*
Potato	0.454*	0.336*	0.292*	0.221*	-0.739*	-0.814*	-0.844*	-0.888*
Coffee	0.356*	0.267*	0.225*	0.171*	-0.842*	-0.858*	-0.865*	-0.874*
Mango	2.013*	0.464*	0.296**	-0.173	-1.481**	-0.920*	-0.822*	-0.658**
Plantain	-0.059	0.161*	0.196*	0.252*	-0.883*	-0.836*	-0.820*	-0.795
Palm heart	-2.522	0.524	0.927	2.142**	-1.766**	-1.172*	-1.100*	-0.851**
Banana	0.211**	0.218*	0.218*	0.230*	-0.938**	-0.727*	-0.654*	0.528**
Melon	0.102	0.385**	0.437**	0.523**	-0.740	-0.816**	-0.829*	-0.850*
Orange	0.546**	0.656*	0.625*	0.629*	-0.735**	-0.673*	-0.577*	-0.738**
Pineapple	-0.237	0.092	0.167**	0.091	-0.796**	-0.733*	-0.719*	-0.734*
Cassava	0.026	0.083	0.099*	0.127	-0.492*	-0.590**	-0.618*	-0.666**

Table 1.2: Expenditure and price elasticities obtained from the Cragg model estimations, by income quartile

Looking at the expenditure- and price elasticities most of the products behave as expected, declining in the absolute value with rising income, although the price elasticities are all very high. The shaded elasticities do not behave as expected some elasticities (plantain, palm heart, melon, pineapple, cassava, potato and) more than others (banana, orange, beef, onion and coffee). Six products show non-significant expenditure elasticities and three products non-significant price-elasticities. For every product (product group) the average expenditure and own-income elasticities is calculated and the results are listed in table 1.3 on the following page.
The next session will briefly discuss each product (product group), starting with those products to which the 'infrequency of purchase model' interpretation of the Cragg specifications applies, followed by products for which the 'market participation model' is appropriate.

* (**) significantly different from zero at the five (ten) percent level according to the t-test, see also section 5.2 and 5.3.2 of Geurts et al. (1997)

	Expenditure elasticities by total expenditure quartile (=Q)	*Price elasticities by total expenditure quartile (=Q)*
Products	Average Q	Average Q
Rice	0.263*	-0.864*
Maize	0.255*	-0.936*
Beef	0.554*	-0.896*
Beans	0.166*	-0.887*
Sugar	0.290*	-0.993*
Milk	0.553*	-0.880*
Palm oil	0.402*	-1.075*
Onion	0.353*	-0.848*
Potato	0.325*	-0.822*
Coffee	0.255*	-0.859*
Mango	0.668*	-0.966*
Plantain	0.167*	-0.833*
Palm heart	0.414	-1.193*
Banana	0.219*	-0.711*
Melon	0.361	-0.808*
Orange	0.601*	-0.737*
Pineapple	0.077	-0.735*
Cassava	0.083	-0.591**

Table 1.3: Average expenditure and price elasticities obtained from the Cragg model estimations

Chapter 2

2.1 Infrequency of purchase model

This chapter will discuss seven products (product groups) which are interpreted by the infrequency-of-purchase model of the Gragg model. The significant coefficients of different variables will be analysed and at the end of the chapter a summary of the infrequency-of-purchase model results will be given.

2.2 Rice

Appendix D table I shows the computer results of the Probit and Truncated equation of rice. The probability of observing a rice purchase is influenced by total per capita expenditure and by the price of other products (both in a positive way).
Total per capita expenditure also has a significant positive influence on per capita expenditure on rice, while its squared term has a significant negative influence.
CPI has a positive effect which indicates that rice can act as a substitute for some other products. Household size has the expected negative influence on per capita expenditure, indicating that larger households have lower per capita expenditure on rice than smaller households.
Household members in urban areas consume less rice than those in rural areas.
Households in Central, Chorotega and Huetar Norte have lower capita expenditure on rice than the households in Brunca (reference region).
Expenditure elasticities sharply decline with rising income and lay in the range for a necessity. Price elasticities differ little by income which can be explained by the 'wrong' (significant) positive sign of the own-price variable.

2.3 Beans

Only the CPI has a (positive) significant influence on the probability of observing a beans purchase (appendix D, table II), indicating that an increase in the general price level increases the probability of observing a beans purchase. The CPI also has a positive effect on per capita expenditure on beans. This indicates that an increase in the general price level would result in an increase in per capita beans expenditure. Per capita expenditure on beans is influenced neither by per capita expenditure nor by own-price. Households size has a significant negative effect and urban areas have lower per capita expenditure on beans than the rural areas. This trend is confirmed by the fact that households in the Central region have a lower per capita expenditure on beans compared with those in the Brunca. Elasticities hardly vary with rising income, which finding can be explained by the relatively large number of non-significant coefficients in the regression model.

2.4 Beef

As with beans the CPI variable coefficient has a significant positive effect (relatively high) on the probability of observing a beef purchase (appendix D, table III).
Even though it does not influence the probability of observing a purchase, per capita total expenditure does have a positive significant effect on per capita expenditure on beef. The same holds for the own-price coefficient. The combination of a positive own-price coefficient and a negative price-income interaction term results in a price-inelastic demand.
Household members in urban areas consume more beef than household members in rural areas. Household size appears to have a negative effect on per capita meat expenditure. The significant positive coefficients of Chorotega, Huetar Norte and Huetar Atlantico indicate that household members in those regions have a higher expenditure on beef than households in the Brunca region.
Expenditure elasticities decline with rising income indicating that beef tends towards a luxury good for low-income families in comparison with higher income quartiles. Price elasticities do not behave as expected, which can be explained by the 'wrong' (significant) positive sign of the own-price variable. Although the increase of price elasticities with rising income is rather small, it does seem to suggest that rich households are more price sensitive than poor households.

2.5 Maize

Appendix D table IV shows a relatively large number of variable coefficients which have a significant influence on the probability of observing a maize purchase. The regional significant coefficients indicate that household in some regions have a lower probability of observing a maize purchase than households in the reference region Brunca.
Total per capita expenditure does not have a significant influence on per capita maize expenditure. The variables household size, zone and own-price, on the other hand, all exert significant negative effects. Also the regional dummies for Central and Pacifico have a significant negative influence on per capita maize expenditure, indicating that those regions have a lower per capita expenditure on maize than the Brunca region.
The expenditure elasticities behave as expected although the underlying expenditure coefficient is not significant. For low income groups maize is a price-elastic good, which becomes price inelastic at higher income levels.

2.6 Sugar

The Probit equation shows two variables, CPI (positive) and household size (negative) that have a significant effect on the probability of observing an sugar purchase. The former indicates that an increase in the general price level increases the probability of observing an rice purchase.

The Truncated equation indicates that per capita expenditure on sugar is positively affected by per capita total expenditure and negatively by its squared term, guaranteeing decreasing expenditure elasticities as income rises. Household size has the expected negative influence on per capita expenditure on sugar. Per capita expenditure on sugar in urban areas is lower than in rural areas, while the coefficients of the Huetar Norte and Chorotega region indicate that households in these regions spend more on sugar than household members in the Brunca region. As for the elasticities they all behave as expected although the underlying own-price variable is not significant.

2.7 Coffee

It was technically not possible to estimate the Probit equation because of a singular Hessian matrix during the iterative estimation procedure. This implies that it is impossible to say which variables significantly influence the probability of observing a coffee purchase.
Total per capita expenditure as well as the CPI have a significant positive effect on per capita coffee expenditure, indicating that coffee can substitute for other products when these get relatively expensive. Household size influences per capita expenditure in agreement with expectations, while households in the urban area have lower per capita coffee expenditure than households in the rural areas. Households in the Chorotega, Pacifico and Huetar Atlantico all have lower per capita expenditure than households in Brunca. Expenditure elasticities decline with rising income, contrary to the behaviour of the price elasticities. These indicate that the rich households are slightly more price sensitive than poor households. This may be due to the 'wrong' sign of the own-price variable in the regression model.

2.8 Potato

Two variables (CPI and Chorotega) significantly influence the probability of observing a potato purchase (appendix D, table VII). The regional variable's significant coefficient indicates that household in Chorotega have a lesser probability of observing a potato purchase than households in Brunca. The truncated equation shows that total per capita expenditure and own-price variable coefficients both have a significant positive effect on per capita potato expenditure. The CPI has a negatively significant effect which indicates that potato as a product is complementary. Household size has the expected negative influence on per capita expenditure, indicating that large households have lower per capita expenditure on potato than smaller households.
Household members in urban areas consume less potato than those in rural areas, although households in the central region consume more potato than in the Brunca region (this also holds for households in Huetar Norte). Expenditure elasticities behave as expected an indicate that potato is an necessary good. The price elasticities behave strangely indicating that richer households are more price sensitive, concerning potato, than poorer households. Again this can be explained by the 'wrong' significant own-price coefficient in the truncated regression model.

2.8 Summary of infrequency-of-purchase model results

Table 2.1 and table 2.1 show the signs of the significant coefficients estimated infrequency-of-purchase model and the expenditure equation.

Category	lnx	$(\ln x)^2$	lnp	lnp.lnx	z	lnN	lncpi	Cent	chir	Pac	Nor	Ati
Rice	+						+					
Beans							+					
Beaf							+					
Maize			+	-			+	-			-	-
Sugar						-	+					
Coffee												
Potato							+		-			

Table 2.1: 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	chir	Pac	Nor	Ati
Rice	+	-			-	-	+	-	-		-	
Beans					-	-	+	-				
Beef	+	-	+		+	-			+		+	+
Maize			-	+	-	-		-	+	-		
Sugar	+	-			-	-	+		+		+	
Coffee	+	-			-	-	+		-	-		-
Potato	+	-	+	-	-	-	-	+		-	+	

Table 2.2: Sign of significant coefficient in the Truncated equation of the infrequency-of-purchase model

Table 2.1 shows many empty cells indicating that only a few variable coefficients significantly influenced the probability of observing a purchase of a product.
The table shows that for every product, except for coffee, CPI positively influence the probability of observing a purchase, indicating that an increase in the general price level increases the probability of observing a product purchase.
The Truncated equation resulted in more significantly coefficients. Per capita total expenditure, has the a-priori assumed, positive influence on five products. The results concerning the own-price variable coefficient were less stable. The CPI coefficient is positive for most products. As expected, household size has a negative significant influence on per capita expenditure of a product. The results for the regional dummy variable coefficients vary by product.

Chapter 3

3.1 Market-participation models

This chapter discuss the remaining eleven products analysed with the market-participation model of the Cragg model. Again the important variables, which have a (significant) influence on the probability of observing a purchase and per capita expenditure, will be analysed for every product. At the end of this chapter a summary of the market-participation results will be given.

3.2 Milk products

It was technically not possible to estimate the Probit equation because of a singular Hessian Matrix during the iterative estimation procedure (Appendix E, table I). The Truncated equation did not give such technical problems. Per capita total expenditure had the expected positive effect on per capita milk expenditure. This also holds for household size (negative), as larger households normally have lower per capita income. The CPI shows that milk can relatively easily be a substitute for other products. Households in Huetar Norte consume more milk than households in the reference region (Brunca). Expenditure elasticities decline with rising income, even though price elasticities differ little with rising income. Regarding the price elasticity estimates, the underlying expenditure coefficient is significantly different from zero, in contrast to the underlying own-price coefficient.

3.3 Palm oil

The Probit equation (Appendix E, table II) shows that CPI is the only significant variable which has an (positive) influence on the probability of a household being in the market, meaning that an increasing general price level increases the probability of a household being in the market, a result which is rather difficult to explain.
Although total per capita expenditure and own-price do not significant influence the probability of a households being in the palm oil market, they all have a significantly influence on per capita palm oil expenditure. The own-price variable coefficient suggests that price elasticities are elastic. Household size have the expected negative influence on per capita palm oil expenditure and households in the urban zone consume less palm oil than households in the rural zone. Households in the region Chorotega spend more money on palm oil than households in the region Brunca. The coefficient of CPI indicates that palm oil can be used as a substitute for other products. Expenditure and own-price elasticities behave as expected. Both underlying coefficients were significant different from zero.

3.4 Onion

Own-price and CPI are variables which coefficients have a positive influence on the probability of a household being in the market of onion (Appendix E, table III).
Total per capita expenditure and own-price variables both have a positive significant influence on per capita onion expenditure. This latter also holds the variable CPI, while household size has a negative influence. Households in the urban zone consume less onion than households in the rural zone. Households in the Central region spend less money on onion than households in the reference region, in contrary to households in the Huetar Atlantico. Expenditure elasticities decline with rising income. Price elasticities indicate that richer households are (a bit) more price-sensitive than poorer households, a result which is caused by the positive (significant) own-price coefficient estimate.

3.5 Plantain

The Probit equation resulted in four variables which coefficients have a significant effect on the probability of a household being in the market (Appendix E, table IV). The CPI has a rather positive influence indicating that an increase in the general price level increases the probability of a household being in the plantain market.
This seems contradictory but is difficult to explain.
Total per capita expenditure and own-price do not significantly influence the per capita plantain expenditure. The coefficient of CPI indicates that plantain is a substitute for other products. Households in the urban zone consume less plantain than households in the rural zone and household size has a negative significant influence on per capita expenditure on plantain. Expenditure elasticities behave contrary to a-priori expectations (probably as a result of the 'wrong' sign of the total expenditure variable), contrary to the price elasticities. Both underlying coefficients are non-significant, so the results are not robust.

3.6 Banana

Appendix E, table V shows a good number of significant coefficients for the Probit equation. Total per capita expenditure and own-price have a significant positive influence on the probability of a household being in the banana market. This also counts for the coefficients of the variables household and zone. Households in the central region have a higher probability of participating in the banana market, which is logical because there is less own production.
Total per capita expenditure has a significant influence on the probability of a household being in the market, even though it does not have an influence on per capita banana expenditure, in contrary to own-price. Households size has the expected negative influence on per capita banana expenditure.
Expenditure elasticities increase a little with increasing income, which is contrary to a-priori expectations (the underlying expenditure coefficient is not significant). Price elasticities behave as expected with, a significant underlying own-price coefficient.

3.7 Palm heart

The Probit equation shows four variables, i.e. household size (positive) and Central, Chorotega and Pacifico (negative) that have a significant effect on the probability of a household being in the market (Appendix E, table VI).
The truncated equation shows that both total per capita expenditure and own-price have a significant negative influence on per capita palm heart expenditure. The former is contrary to what one would believe is true (per capita total expenditure should have a positive effect on per capita palm heart expenditure).
The negative own-price coefficient estimates suggests that price elasticities are elastic. Although the underlying expenditure coefficient is significant, expenditure elasticities behave strange. This can be explained by the 'wrong' (significant) sign of the total expenditure variable. The price elasticities behave as expected, the first three price elasticities show that palm heart is a price-elastic good but which turns inelastic for the richest quartile.

3.8 Mango

Appendix E, table VII shows that the probability of a household being in the mango market is significant influenced by one variable (interaction term). High standard errors for the coefficient estimates of the remaining variables might point toward a multicollinearity problem. In contrast to the Probit equations, the Truncated equation resulted in many significant variable coefficients. Total per capita expenditure influences per capita mango expenditure as expected (positively), as does household size (negatively). The quadratic expenditure and the interaction term have opposite effects; whereas the former discourages the effect of income on the expenditure on mango, the positive sign of the interaction term forces the price elasticity to decrease with rising income. The region variables show that households in the regions Central and Huetar Atlantico consume more mango compared with households in the Brunca. Both the expenditure and price elasticities behave as expected and their underlying coefficients are significantly different from zero. The expenditure elasticities indicate that mango is a luxury good for low income groups but a necessity for higher income groups. Similarly, for low income groups mango is a price-elastic good, which becomes price-inelastic at higher income levels.

3.9 Melon

The Probit equation results show that two variables have a significant influence on the probability of a household being in the market (Appendix E, table VIII). The CPI has a fairly strong significant influence, indicating that prices of other products negatively influences the probability of a household participate in the melon market. Also the Truncated equation shows only a few variables which have a significant influence per capita mango expenditure. Per capita expenditure on melon is influenced neither by per capita expenditure nor by own-price. The coefficient of the CPI indicates that melon can be used as a substitute for other products when these get relatively expensive. The regions Chorotega, Pacifico and Huetar Norte all have households who consume more melon than households in the reference region. The expenditure elasticities as well as the price elasticities both behave strangely, increasing with increasing income, but it is worthily to mention that the total expenditure variable and the own-price variable both

have the 'wrong' (significant) sign. Besides this are the underlying coefficients non-significant.

3.10 Orange

Appendix E, table IX shows that the own-price variable coefficient has a positive significant influence on the probability of a household being in the market. This also counts for the coefficients of the variables zone and household size. The latter also has the expected negative effect on per capita orange expenditure.
Per capita expenditure on orange is influenced neither by total per capita expenditure nor by own-price. A negative coefficient for CPI indicates a complementary character of a good, which in case of orange is hard to believe. The households in the regions Pacifico and Huetar Atlantico consume less orange than households in the region Brunca. The former is quite strange because there are many oranges in the region Pacifico.
The expenditure elasticities behave quite strangely in contrary to the price elasticities. For the lowest income group orange tend to be a price-elastic good. Both underlying coefficients are non-significant.

3.11 Pineapple

The Probit equation (Appendix E, table X) indicates that household size negatively influences the probability of a household being in the pineapple market. It also suggests that households in the Pacifico have a lower probability of participating in the market of pineapple. Although own-price significantly influences the probability of a household being in the market it does not significantly influences per capita pineapple expenditure. Total per capita expenditure (negatively) influences per capita pineapple expenditure and so does the household size. All significant regional coefficients indicate that in those regions the product pineapple is less consumed than in the Brunca region. The expenditure elasticities behave strangely as a result of the 'wrong' (significant negative) sign of the total expenditure variable. The price elasticities decrease rather slowly as a result of the non-significant coefficient of the own-price variable.

3.12 Cassava

Own-price has a positive effect on the probability of a household being in the cassava market, while the interaction term of price and total expenditure has a significant negative effect, indicating that the positive price effect is weaker at higher income (Appendix E, table XI). Only the own-price coefficient significantly influences the per capita cassava expenditure. Household size has the expected negative influence and households in the urban zone consume less cassava than households in the rural zone. The negative coefficients of the variables Central, Chorotega and Pacifico indicate that households in these regions consume less cassava than households in the reference region.
Both expenditure and price elasticities do not behave as expected, mainly because of the 'wrong' sign of the (significant) total expenditure variable and the positive own-price variable.

3.13 Summary of market-participation-model results:

Table 3.1 and 3.2 list the signs of the significant coefficients estimated with the market-participation model and the expenditure equation.

Category	lnx	$(lnx)^2$	lnp	lnp.lnx	z	lnN	Incpt	Cent	chor	Pac	Nort	Atl
Milk												
Palm oil							+					
Onion			+				+					
Plantain												
Banana	+	-	+	-	+	+	-	+				
Palm heart						+		-	-	-		
Mango				+								
Melon			+				-					
Orange			+		+	+	-				+	
Pineapple	+		+			-				-		-
Cassava			+	-							+	

Table 3.1: Sign of significant coefficients in the Probit equation of the market participation model

Category	lnx	$(lnx)^2$	lnp	lnp.lnx	z	lnN	Incpt	Cent	chor	Pac	Nort	Atl
Milk	+	-				-	+	+			+	
Palm oil	+	-	-	+	-	-	+		+			
Onion	+	-	+		-	-	+	-			+	
Plantain		+			-	-	+					
Banana			-	+		-						
Palm heart	-	+	-	+								
Mango	+	-	-	+		-		+				+
Melon							+		+	+	+	
Orange				+		-	-			-		-
Pineapple	-	+				-	+	-	-	-		-
Cassava			+	-	-	-		-	-	-		

Table 3.2: Sign of significant coefficients in the Truncated equation of the market participation model

Table 3.1 shows that only banana and orange have relatively many significant coefficients influencing the probability of a household being in the market. For the remaining products the Probit equation did not result in many significant coefficients. Own-price (positive for all related products) acts as a more important variable in the market-participation model than in the infrequency-of-purchase model. The positive sign of these coefficients indicate that the probability of a household participating in the market is bigger when price reaches a certain level. The table shows also that household size has a positive influence of the probability of a household being in the market.

For four products per capita total expenditure shows the expected positive influence on the per capita expenditure; for five products capita total expenditure did not have a significant influence; and for palm heart and pineapple this variable gave an unexpected positive significant influence.

Own-price has a negative significant influence on four products, and for two products a positive significant influences. Per capita expenditure for the remaining 5 other products was not influenced by own-price. The significant coefficient of the zonity variable is negative for four products indicating that households in the urban zone consume less of these products than households of the rural zone. Household size has the expected negative influence on per capita expenditure. As in the case of the infrequency-of-purchase models, the results for the regional dummy variables vary by product which might indicate regional preferences and availability.

Chapter 4

4.1 Reviewing

Recently a study was carried out by Geurts et al. (1997) analysing food consumption patterns in Costa Rica. This study is a follow up of the study of Geurts et al. (1997) only focused on more specific products (product groups). The goal of this study was to estimate the expenditure and own-price elasticities of 18 important food products (product groups) using the same methodology (Cragg-type double hurdle model) as used in Geurts et al (1997).
In 1987-88 a National household income and expenditure survey was carried out and the data of this survey has been used as the input for the estimation of the elasticities.

The Cragg model distinguishes two sub-models, namely a Probit regression model (using non-zero and zero observations) which is used to identify the factors that explain the purchasing decision and the truncated regression equation (using only non-zero observations) to determine the factors that influence quantities bought. Products which can be considered as being consumed by the entire Costa Rican population are analysed by an infrequency-of-purchase interpretation (this counted for seven of the eighteen analysed products. For the remaining eleven products 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 given.

Monthly per capita expenditure on a particular food product was the dependent variable in the estimated model specification. The independent variables were 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. Dummies were included for the effect of regional differences in food demand patterns and to distinguish six different regions. The quadratic expenditure term and an own-price total expenditure interaction variable allowed both expenditure and own-price elasticities to vary by income quartile.

4.2 Summary and conclusions

Per capita expenditure concerning all products is consistently (as a-priori expected) negatively influenced by household size, meaning that large households have lower per capita expenditure on a particular product than smaller households. The coefficient of the zonity variable shows that, at lest for some products, food expenditure patterns significantly differ between rural and urban areas. Of the 18 analysed product groups, 7 product groups (milk, banana, palm heart, mango, melon, orange and pineapple) did not have coefficients which indicate a significant difference between rural and urban expenditure, in contrary to the remaining 11 products . Households in the urban zone consume less palm oil, onion, plantain, cassava, rice, beans, maize, sugar, coffee, potato than households in the rural zone. Beef is the only product which is more consumed by households in the urban zone than households in the rural zone.

Of the 18 products, the general price level significantly influenced total expenditure of 12 products. The results indicated that rice, beans, sugar, coffee, milk, palm oil, onion, plantain, melon and pineapple can be used as a substitute for other products. Orange and potato were pointed out as complements.
Looking at the elasticities, expenditure elasticities estimated for the product groups analysed with the infrequency-of-purchase model all were smaller than 0.5 (with the exception of beef). First, this indicates that all these products can be considered as necessities. Second it shows that expenditure on each of these products increases less than 0.5% for each percentage point increase in total expenditure (or income). For all these products the estimated elasticities decreased with rising income, i.e. behaved as expected. The estimated expenditure elasticity for beans for tha last income quartile was statistically non-significant.

The products approached by a market-participation model showed more varied elasticities. The products plantain, melon, cassava, pineapple and palm heart all have a 'wrong' sign of the total expenditure elasticities with rising income, resulting in increasing (instead of the expected decreasing) expenditure elasticities with rising income. This latter also holds for banana, orange but now as a result of a non-significant expenditure coefficient. The expenditure elasticities of mango and palm heart show that these products are luxury for lower income groups, however the expenditure elasticities of palm heart show that palm heart is also a luxury good for higher income groups.

Most price elasticities are negative but on the high side. Nine products (rice, beans, sugar, coffee, milk, plantain, melon, orange, pineapple) had a non-significant own-price variable. The products beef, coffee, potato, onion, melon and cassava all have a 'wrong' sign of the own-price variable resulting in increasing price elasticities with rising income (in contrary to expectations). Absolute price elasticity estimates exceeded one (pointing to price-elastic demand) for the products palm oil and palm heart. Demand for mango, maize and sugar showed a price-elastic demand in the first income group, although the demand for the remaining income quartiles are price-inelastic.

Appendix A Data set Hogar in ASCII language

Núm.	Nombre		Largo
01	Periodo		6
02	Segmento		8
03	Vivienda		2
04	Hogar		1
05	HV 53	= Miembros activos	2
06	HV 54	= Miembros inactivos	2
07	HV 81	= Población Economice Activa, 12 años y más	2
08	HV 99	= Gasto mensual, aliment.,bebidas, Tobacco	8
09	HV 100	= Gasto mensual, vestido y calzado	8
10	HV 101-1	= Gasto mensual, alquiler etc.	8
11	HV 102	= Gasto mensual, muebles etc.	8
12	HV 103	= Gasto mensual, servicio medico etc.	8
14	HV 104	= Gasto mensual, transporte y comunicaciones	8
15	HV 105	= Gasto mensual, educación etc.	8
16	HV 106-1	= Alimentos y bebidas fuera de la vivienda	8
17	HV 106-2	= Otros gastos	8
18	HV 140	= Zona	1
19	HV 141	= Región	1
20	HV 142	= Área	1
21	Factor	= Factor de Expansión	9

Appendix B Data set Viernes in ASCII language

Núm.	Nombre	Largo
01	Periodo	6
02	Segmento	8
03	Vivienda	2
04	Hogar	1
05	Código	2
06	Cantidad	2
07	Valor	2

Núm. de Grupo	Producto	Código
1.00	**Arroz**	
1.01	Arroz	10132
2.00	**Maíz**	
2.01	Harina de maíz	110141
2.02	Maicena	110144
2.03	Maíz cascado	110145
2.04	Maíz dulce	110146
2.05	Maíz para palomitas	110147
2.06	Malta	110148
2.07	Masa de maíz	110149
2.08	Tortilla de maíz	110155
2.09	Bita maíz	110156
2.10	Maíz corriente	110157
3.00	**Carne**	
3.01	Carne molida corriente	110202
3.02	Carne molida especial	110203
3.03	Carne para asar	110204
3.04	Chuleta	110205
3.05	Costilla	110206
3.06	Falda	110207
3.07	Hígado	110208
3.08	Lengua	110209
3.09	Lomito	110210

Núm. de Grupo	Producto	Código
3.10	Lomo	110211
3.11	Mano de piedra	110212
3.12	Mondongo	110213
3.13	Morcilla	110214
3.14	Posta de lomo	110215
3.15	Posta de res primera	110216
3.16	Posta de res segunda	110217
3.17	Posta y hueso	110218
3.18	Trabo	110219
3.19	Riñón	110220
3.20	Sesos	110221
3.21	T-bone	110222
3.22	Otros carnes de res	110234
4.00	**Productos de leche**	
4.01	Leche agria	110401
4.02	Leche condensada	110402
4.03	Leche en polvo	110403
4.04	Leche evaporada	110404
4.05	Leche fresca	110405
4.06	Leche homogeneizada y pasteurizada	110406
4.07	Otras leches	110412
4.08	Crema dulce	110413
4.09	Cuajada	110414
4.10	Dulce de leche	110415
4.11	Helados	110416
4.12	Natillas	110417
4.13	Queque con helado	110418
4.14	Queso amarillo	110419
4.15	Queso blanco	110420
4.16	Queso crema	110421
4.17	Queso procesado	110422
4.18	Requesón	110423
4.19	Suero de leche	110424
4.20	Yogur	110425
4.21	Otros productos lácteos	110436
4.22	Otros quesos	110437
5.00	**Productos de Palma Africana**	
5.01	Aceite vegetal	110504
5.02	Manteca vegetal	110506
5.03	Margarina	110509
6.00	**Cebolla**	
6.01	Cebolla	110612

Núm. de Grupo	Producto	Código
7.00	**Plátano**	
7.01	Plátano	110626
8.00	**Palmito**	
8.01	Pejibaye	110737
8.02	Palmito en conserva	110659
9.00	**Banano**	
9.01	Banano	110703
9.02	Banano pasa	110704
10.00	**Mango**	
10.01	Mango	110726
11.00	**Melón**	
11.01	Melón	110732
12.00	**Naranja**	
12.01	Naranja	110735
13.00	**Pina**	
13.01	Pina	110738
13.02	Pina en conserva	110785
14.00	**Macadamia**	
14.01	Macadamia	110762
15.00	**Frijoles**	
15.01	Frijoles blancos	110803
15.02	Frijoles listos para comer	110804
15.03	Frijoles molidos	110805
15.04	Frijoles negros	110806
15.05	Frijoles rojos	110807
15.06	Frijoles no especificados	110808
15.07	Frijoles tiernos	110815
16.00	**Papa**	
16.01	Papa	110905
17.00	**Yuca**	
17.01	Yuca	110907
17.02	Harina de Yuca	110920

Núm. de Grupo	Producto	Código
18.00	**Azúcar**	
18.01	Azúcar corriente	111001
18.02	Azúcar en cúbitos	111002
18.03	Azúcar molido	111003
18.04	Azúcar moreno	111004
18.05	Azúcar refinado	111005
19.00	**Café**	
19.01	Café en grano	111103
19.02	Café instantáneo	111104
19.03	Café molido	111105

Appendix C Computer program in Pascal language

```
program merge;
uses
  crt;

type
 product = record
   two : string[9];
   three : string[9];
 end;

var
  tab1_1 : string[6];  tab1_11 : string[8];
  tab1_2 : string[11]; tab1_12 : string[8];
  tab1_3 : string[2];  tab1_13 : string[8];
  tab1_4 : string[2];  tab1_14 : string[8];
  tab1_5 : string[2];  tab1_15 : string[1];
  tab1_6 : string[8];  tab1_16 : string[1];
  tab1_7 : string[8];  tab1_17 : string[1];
  tab1_8 : string[8];  tab1_18 : string[9];
  tab1_9 : string[8];
  tab1_10 : string[8];

  tab2_1 : string[6];
  tab2_2 : string[11];
  tab2_3 : string[6];
  tab2_4 : string[9];
  tab2_5 : string[9];

  outstring : array[1..90] of product;

  in_file1,in_file2  : TEXT;
  out_file,p,q : TEXT;

  code : longint;
  dum,clm : integer;
  i,j,k,l : integer;
  c : char;

procedure pause;
begin
  repeat
    c:=readkey;
  until(c<>'');
end;
```

```
begin
  clrscr;
  assign(in_file1,'hogar.txt');
  reset(in_file1);
  assign(in_file2,'bienes.txt');
  reset(in_file2);

  assign(out_file,'outtest.txt');
  rewrite(out_file);


  for i:=1 to 3910 do begin

    for k:=1 to 90 do begin
      outstring[k].two:= '000000000';
      outstring[k].three:='000000000';
    end;

    writeln(i:10);


readln(in_file1,tab1_1,tab1_2,tab1_3,tab1_4,tab1_5,tab1_6,tab1_7,tab1_8,tab1_9,tab1
_10,
          tab1_11,tab1_12,tab1_13,tab1_14,tab1_15,tab1_16,tab1_17,tab1_18);

    reset(in_file2);

    for j:=1 to 27896 do begin
      readln(in_file2,tab2_1,tab2_2,tab2_3,tab2_4,tab2_5);


      (* als familienaam uit bienes is gelijk aan
        familienaam uit hogar dan *)

      if(tab2_2=tab1_2) then begin
        writeln(tab2_2);

        val(tab2_3,code,dum);
        code:=code-100000;

        case code of
          10132 : clm:=1;
          10141 : clm:=2;
          10144 : clm:=3;
          10145 : clm:=4;
          10146 : clm:=5;
          10147 : clm:=6;
          10148 : clm:=7;
```

```
10149 : dm:=8;
10155 : dm:=9;
10156 : dm:=10;
10157 : dm:=11;
10202 : dm:=12;
10203 : dm:=13;
10204 : dm:=14;
10205 : dm:=15;
10206 : dm:=16;
10207 : dm:=17;
10208 : dm:=18;
10209 : dm:=19;
10210 : dm:=20;
10211 : dm:=21;
10212 : dm:=22;
10213 : dm:=23;
10214 : dm:=24;
10215 : dm:=25;
10216 : dm:=26;
10217 : dm:=27;
10218 : dm:=28;
10219 : dm:=29;
10220 : dm:=30;
10221 : dm:=31;
10222 : dm:=32;
10234 : dm:=33;
10401 : dm:=34;
10402 : dm:=35;
10403 : dm:=36;
10404 : dm:=37;
10405 : dm:=38;
10406 : dm:=39;
10412 : dm:=40;
10413 : dm:=41;
10414 : dm:=42;
10415 : dm:=43;
10416 : dm:=44;
10417 : dm:=45;
10418 : dm:=46;
10419 : dm:=47;
10420 : dm:=48;
10421 : dm:=49;
10422 : dm:=50;
10423 : dm:=51;
10424 : dm:=52;
10425 : dm:=53;
10436 : dm:=54;
10437 : dm:=55;
10504 : dm:=56;
```

```
        10506  : clm:=57;
        10509  : clm:=58;
        10612  : clm:=59;
        10626  : clm:=60;
        10737  : clm:=61;
        10659  : clm:=62;
        10703  : clm:=63;
        10757  : clm:=64;
        10726  : clm:=65;
        10732  : clm:=66;
        10735  : clm:=67;
        10738  : clm:=68;
        10785  : clm:=69;
        10762  : clm:=70;
        10803  : clm:=71;
        10804  : clm:=72;
        10805  : clm:=73;
        10806  : clm:=74;
        10807  : clm:=75;
        10808  : clm:=76;
        10815  : clm:=77;
        10905  : clm:=78;
        10919  : clm:=79;
        10907  : clm:=80;
        10920  : clm:=81;
        11001  : clm:=82;
        11002  : clm:=83;
        11003  : clm:=84;
        11004  : clm:=85;
        11005  : clm:=86;
        11103  : clm:=87;
        11104  : clm:=88;
        11105  : clm:=89;
      else
        clm:=90;
        tab2_3:='       0';
      end;
      outstring[clm].two:=tab2_4;
      outstring[clm].three:=tab2_5;

    end; (* if *)


end;
write(out_file,tab1_1,' ',tab1_2,' ',tab1_3,' ',tab1_4,' ',tab1_5,' ',
              tab1_6,' ',tab1_7,' ',tab1_8,' ',tab1_9,' ',tab1_10,' ',
              tab1_11,' ',tab1_12 ,' ',tab1_13,' ',tab1_14,' ',tab1_15,' ',
              tab1_16,' ',tab1_17,' ',tab1_18,' ');
```

```
      for k:=1 to 90 do begin
        write(out_file,outstring[k].two,' ');
        write(out_file,outstring[k].three,' ');

      end;
       writeln(out_file);

    end;

    close(in_file1);
    close(in_file2);
    close(out_file);

    writeln('ready');
    pause;

end.
```

Appendix D :Infrequency-of-purchase model results

Table I: Computer results of the Probit and Truncated equation (Rice)

Rice *Variabele*	*Probit Equation* *Coefficient*	*Standard error*	*Truncated Equation* *Coefficient*	*Standard error*
Intercept	-20.697*	6.286	-9.274*	1.908
Total per capita expenditure	1.338*	0.997	1.298*	0.295
(Total per capita expenditure)^2	0.071	0.058	-0.067*	0.016
Price	-2.659	50.07	0.048	0.274
Price * Total per capita expenditure	0.950	8.928	0.010	0.032
Zone	0.043	0.139	-0.213*	0.038
Household size	-0.014	0.118	-0.262*	0.035
CPI	2.660*	1.014	1.761*	0.277
Central	0.189	0.210	-0.324*	0.053
Chorotega	-0.278	0.289	-0.096*	0.059
Pacifico	-0.172	0.273	0.019	0.063
Huetar Norte	0.142	0.244	-0.134*	0.062
Huetar Atlantico	0.001	0.242	0.025	0.064
Likelihood	-232.3095		-2173.703	
	Expenditure elasticities		*Price elasticities*	
Quartile I	0.427		- 0.878	
Quartile II	0.288		- 0.867	
Quartile III	0.214		- 0.861	
Quartile IV	0.123		- 0.853	

N.B. Likelihood of Tobit Equation = - 3545.431
Loglikehood Ratio = 2278.836

Table II: Computer results of the Probit and Truncated equation (Beans)

Beans *Variabele*	*Probit Equation* *Coefficient*	*Standard error*	*Truncated Equation* *Coefficient*	*Standard error*
Intercept	-17.216*	6.320	-0.363	2.153
Total per capita expenditure	0.849	0.926	0.346	0.323
(Total per capita expenditure)^2	-0.037	0.054	-0.011	0.017
Price	-0.322	43.13	0.102	0.269
Price * Total per capita expenditure	0.411	7.660	0.001	0.031
Zone	-0.175	0.140	-0.228*	0.043
Household size	-0.078	0.113	-0.404*	0.042
CPI	2.33*	1.053	0.627*	0.307
Central	-0.016	0.195	-0.095*	0.062
Chorotega	-0.353	0.270	0.060	0.068
Pacifico	-0.116	0.242	-0.035	0.073
Huetar Norte	-0.010	0.224	-0.016	0.072
Huetar Atlantico	-0.081	0.224	0.062	0.072
Likelihood	-225.7822		-1924.219	
	Expenditure elasticities		*Price elasticities*	
Quartile I	0.195		- 0.889	
Quartile II	0.170		- 0.888	
Quartile III	0.158		- 0.887	
Quartile IV	0.142		- 0.886	

N.B. Likelihood of Tobit Equation = - 2970.307
Loglikehood Ratio = 1660.613

Table III: Computer results of the Probit and Truncated equation (Beef)

Beef *Variabele*	*Probit Equation* *Coefficient*	*Standard error*	*Truncated Equation* *Coefficient*	*Standard error*
Intercept	-21.200*	5.567	-4.221*	2.073
Total per capita expenditure	0.507	0.750	1.644*	0.350
(Total per capita expenditure)^2	-0.011	0.044	-0.061*	0.020
Price	-0.090	34.42	0.217*	0.153
Price * Total per capita expenditure	0.301	5.464	-0.013	0.017
Zone	0.003	0.126	0.081*	0.039
Household size	0.047	0.103	-0.453*	0.042
CPI	3.359*	0.968	0.052	0.294
Central	0.124	0.189	-0.079	0.061
Chorotega	-0.293	0.254	0.218*	0.071
Pacifico	0.287	0.213	0.008	0.070
Huetar Norte	0.265	0.208	0.175*	0.071
Huetar Atlantico	0.004	0.217	0.173*	0.071
Likelihood	-300.6969			
	Expenditure elasticities		*Price elasticities*	
Quartile I	0.701		- 0.880	
Quartile II	0.570		- 0.895	
Quartile III	0.516		- 0.901	
Quartile IV	0.430		- 0.911	

N.B. Likelihood of Tobit Equation = -3632.658
Loglikehood Ratio = 2657.741

Table IV: Computer results of the Probit and Truncated equation (Maize)

Maize *Variabele*	*Probit Equation* *Coefficient*	*Standard error*	*Truncated Equation* *Coefficient*	*Standard error*
Intercept	-14.636*	4.393	2.701	2.715
Total per capita expenditure	0.860	0.646	0.405	0.431
(Total per capita expenditure)^2	-0.035	0.038	-0.02	0.025
Price	2.850*	0.646	-0.424*	0.219
Price * Total per capita expenditure	-0.178*	0.073	0.059*	0.026
Zone	-0.048	0.099	-0.390*	0.058
Household size	0.096	0.083	-0.556*	0.060
CPI	1.771*	0.735	-0.035	0.432
Central	-0.491*	0.154	-0.140*	0.088
Chorotega	0.132	0.138	0.349*	0.102
Pacifico	-0.183	0.162	-0.247*	0.104
Huetar Norte	-0.233*	0.167	0.112	0.100
Huetar Atlantico	-0.240*	0.155	-0.016	0.108
Likelihood	-483.2784			
	Expenditure elasticities		*Price elasticities*	
Quartile I	0.304		- 1.009	
Quartile II	0.265		- 0.944	
Quartile III	0.238		- 0.916	
Quartile IV	0.213		- 0.875	

N.B. Likelihood of Tobit Equation = 1755.669
Loglikehood Ratio = -3299.139

Table V: Computer results of the Probit and Truncated equation (Sugar)

Sugar *Variabele*	*Probit Equation* *Coefficient*	*Standard error*	*Truncated Equation* *Coefficient*	*Standard error*
Intercept	-23.327*	7.372	-3.620*	1.837
Total per capita expenditure	0.769	1.059	1.287*	0.268
(Total per capita expenditure)^2	-0.031	0.061	-0.068*	0.014
Price	-0.691	35.75	-0.230	0.306
Price * Total per capita expenditure	0.542	6.463	0.029	0.035
Zone	-0.168	0.156	-0.270*	0.036
Household size	-0.181*	0.124	-0.333*	0.033
CPI	3.658*	1.224	0.586*	0.262
Central	0.126	0.236	-0.001	0.052
Chorotega	-0.107	0.298	0.127*	0.058
Pacifico	0.135	0.275	-0.009	0.060
Huetar Norte	0.187	0.268	0.162*	0.059
Huetar Atlantico	0.092	0.262	0.0618	0.062
Likelihood	-184.1683		-2123.791	
	Expenditure elasticities		*Price elasticities*	
Quartile I	0.468		- 1.032	
Quartile II	0.314		- 0.999	
Quartile III	0.239		- 0.983	
Quartile IV	0.141		- 0.962	

N.B. Likelihood of Tobit Equation = -3325.271
Loglikehood Ratio = 2034.623

Table VI: Computer results of the Probit and Truncated equation (Coffee)

Coffee *Variabele*	*Probit Equation* *Coefficient*	*Standard error*	*Truncated Equation* *Coefficient*	*Standard error*
Intercept			-11.368*	1.847
Total per capita expenditure			0.928*	0.286
(Total per capita expenditure)^2			-0.038*	0.016
Price			0.246	0.193
Price * Total per capita expenditure			-0.013	0.022
Zone			-0.251*	0.039
Household size			-0.623*	0.036
CPI			2.314*	0.286
Central			0.018	0.056
Chorotega			-0.108*	0.063
Pacifico			-0.155*	0.066
Huetar Norte			-0.038	0.064
Huetar Atlantico			-0.114*	0.068
Likelihood	-3185.660		-2027.627	
	Expenditure elasticities		*Price elasticities*	
Quartile I	0.356		- 0.842	
Quartile II	0.267		- 0.858	
Quartile III	0.225		- 0.865	
Quartile IV	0.171		- 0.874	

N.B. Likelihood of Tobit Equation =-3185.660
Loglikehood Ratio = -4055.254

Table VII: Computer results of the Probit and Truncated equation (Potato)

Potato *Variabele*	*Probit Equation* *Coefficient*	*Standard error*	*Truncated Equation* *Coefficient*	*Standard error*
Intercept	-18.642*	6.130	-1.186	2.102
Total per capita expenditure	0.449	0.829	1.383*	0.342
(Total per capita expenditure)^2	-0.011	0.048	-0.050*	0.018
Price	-1.477	46.42	0.700*	0.243
Price * Total per capita expenditure	0.595	7.887	-0.063*	0.028
Zone	-0.187	0.143	-0.090*	0.038
Household size	0.038	0.115	-0.497*	0.040
CPI	2.893*	1.081	-0.584*	0.288
Central	0.199	0.206	0.091*	0.058
Chorotega	-0.447*	0.311	-0.035	0.069
Pacifico	0.107	0.244	-0.106*	0.068
Huetar Norte	0.276	0.227	0.201*	0.066
Huetar Atlantico	-0.001	0.235	0.014	0.071
Likelihood	-228.6567		-1724.759	
	Expenditure elasticities		*Price elasticities*	
Quartile I	0.454		- 0.739	
Quartile II	0.336		- 0.814	
Quartile III	0.292		- 0.844	
Quartile IV	0.221		- 0.888	

N.B. Likelihood of Tobit Equation = -2806.943
Loglikehood Ratio = 1707.055

Appendix E : Market-participation model results

Table I: Computer results of the Probit and Truncated equation (Milk products)

Productos de Milk products *Variabele*	*Probit Equation* *Coefficient*	*Standard error*	*Truncated Equation* *Coefficient*	*Standard error*
Intercept			-6.914*	1.895
Total per capita expenditure			1.556*	0.302
(Total per capita expenditure)^2			-0.064*	0.017
Price			0.027	0.164
Price * Total per capita expenditure			0.011	0.019
Zone			-0.025	0.040
Household size			-0.315*	0.041
CPI			0.730*	0.301
Central			0.098*	0.060
Chorotega			0.018	0.071
Pacifico			0.075	0.071
Huetar Norte			0.191*	0.073
Huetar Atlantico			0.037	0.072
Likelihood	-4880.848		-2735.355	
	Expenditure elasticities		*Price elasticities*	
Quartile I	0.722		- 0.895	
Quartile II	0.571		- 0.882	
Quartile III	0.505		- 0.876	
Quartile IV	0.416		- 0.868	

N.B. Likelihood of Tobit Equation = -4880.848
Loglikehood Ratio = -5470.710

Table II: Computer results of the Probit and Truncated equation (Palm oil)

Palm oil *Variabele*	*Probit Equation* *Coefficient*	*Standard error*	*Truncated Equation* *Coefficient*	*Standard error*
Intercept	-14.314*	6.235	-1.416	1.856
Total per capita expenditure	0.551	0.874	0.872*	0.276
(Total per capita expenditure)^2	-0.022	0.051	-0.046*	0.016
Price	0.876	40.48	-0.603*	0.226
Price * Total per capita expenditure	0.229	7.496	0.065*	0.026
Zone	-0.03	0.144	-0.139*	0.038
Household size	-0.142	0.113	-0.433*	0.038
CPI	2.021*	1.073	0.579*	0.282
Central	0.061	0.218	0.003	0.056
Chorotega	-0.280	0.283	0.111*	0.063
Pacifico	0.131	0.247	0.009	0.065
Huetar Norte	0.221	0.239	0.006	0.064
Huetar Atlantico	0.012	0.241	-0.013	0.067
Likelihood	-216.7680		-2424.874	
	Expenditure elasticities		*Price elasticities*	
Quartile I	0.519		- 1.158	
Quartile II	0.419		- 1.087	
Quartile III	0.366		- 1.051	
Quartile IV	0.304		- 1.006	

N.B. Likelihood of Tobit Equation = -3740.169
Loglikehood Ratio = 2197.055

Table III: Computer results of the Probit and Truncated equation (Onion)

Onion	*Probit Equation*		*Truncated Equation*	
Variabele	*Coefficient*	*Standard error*	*Coefficient*	*Standard error*
Intercept	-10.842*	4.400	-7.804*	2.817
Total per capita expenditure	0.299	0.633	1.069*	0.463
(Total per capita expenditure)^2	-0.010	0.038	-0.038*	0.026
Price	0.832*	0.440	0.329*	0.214
Price * Total per capita expenditure	0.041	0.054	-0.021	0.025
Zone	0.066	0.099	-0.126*	0.060
Household size	-0.036	0.877	-0.593*	0.061
CPI	1.533*	0.754	1.100*	0.426
Central	-0.017	0.147	-0.119*	0.089
Chorotega	-0.181	0.177	0.010	0.104
Pacifico	0.191	0.164	-0.083	0.101
Huetar Norte	0.056	0.172	0.233*	0.099
Huetar Atlantico	-0.002	0.170	0.004	0.105
Likelihood	-442.8136		-1209.998	
	Expenditure elasticities		*Price elasticities*	
Quartile I	0.456		- 0.819	
Quartile II	0.361		- 0.846	
Quartile III	0.326		- 0.856	
Quartile IV	0.270		- 0.872	

N.B. Likelihood of Tobit Equation =-2264.676
Loglikehood Ratio =1223.729

Table IV: Computer results of the Probit and Truncated equation (Plantain)

Plantain	*Probit Equation*		*Truncated Equation*	
Variabele	*Coefficient*	*Standard error*	*Coefficient*	*Standard error*
Intercept	-12.222*	4.978	1.169	3.235
Total per capita expenditure	-0.184	0.712	-0.518	0.484
(Total per capita expenditure)^2	0.014	0.043	0.037*	0.028
Price	-0.732	1.042	-0.120	0.541
Price * Total per capita expenditure	0.448*	0.136	0.035	0.065
Zone	-0.026	0.119	-0.120*	0.072
Household size	0.017	0.099	-0.476*	0.071
CPI	2.302*	0.865	0.870*	0.527
Central	-0.319*	0.159	-0.441	0.116
Chorotega	-0.553*	0.201	0.156	0.126
Pacifico	-0.146	0.183	-0.078	0.127
Huetar Norte	0.136	0.155	0.054	0.139
Huetar Atlantico	-0.065	0.170	0.148	0.135
Likelihood	-342.4732		-1338.610	
	Expenditure elasticities		*Price elasticities*	
Quartile I	- 0.059		- 0.883	
Quartile II	0.161		- 0.836	
Quartile III	0.196		- 0.820	
Quartile IV	0.252		- 0.795	

N.B. Likelihood of Tobit Equation = -2299.809
Loglikehood Ratio = 1237.452

Table V: Computer results of the Probit and Truncated equation (Banana)

Banana *Variabele*	*Probit Equation* *Coefficient*	*Standard error*	*Truncated Equation* *Coefficient*	*Standard error*
Intercept	-4.921*	2.923	1.681	3.042
Total per capita expenditure	1.683*	0.492	0.026	0.526
(Total per capita expenditure)^2	-0.083*	0.029	0.007	0.030
Price	14.937*	2.612	-1.177*	0.794
Price * Total per capita expenditure	-1.043*	0.300	0.177*	0.092
Zone	0.326*	0.063	0.043	0.065
Household size	0.279*	0.063	-0.380*	0.074
CPI	-1.088*	0.470	0.088	0.480
Central	0.313*	0.101	0.147	0.116
Chorotega	-0.029	0.124	0.157	0.125
Pacifico	-0.076	0.127	-0.094	0.131
Huetar Norte	0.110	0.122	0.107	0.141
Huetar Atlantico	-0.096	0.123	-0.182	0.154
Likelihood	-1611.911		-1000.582	
	Expenditure elasticities		*Price elasticities*	
Quartile I	0.211		- 0.938	
Quartile II	0.218		- 0.727	
Quartile III	0.2118		- 0.654	
Quartile IV	0.230		- 0.528	

N.B. Likelihood of Tobit Equation = -2855.900
Loglikehood Ratio = 1386.813

Table VI: Computer results of the Probit and Truncated equation (Palm heart)

Palm heart *Variabele*	*Probit Equation* *Coefficient*	*Standard error*	*Truncated Equation* *Coefficient*	*Standard error*
Intercept	-16.771	13.62	45.017	47.55
Total per capita expenditure	2.306	2.195	-12.467*	8.958
(Total per capita expenditure)^2	-0.086	0.118	0.694*	0.494
Price	6.898	92.78	-2.569*	1.636
Price * Total per capita expenditure	-0.434	11.57	0.281*	0.182
Zone	-0.002	0.265	-0.335	0.727
Household size	0.786*	0.305	0.237	0.818
CPI	0.012	2.054	2.995	7.863
Central	-0.725*	0.313	-0.201	0.938
Chorotega	-0.710*	0.438	-0.689	1.195
Pacifico	-0.660*	0.427	0.516	1.141
Huetar Norte	-3.824	60.47	1.063	0.992
Huetar Atlantico	-3.625	58.37	0.798	1.234
Likelihood	-58.94381		-47.4051	
	Expenditure elasticities		*Price elasticities*	
Quartile I	-2.522		- 1.766	
Quartile II	0.524		- 1.172	
Quartile III	0.927		- 1.100	
Quartile IV	2.142		- 0.851	

N.B. Likelihood of Tobit Equation = 0.00, not able to calculate
Loglikehood Ratio = -212.6980

Table VII: Computer results of the Probit and Truncated equation (Mango)

Mango *Variabele*	*Probit Equation* *Coefficient*	*Standard error*	*Truncated Equation* *Coefficient*	*Standard error*
Intercept	-9.432	15.30	-35.737*	16.12
Total per capita expenditure	-0.125	2.232	6.499*	1.770
(Total per capita expenditure)^2	0.013	0.136	-0.390*	0.101
Price	-327.97	935.1	-2.260*	1.150
Price * Total per capita expenditure	332.18*	185.5	0.281*	0.136
Zone	-0.202	0.386	-0.125	0.201
Household size	-0.201	0.254	-0.553*	0.205
CPI	1.478	2.636	2.597	2.991
Central	-1.951	5.824	0.511*	0.250
Chorotega	-0.008	0.461	0.059	0.454
Pacifico	-3.541	818.3	-0.184	0.417
Huetar Norte	0.032	0.455	0.391	0.330
Huetar Atlantico	0.286	0.405	0.834*	0.258
Likelihood	-33.902		-152.6312	
	Expenditure elasticities		*Price elasticities*	
Quartile I	2.128		- 1.481	
Quartile II	0.464		- 0.920	
Quartile III	0.296		- 0.822	
Quartile IV	- 0.173		- 0.658	

N.B. Likelihood of Tobit Equation = -369.4337
Loglikehood Ratio = 365.8010

Table VIII: Computer results of the Probit and Truncated equation (Melon)

Melon *Variabele*	*Probit Equation* *Coefficient*	*Standard error*	*Truncated Equation* *Coefficient*	*Standard error*
Intercept	9.287	10.31	-16.63	13.88
Total per capita expenditure	2.233	1.832	-0.456	2.067
(Total per capita expenditure)^2	-0.102	0.101	0.056	0.114
Price	2.743*	1.520	0.439	0.802
Price * Total per capita expenditure	-0.159	0.170	-0.030	0.089
Zone	0.202	0.198	0.143	0.227
Household size	0.011	0.170	-0.175	0.222
CPI	-5.190*	1.497	3.927*	2.334
Central	0.944	0.807	0.810	0.638
Chorotega	0.456	0.852	1.219*	0.684
Pacifico	0.849	0.838	0.922*	0.685
Huetar Norte	0.898	0.837	1.478*	0.735
Huetar Atlantico	0.923	0.828	0.711	0.672
Likelihood	-110.9955		-145.0340	
	Expenditure elasticities		*Price elasticities*	
Quartile I	0.102		- 0.740	
Quartile II	0.385		- 0.816	
Quartile III	0.437		- 0.829	
Quartile IV	0.523		- 0.850	

N.B. Likelihood of Tobit Equation = 0.00, unable to compute result
Loglikehood Ratio = -512.0590

Table IX: Computer results of the Probit and Truncated equation (Orange)

Orange	*Probit Equation*		*Truncated Equation*	
Variabele	*Coefficient*	*Standard error*	*Coefficient*	*Standard error*
Intercept	2.341	4.173	6.157	4.578
Total per capita expenditure	0.659	0.668	0.234	0.836
(Total per capita expenditure)^2	-0.023	0.039	0.012	0.048
Price	4.370*	1.503	-0.850	0.728
Price * Total per capita expenditure	-0.080	0.176	0.135*	0.085
Zone	0.396*	0.094	0.074	0.104
Household size	0.172*	0.089	-0.297*	0.103
CPI	-1.799*	0.680	-1.197*	0.650
Central	-0.012	0.151	-0.156	0.176
Chorotega	0.185	0.165	-0.036	0.194
Pacifico	-0.080	0.181	-0.393*	0.201
Huetar Norte	0.289*	0.167	-0.148	0.209
Huetar Atlantico	-0.053	0.180	-0.293*	0.208
Likelihood	-499.4122		-757.2362	
	Expenditure elasticities		*Price elasticities*	
Quartile I	0.546		- 0.966	
Quartile II	0.605		- 0.734	
Quartile III	0.625		- 0.673	
Quartile IV	0.629		- 0.577	

N.B. Likelihood of Tobit Equation =-1818.644
Loglikehood Ratio =1123.992

Table X: Computer results of the Probit and Truncated equation (Pineapple)

Pineapple	*Probit Equation*		*Truncated Equation*	
Variabele	*Coefficient*	*Standard error*	*Coefficient*	*Standard error*
Intercept	-15.977*	7.851	0.192	6.102
Total per capita expenditure	1.769*	1.332	-1.510*	1.132
(Total per capita expenditure)^2	-0.085	0.075	0.088*	0.064
Price	1.799*	0.643	-0.207	0.585
Price * Total per capita expenditure	-0.481	0.075	0.034	0.066
Zone	0.069	0.147	-0.004	0.101
Household size	-0.309*	0.129	-0.540*	0.112
CPI	1.118	1.143	2.066*	0.806
Central	-0.077	0.213	-0.366*	0.195
Chorotega	-0.359	0.287	-0.509*	0.217
Pacifico	-0.451*	0.287	-0.345*	0.221
Huetar Norte	0.117	0.236	-0.294	0.227
Huetar Atlantico	-0.330*	0.273	-0.520*	0.226
Likelihood	-189.6902		-455.2458	
	Expenditure elasticities		*Price elasticities*	
Quartile I	- 0.237		- 0.796	
Quartile II	0.092		- 0.733	
Quartile III	0.167		- 0.719	
Quartile IV	0.091		- 0.734	

N.B. Likelihood of Tobit Equation = -848.2355
Loglikehood Ratio = 406.5990

Table XI: Computer results of the Probit and Truncated equation (Cassava)

Cassava	*Probit Equation*		*Truncated Equation*	
Variabele	*Coefficient*	*Standard error*	*Coefficient*	*Standard error*
Intercept	-5.578	5.595	1.121	3.347
Total per capita expenditure	-0.606	0.769	-0.056	0.525
(Total per capita expenditure)^2	0.04	0.045	0.020	0.030
Price	2.238*	0.504	0.944*	0.384
Price * Total per capita expenditure	-0.082*	0.059	-0.065*	0.0451
Zone	0.118	0.131	-0.198*	0.066
Household size	-0.075	0.117	-0.614*	0.070
CPI	1.095	1.110	0.182	0.486
Central	-0.033	0.205	-0.250*	0.107
Chorotega	-0.232	0.264	-0.298*	0.131
Pacifico	0.031	0.239	-0.409*	0.130
Huetar Norte	0.602*	0.206	-0.056	0.124
Huetar Atlantico	-0.027	0.240	-0.119	0.131
Likelihood	-249.1265		-752.4561	
	Expenditure elasticities		*Price elasticities*	
Quartile I	0.026		- 0.492	
Quartile II	0.083		- 0.590	
Quartile III	0.099		- 0.618	
Quartile IV	0.127		- 0.666	

N.B. Likelihood of Tobit Equation = -1281.726
Loglikehood Ratio = -752.4561

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