ECONOMETRIC ESTIMATION OF FOOD DEMAND ELASTICITIES FROM HOUSEHOLD SURVEYS IN ARGENTINA, BOLIVIA AND PARAGUAY

Daniel Lema*

Víctor Brescia*

Miriam Berges**

Karina Casellas**

Abstract

This paper presents an econometric estimation of food demand elasticities for Argentina, Bolivia and Paraguay using household survey data. The empirical approach consists in the estimation of a censored corrected LinQuad incomplete demand system of eleven equations using microdata from national household surveys. The limited dependent variable problem is accounted for using the Shonkwiler and Yen two step estimation procedure. Comparative results suggest distinct consumption behaviors in Argentina, Bolivia and Paraguay. Food demand is in general less elastic in Argentina, particularly for dairy products, beef, chicken wheat and sugar. Estimated magnitudes of income elasticities shows a more elastic response in Argentina for dairy products, beef, chicken and oil.

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*Instituto de Economía y Sociología, INTA

** Universidad Nacional de Mar del Plata

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I. Introduction

In the literature on demand estimation several theoretical and empirical approaches could be identified: single equation, system equations, time series, cross-section, panel data. Recently, new econometric techniques and the increasing use of cross-section household survey data in applied demand analysis present new opportunities for examination of consumption behavior using demand system approach. One important methodological issue is the many zero observations common in household survey data. The bias in the parameter estimates resulting from the use of only positive consumption values when there are many zero observations is a common result. Several approaches have been used for dealing with the zero values. Usually, some variant of Heckman´s two step technique (Heckman, 1979) is used to solve this censored response problem. Heien and Wessells (1990) present a generalization of this procedure to account for zero expenditure in demand systems.

One frequent used methodological approach is the estimation of complete demand systems for food consumption. One of the widely used functional forms derived from constrained utility maximization is the Linear Expenditure System (LES). Several reasons are usually invoked to make use of the LES: 1) it has a straightforward and reasonable interpretation, 2) it is one of the few systems that automatically satisfies all the demand theoretical restrictions and 3) it can be derived from a specific utility function: the *Stone-Geary function*.[1] This kind of system does not allow for inferior goods and all of them behave as gross complementary goods. The estimation of the LES is difficult due to nonlinearity in the coefficients β and γ, which enter the formula in a multiplicative form. Some iterative approaches have been developed to overcome this difficulty (*Two-Stage Procedure* and *Full Information Maximum Likelihood Technique)*

We follow a different approach, choosing a theoretically consistent demand system with the least theoretical restrictions imposed on the parameter space. We estimate a LinQuad incomplete demand system derived from a *"quasi expenditure"* function, following Fabiosa and Jensen (2003) who mention several advantages of LinQuad over other complete systems in a censored regression.

The availability of detailed household survey data on expenditures and consumption of a wide range of food products for Argentina, Bolivia and Paraguay allows the estimation of incomplete demand system parameters. Our main goal is to estimate a price and income elasticites matrix with a common methodology for economic analysis and comparative purposes. This paper presents the methodology, data sources and estimation results of food

[1] This function assumes a Cobb-Douglas function with an origin P –the subsistence quantities- with linear Engel curves. $U = (x_1 - \gamma_1)^{\alpha} (x_2 - \gamma_2)^{\beta}$; $\alpha + \beta = 1$. Separability is assumed and it is more plausible when we use broad groups of goods. Their marginal utilities are independent of the quantities of any other good. There are no cross substitution effects.

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** Facultad de Ciencias Económicas y Sociales - Universidad Nacional de Mar del Plata

demand elasticities for these three countries. The organization of the paper is the following: Section II briefly reviews the theoretical and empirical approach behind this study of applied food demand. Section III describes the dataset for each of the countries, which draws mainly on national surveys on household consumption. Section III presents the econometric estimations and results. Section IV has the final remarks and questions for further research.

II. Demand System Analysis of Food Consumption

Theoretical Background

The applied approach of this paper consists in the estimation of a theoretically consistent demand system. Our selected approach was the estimation of a LinQuad incomplete demand system.

The LinQuad system is derived from the so called *"quasi expenditure"* function

$$\xi[\mathbf{p},\mathbf{r},\vartheta(\mathbf{r},\mathrm{U})] = \sum_{k=1}^{K}\alpha(\mathbf{r})_k p_k + \frac{1}{2}\sum_{j=1}^{K}\sum_{k=1}^{K}\beta_{jk}p_j p_k + \vartheta(\mathbf{r},\mathrm{U})\times \mathrm{e}^{\gamma'\mathbf{p}}\ . \quad (1)$$

Where p is a vector of prices corresponding to the relevant products, r is a vector of prices for the rest of the products, U is the utility function, and e is the expenditure function.

Using Shephard´s Lemma and duality properties, the K marshallian demands are obtained:

$$q_i = \alpha_i + \sum_{k=1}^{K}\beta_{ik}p_k + \gamma_i\left[y - \sum_{k=1}^{K}\alpha_k p_k - \frac{1}{2}\sum_{j=1}^{K}\sum_{k=1}^{K}\beta_{jk}p_j p_k\right] \quad (2)$$

Fabiosa and Jensen (2003) mention that LinQuad is preferred over other complete systems (like the Almost Ideal Demand System-AIDS-) in a censored regression.

The Censored Response Problem

An important issue in empirical estiamation using household surveys is the censoring in response. Some households might not consume certain food groups, resulting in a zero value for the dependent variable. The main reasons for this outcome are: 1) infrequency of purchase because the period of the survey is too short, 2) consumers preferences and 3) consumers do not purchase the good at the current prices and income levels (corner solution).

The zero expenditure presents an empirical difficulty of censored response bias. Usually, some variant of Heckman´s two step technique (Heckman, 1979) is used to solve this censored response problem. Heien and Wessells (1990) present a generalization of this procedure to account for zero expenditure.

The first step involves a probit regression to estimate the probability that a given household would purchase the good. From this information the Inverse Mills Ratio (IMR) is computed. Therefore:

$$Pr\ [Z_{ij} = 1] = \Phi(W_i\ \delta_j)$$
$$Pr\ [Z_{ij} = 0] = 1 - \Phi(W_i\ \delta_j) \quad (3)$$

where Z_{ij} is the binary dependent variable, Φ the standard normal cumulative distribution function (CDF), W_i is the vector of regressors related to the purchase decisions and δ_j is the coefficient vector associated with the regressors.

The IRM generated by the probit is described as:

$$IMR_{ij} = \phi(W_i\ \delta_j) / \Phi(W_i\ \delta_j) \qquad if\ Z_{ij} = 1$$
$$IMR_{ij} = \phi(W_i\ \delta_j) / 1 - \Phi(W_i\ \delta_j) \qquad if\ Z_{ij} = 0 \quad (4)$$

where ϕ is the standard normal probability density function (PDF). The second stage of the procedure involves the demand system estimation (LES or LinQuad) with the IRM used as an instrumental variable. All observations are used for the second step estimation.

However, a most recent development by Shonkwiler and Yen (1999) has shown, using Monte Carlo simulation, that the procedure in two steps that they propose for equations systems with limited dependent variables, yields consistent estimations and behaves better than that the one proposed by Heien and Wessels.[2] Instead of using the IMR as an additional explanatory variable in the equation, Shonkwiler and Yen multipliy the explanatory variables by the CDF and includes the PDF as an additional explanatory variable in each equation.

In our demand estimations we follow the two step Shonkwiler and Yen metholodology to address the censoring problem.

The Quality Adjusted Prices

Quality adjusted prices were used to estimate food demand functions for Argentina. The correction of composite goods unit values is needed to adjust quality. This is a consequence of the aggregation of goods into commodity bundles. Consumption of aggregated commodities reflects cobined choices of both quantity and quality, and, in consequence the matching between quantity and prices is more complex. Cox and Wohlgenant (1986) remark the importance of adjusting prices for quality differences among households, to account for price variation[3] and to obtain unbiased estimates of quantity-price relationships. Following this approach, the price adjustments are performed regressing the imputed prices on selected social and demographic characteristics.

$$P_j = \beta_0 + \Sigma \beta_i X_i + \xi \quad (5)$$

Where p_j is the inputed price of the *jth* food group and $\mathbf{X_i}$ a vector of social and demographic characteristics of the *ith* household (i.e. educational level for household heads; household income quintile, household geographic localization, monthly income; household

[2] Shonkwiler and Yen say that there is an internal inconsistency in Heien and Wessels' model. "...the unconditional expectation of y_{ji} is $f(x_{ji},\beta_j)$. However the system suggests that as $W'_{ij}\ \delta_j \rightarrow -\infty$ then $y_{ji} \rightarrow 0$ as one would expect." (pp 973)

[3] They assume that the household first determines commodity quality through the selection of component goods and then the quantity of a composite commodity. This means that the household quality decision (as reflected in the quality/price function) can be modeled independently of the quantity decision at the commodity level.

size, etc). Quality adjusted prices are generated adding the intercept of equation (5) to its residuals (Cox and Wohlgenant, 1986)[4].

Quality adjusted prices were used for Argentina estimations following the approach presented in Berges and Casellas (2002). The adjustments were made to prices by regressing the imputed prices on selected social and demographic characteristics. The estimated price equations are:

$$P_j = \beta_0 + \beta_1 Dalto + \beta_2 Dbajo + \beta_3 Djsexo + \beta_4 Dquin1 + \beta_5 Dquin5 + \beta_6 DR1 + \beta_7 DR3 + \beta_8 DR4 + \beta_9 DR5 + \beta_{10} DR6 + \beta_{11} Ing + \beta_{12} Miembros + \beta_{13} Prgalhip + \xi \qquad (6)$$

The variables included are: p_j, the imputed price of the *jth* food group; *Dalto y Dbajo* binary variables are, respectively, the high and low education level for household heads; *Djsexo*, a binary variable if the household head is female; *Dquin1*, a binary variable representing the household located in the first quintile dummy; *Dquin5*, a binary variable representing the household located in the fifth quintile dummy; *DR1*, *DR3*, *DR4, DR5 y DR6*, binary variables dummy representing the regions of the country (Metropolitan, Northwest, Northeast, Cuyo y Patagónica); *Ing*, monthly income; *Miembros*, the household size and *Prgalhip*, the share of food expenditure at supermarkets.

Quality adjusted prices were then generated adding the estimated intercept of equation (6) to the residuals (Cox and Wohlgenant). When either expenditure or quantity was zero, the adjusted price was equal to the intercept. The generation of these prices admits the possibility that some of them may be negative. This situation suggests that, after accounting for quality differences, one would have to pay a particular household to consume the good in question.

For Paraguay and Bolivia, there were no social and demographic characteristics of households availables in our data base, so quality adjustment was no possible. For these two estimations the price of a composite commodity is recovered from the survey as the ratio of expenditures to quantitiy, referred to as the unit value or implicit price. For cases of non purchase, the weighted median of regional prices was used as the implicit price.

Estimation Procedures

The first step of the selected estimation procedure requires the estimation of Probit regressions for each commoditiy to adress the censoring problem. The standard normal density function $\phi(W_i\,\delta_j)$ and the estimated value of the standard normal cumulative distribution function $\Phi(W_i\,\delta_j)$ were estimated for each household.

The second step of the analysis, the estimation of the demand system equations, was performed using the Iterative Seemingly Unrelated Regression technique. A censored LinQuad demand system of eleven equations that includes prices (quality adjusted for Argentina) and income was estimated for each country using specific commodity definitions.

Elasticities were estimated based on the LinQuad demand system. The own price elasticities, cross price elasticities an the income elasticities have the following form

$$\xi_{ii} = \frac{\partial x_i}{\partial p_i} * \frac{\overline{p}_i}{\overline{\overline{x}}_i} = \Phi(Z_{it}v_i) * \left[b_{ii} - \gamma_i(\alpha_i + \sum_j b_{ij} p_j) \right] * \frac{\overline{p}_i}{\overline{\overline{x}}_i}, \qquad (7)$$

[4] The generation of these prices admits the possibility that some of them may be negative. This situation suggests that, after accounting for quality differences, one would have to pay a particular household to consume the good in question.

$$\xi_{ij} = \frac{\partial x_i}{\partial p_j} * \frac{\overline{p_j}}{\overline{x_i}} = \Phi(Z_{it} v_i) * \left[b_{ij} - \gamma_i (\alpha_j + \sum_k b_{jk} p_k) \right] * \frac{\overline{p_j}}{\overline{x_i}}, \quad (8)$$

$$\eta_i = \frac{\partial x_i}{\partial y} * \frac{\overline{y}}{\overline{x_i}} = \Phi(Z_{it} v_i) * \gamma_i * \frac{\overline{y}}{\overline{x_i}} \quad (9)$$

Where equations 6, 7 and 8 represent own price elasticities, cross price elasticities an the income elasticities, respectively. The term $\Phi(Z_{it}\ v_t)$ represents the standard cumulative distribution function. Elasticities were calculated using the sample mean of the prices, income (expenditure) and quantities.

III. Data

Argentina: The National Survey on Houselhod Expenditure 1996/97

The National Survey on Household Expenditure (ENGH) is conducted by the National Institute of Statistics and Census (INDEC).

The survey was aimed at private households located in the urban area, in cities of 5,000 inhabitants and more (according to the 1991 Census) all across the country. The data consists in the full sample of 27,260 households and includes the money value, the quantities and type of food purchased by the households over a one-week period (March 96-April 97).

The key variables of the survey are household expenditure and income. Demographic, occupational and educational characteristics of their members, as well as their dwelling features are the classification variables. This survey provides quantities, but not prices, therefore the latter were estimated.

The food consumption was aggregated in the following groups for the demand demand system estimation

1. Dairy Products:Cheese, yoghurt, butter.
2. Milk: Fluid milk and powder milk
3. Beef A: High and medium quality beef.
4. Beef B: Low quality beef
5. Sweets: Candies, marmalades, chocolate.
6. Chicken: Chicken
7. Wheat: Wheat flour, pasta, pizza, bread, cookies.
8. Rice: Rice
9. Sugar: Sugar
10. Apple: Apples
11. Oil: Vegetal oil.

Paraguay: Household Survey 2000-2001

The Integrated Household Survey (Encuesta Integrada de Hogares) was performed by the Direccion General de Estadistica, Encuestas y Censos (DGEEC) on urban and rural areas.

The survey was aimed at private households located in the urban and rural areas, all across the country. The data consists in a sample of 2682 households and includes the money value, the quantities and type of food purchased by the households over a one-week period (September-December 2000).

The food consumption was aggregated in the following groups for the demand demand system estimation:

1. Maize: corn, corn flour.
2. Milk: Fluid milk and powder milk, cheese, yoghurt, butter.
3. Beef A: High quality beef.
4. Beef B: Medium quality beef
5. Beef C: Low quality beef.
6. Chicken: Chicken
7. Wheat: Wheat flour, pasta, pizza, bread, cookies.
8. Rice: Rice
9. Sugar: Sugar and brown sugar
10. Apple: Apples
11. Oil: Vegetal oil.

Bolivia: Household Survey 2003-2004

For Bolivia demand estimation the data source is the Household Survey 2003-2004 (Encuesta Continua de Hogares de Bolivia 2003-2004) conducted by the Instituto Nacional de Estadística (INE).

The survey was aimed at private households located in urban and rural areas at a national level (nine states) between november 2003 and november 2004. The full data set consists in 9770 households and includes data on quantities and type of food purchased, expenditures, prices and incomes. The data collection was done in two periods, November 2003-March 2004 and May-November 2004. For the econometric estimations the usefull sample was reduced to 2983 households after controlling for outlayers, inconsistencies and incomplete data. The aggregate food groups are:

1. Maize: corn, corn flour, corn flakes, starch.
2. Milk: fluid milk, powder milk, milk cream, cheese, yoghurt, butter.
3. Beef A: high quality beef.
4. Beef B: medium quality beef
5. Beef C: low quality beef.
6. Chicken: chicken
7. Wheat: wheat flour, pasta, pizza, bread, cookies.
8. Rice: rice
9. Sugar: sugar
10. Apple: Apples
11. Oil: Vegetal oil (sunflower, almond, soybean, olive).

IV. ESTIMATION RESULTS

The complete set of estimated coeffients are presented in appendix A, B and C. In the interest of space, the followng discussion will focus on the matrix of own and cross price elasticities and income elasticities for each country.

A. ARGENTINA

Estimations of own-price, cross price and income elasticities are presented in Tables II and III. All quantities were transformed in homogenous units and measured in kg. equivalent. Elasticities were calculated using the sample mean of the data (prices and quantities).

TABLE II. PRICE AND INCOME ELASTICITIES

	ELASTICITIES	
	Own Price	**Income**
Dairy Products	-0.090	0.291
Milk	-0.089	0.132
Beef A	-0.358	0.205
Beef B	-0.369	0.216
Sweets	0.000	0.053
Chicken	-0.092	0.147
Wheat	-0.058	0.131
Rice	0.364	0.106
Sugar	-0.190	0.167
Apple	0.737	0.156
Oil	0.085	0.162

TABLE III. CROSS PRICE ELASTICITIES

	Diary Prod.	**Milk**	**Beef A**	**Beef B**	**Sweets**	**Chicken**	**Wheat**	**Rice**	**Sugar**	**Apple**	**Oil**
Dairy Products		0.006	0.097	0.051	-0.006	0.042	0.098	0.023	0.019	-0.010	0.037
Milk	0.014		0.144	0.005	-0.004	0.048	0.032	-0.001	-0.028	0.028	-0.016
Beef A	0.098	0.095		0.023	-0.007	0.020	0.018	0.016	-0.004	0.004	-0.007
Beef B	0.051	0.003	0.019		0.002	0.019	-0.050	-0.031	-0.031	0.016	-0.012
Sweets	-0.004	-0.003	-0.008	-0.001		0.000	-0.001	0.000	-0.003	-0.002	-0.001
Chicken	0.047	0.036	0.021	0.022	0.002		0.006	0.002	-0.012	0.004	0.023
Wheat	0.068	0.015	0.013	-0.037	0.002	0.005		0.018	-0.005	0.010	-0.010
Rice	0.093	-0.003	0.068	-0.155	-0.001	0.006	0.113		-0.054	0.062	0.020
Sugar	0.092	-0.085	-0.016	-0.159	-0.017	-0.043	-0.034	-0.059		-0.002	-0.081
Apple	-0.034	0.065	0.009	0.062	-0.007	0.011	0.047	0.053	-0.003		0.047
Oil	0.094	-0.029	-0.024	-0.041	-0.001	0.055	-0.046	0.013	-0.048	0.036	

The absolute value of price elastcities is low, as expected because most of included items are staple foods. However, in some cases are extremely low (below 0.10). A non expected result is the positive value of price coefficient in rice, apple and oil. Income elasticities are in all cases positives and low as expected for staple foods.

The full econometrics results and estimated coefficients are presented in the appendix A at the end of this paper. Tables A.I and AII in the appendix describes the coefficients identification in econometric estimation output. This coefficients matrix considers the symmetry restrictions imposed by theory. Table A.III presents the full estimated coefficients, standard errors and results by equation.

B. PARAGUAY

Estimations of own-price, cross price and income elasticities are presented in Tables IV and V. All quantities were transformed in homogenous units and measured in kg. equivalent. Elasticities were calculated using the sample mean of the data (prices and quantities).

TABLE IV. PRICE AND INCOME ELASTICITIES

ELASTICITIES		
	Own Price	**Income**
Maize	-0.156	0.106
Dairy Products	-0.126	0.205
Beef A	4.980	0.157
Beef B	-0.439	0.245
Beef C	-0.003	0.029
Chicken	0.752	0.106
Wheat	-0.410	0.278
Rice	-0.083	0.067
Sugar	-0.411	0.038
Apple	-0.209	0.180
Oil	-0.049	0.037

TABLE V. CROSS PRICE ELASTICITIES

	Maize	**Dairy Prods.**	**Beef A**	**Beef B**	**Beef C**	**Chicken**	**Wheat**	**Rice**	**Sugar**	**Apple**	**Oil**
Maize		-0.229	-0.234	-0.298	0.013	0.144	-0.022	-0.030	0.093	-0.009	-0.069
Dairy Products	-0.067		-0.039	-0.097	-0.001	-0.121	0.013	-0.034	0.000	0.037	-0.024
Beef A	-0.216	-0.117		-0.634	0.032	0.181	0.262	0.096	0.053	-0.194	-0.177
Beef B	-0.109	-0.121	-0.253		-0.005	-0.071	0.007	0.007	-0.034	0.012	0.011
Beef C	0.007	0.009	0.016	0.005		0.002	0.008	0.001	0.000	0.008	0.000
Chicken	0.091	-0.249	0.122	-0.114	0.000		-0.128	0.009	0.028	0.058	0.064
Wheat	-0.009	0.030	0.147	0.014	0.001	-0.110		-0.019	-0.021	0.043	-0.020
Rice	-0.056	-0.214	0.200	0.042	0.004	0.028	-0.064		-0.157	0.027	0.027
Sugar	0.152	0.009	0.095	-0.138	0.001	0.075	-0.056	-0.132		-0.131	0.080
Apple	-0.017	0.267	-0.442	0.073	0.034	0.193	0.170	0.029	-0.173		-0.086
Oil	-0.103	-0.112	-0.283	0.051	0.000	0.155	-0.053	0.022	0.074	-0.060	

The absolute value of price elastcities is relatively low (however higher than those obtained for Argentina). Two elasticities result with a non expected positive sign: Beef A and Chicken. Income elasticities are in all cases positives, and low (below 0.3). The full econometrics results are presented in the appendix B.

C. BOLIVIA

Estimations of own-price, cross price and income elasticities are presented in Tables VI and VII. All quantities were transformed in homogenous units and measured in kg. equivalent. Elasticities were calculated using the sample mean of the data (prices and quantities).

TABLE VI. PRICE AND INCOME ELASTICITIES

ELASTICITIES	Own Price	Income
Maize	-4.195	0.000
Dairy Products	-0.118	0.152
Beef A	2.714	0.236
Beef B	-5.288	0.145
Beef C	-3.347	0.137
Chicken	-2.757	0.120
Wheat	-0.694	0.087
Rice	-10.310	0.074
Sugar	-1.010	-0.041
Apple	-0.161	0.081
Oil	-2.741	-0.094

TABLE VII. CROSS PRICE ELASTICITIES

	Maize	Dairy Prods.	Beef A	Beef B	Beef C	Chicken	Wheat	Rice	Sugar	Apple	Oil
Maize		0.061	2.192	0.118	0.402	-0.501	0.396	0.715	0.162	1.421	-0.278
Dairy Products	0.062		-0.228	0.022	0.024	-0.012	-0.039	-0.100	-0.074	-0.023	-0.103
Beef A	1.634	-0.166		0.042	-0.679	0.444	0.277	-0.437	-0.207	0.364	-0.566
Beef B	0.180	0.028	0.088		-0.211	0.616	0.950	0.510	0.483	-0.312	-0.501
Beef C	0.258	0.015	-0.577	-0.085		-0.739	-0.358	-1.072	-0.171	-0.017	-0.551
Chicken	-0.336	-0.010	0.400	0.265	-0.761		-0.077	-0.648	-0.298	0.130	-0.478
Wheat	0.246	-0.020	0.245	0.387	-0.341	-0.067		0.125	0.110	0.085	-0.043
Rice	1.083	-0.139	-0.876	0.500	-2.496	-1.473	0.303		-2.151	-0.431	-1.258
Sugar	0.435	-0.181	-0.738	0.834	-0.701	-1.196	0.473	-3.797		-0.049	-1.799
Apple	6.252	0.011	2.388	-0.812	0.041	0.999	0.697	-1.214	-0.093		-2.282
Oil	-0.464	-0.103	-1.148	-0.504	-1.334	-1.132	-0.057	-1.369	-1.130	-0.844	

Regarding the own price elasticities the first thing to remark is that some values are extremely high, as te case of rice (-10.3). All the signs were negative, except for the case of high quality beef, a similar result than obtained in Paraguay estimations. The high price elastitcities obtained could be a result related to the quality of the primary data, we detect a lot of outlayers and inconsistent records. The income elasticities were positive except for sugar and oil. The magnitudes were less than one in absolute value as expected for staples. The full econometrics results are presented in the appendix C.

V. Final Remarks

This study has empirically adressed the estimation of food demand systems using several techniques. One is the correction of unit values to adjust quality. Second, the limited dependent variable problem is accounted for using the Shonkwiler and Yen two step estimation procedure. The approach used in these estimations follows a theoretical methodology based in the microeconomics foundations of demand analysis. A LinQuad demand system of eleven equations was estimated for each country.

Table VIII. Marshallian own-price and income elasticities (at the means). Argentina, Paraguay and Bolivia.

Food Product	Marshallian Direct Price Elasticities (At the Mean)			Income Elasticities (At the Mean)		
	Argentina	Paraguay	Bolivia	Argentina	Paraguay	Bolivia
Maize	-	-0.1564	-4.1954	-	0.106294	-0.0002
Dairy Products	-0.0899	-0.1263	-0.1185	0.2910	0.2048	0.1521
Milk	-0.0887	-	-	0.1325		
Beef A	-0.3585	4.9799	2.7139	0.2049	0.1571	0.2360
Beef B	-0.3692	-0.4389	-5.2876	0.2159	0.2455	0.1447
Beef C	-	-0.0026	-3.3472	-	0.0293	0.1368
Sweets	0.0004	-		0.0527		
Chicken	-0.0918	0.7515	-2.7569	0.1468	0.1061	0.1196
Wheat	-0.0575	-0.4098	-0.6943	0.1305	0.2776	0.0873
Rice	0.3639	-0.0829	-10.3101	0.1064	0.0668	0.0745
Sugar	-0.1896	-0.4108	-1.0104	0.1668	0.0379	-0.0415
Apple	0.7366	-0.2089	-0.1613	0.1557	0.1804	0.0808
Oil	0.0848	-0.0493	-2.7406	0.1623	0.0373	-0.0944

Table VIII summarizes the estimated marshallian own price and income elasticities for the three countries. In some cases, we obtain unexpected elasticities results as high absolute value price elasticities or positive price elastitcities. We think that this could be a result related to the quality of the primary data, where we detect a lot of outlayers and inconsistent records.

Comparative results suggest distinct consumption behaviors in Argentina, Bolivia and Paraguay. Food demand is in general less elastic in Argentina, particularly for dairy products, beef, chicken wheat and sugar. This difference is likely due to the fact that in Argentina the average income is higher relative to the other two countries and also that households surveys in Paraguay and Bolivia include rural areas and for Argentina only urban areas are included. Differences in the food distribution system and availability of nonmarket food sources could explain the more elastic demand for purchased goods. Estimated magnitudes of income elasticities shows a more elastic response in Argentina for dairy products, beef, chicken and oil.

Table IX presents the average income and expenditure shares in the sample. While some diffrences may be attibuted to differences in taste or cultural preferences more likely (as mentioned previously) there are substantital differences in the food distribution systems or households otaininig food from nonmarket sources. For example, in Bolivia households consume lower proportions of chicken, milk and beef. Chicken is commonly raised in rural households and milk and beef are expensive in rural areas.

Table IX. Average Income and Expenditure Shares in the sample

Food Product	Income Share			Expenditure Share		
	Argentina	Paraguay	Bolivia	Argentina	Paraguay	Bolivia
Maize	-	0.78%	0.06%	-	0.80%	0.09%
Dairy Products	1.44%	0	0	1.81%	-	-
Milk	1.28%	4.08%	0.73%	1.60%	4.22%	1.14%
Beef A	2.31%	0.18%	0.62%	2.89%	0.19%	0.96%
Beef B	2.66%	2.75%	0.24%	3.33%	2.85%	0.37%
Beef C	-	2.36%	1.79%	-	2.44%	2.79%
Sweets	0.51%	-	-	0.64%	-	-
Chicken	1.33%	1.82%	0.77%	1.67%	1.88%	1.19%
Wheat	4.13%	4.35%	3.23%	5.17%	4.50%	5.02%
Rice	0.27%	0.64%	0.37%	0.34%	0.67%	0.58%
Sugar	0.28%	0.82%	0.23%	0.34%	0.84%	0.58%
Apple	0.38%	0.31%	0.06%	0.47%	0.33%	0.09%
Oil	0.48%	0.80%	0.27%	0.60%	0.83%	0.43%
Total	15.07%	18.11%	8.31%	18.86%	18.75%	13.15%

Our results represent an approximation to the analysis of food demand in South American countries using survey data. Yet there is much more work to be done to examine the quantity and quality choices of consumers. Since quantity and quality are jointly chosen by consumers it might be fruitful in future research to explore other definitions of products and quality. Finally the model specification should be extended to control for differences in socio-demographic characteristics of the households. In this sense, we think that more work is needed with the primary data base to model those characteristics and to obtain more accurate results. Only then a completely robust matrix of elasticities can be estimated.

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APPENDIX A
ECONOMETRIC ESTIMATION RESULTS
ARGENTINA

TABLE A.I IDENTIFICATION NUMBER FOR ESTIMATED COFFICIENTS - INCOME – CONSTANT TERM – CUMULATIVE DISTRIBUTION FUNCION

Product Equation	INCOME	CONSTANT	CDF
Dairy Products	201	101	301
Milk	202	102	302
Beef A	203	103	303
Beef B	204	104	304
Sweets	205	105	305
Chicken	206	106	306
Wheat	207	107	307
Rice	208	108	308
Sugar	209	109	309
Apple	210	110	310
Oil	211	111	311

TABLE A.II. IDENTIFICATION NUMBER FOR ESTIMATED COFFICIENTS - PRICE COEFFICIENTS

Product Equation	Diary Prods.	Milk	Beef A	Beef B	Sweets	Chicken	Wheat	Rice	Sugar	Apple	Oil
Dairy Products	1	2	3	4	5	6	7	8	9	10	11
Milk	2	12	13	14	15	16	17	18	19	20	21
Beef A	3	13	22	23	24	25	26	27	28	29	30
Beef B	4	14	23	31	32	33	34	35	36	37	38
Sweets	5	15	24	32	39	40	41	42	43	44	45
Chicken	6	16	25	33	40	46	47	48	49	50	51
Wheat	7	17	26	34	41	47	52	53	54	55	56
Rice	8	18	27	35	42	48	53	57	58	59	60
Sugar	9	19	28	36	43	49	54	58	61	62	63
Apple	10	20	29	37	44	50	55	59	62	64	65
Oil	11	21	30	38	45	51	56	60	63	65	66

TABLE A.III SYSTEM ESTIMATION OUTPUT

Estimation Method: Seemingly Unrelated Regression

Included observations: 27192

Total system (balanced) observations 299112

Iterate coefficients after one-step weighting matrix

Convergence achieved after: 1 weight matrix, 9 total coef iterations

Coefficient ID	Coefficient	Std. Error	t-Statistic	Prob.
C(101)	-1.398157	0.200091	-6.987597	0.0000
C(1)	-0.098770	0.006002	-16.45701	0.0000
C(2)	0.074496	0.056751	1.312686	0.1893

C(3)	0.167835	0.019639	8.546178	0.0000
C(4)	0.133872	0.023102	5.794829	0.0000
C(5)	-0.010098	0.005347	-1.888711	0.0589
C(6)	0.101212	0.024371	4.152972	0.0000
C(7)	0.351340	0.026150	13.43537	0.0000
C(8)	0.097704	0.017712	5.516404	0.0000
C(9)	0.180577	0.043166	4.183317	0.0000
C(10)	-0.044463	0.025158	-1.767355	0.0772
C(11)	0.131037	0.021197	6.181981	0.0000
C(201)	0.002090	3.65E-05	57.17245	0.0000
C(102)	9.554852	1.194832	7.996819	0.0000
C(103)	9.903828	0.530997	18.65138	0.0000
C(104)	17.79328	0.560280	31.75784	0.0000
C(105)	-0.525272	0.124271	-4.226817	0.0000
C(106)	3.532824	0.662033	5.336329	0.0000
C(107)	18.25451	0.558670	32.67497	0.0000
C(108)	-1.247070	0.462446	-2.696679	0.0070
C(109)	17.51433	1.090133	16.06623	0.0000
C(110)	-6.859405	0.684500	-10.02104	0.0000
C(111)	1.514729	0.491279	3.083233	0.0020
C(12)	-3.060528	0.227943	-13.42672	0.0000
C(22)	-0.819386	0.055741	-14.69978	0.0000
C(31)	-1.753894	0.073125	-23.98503	0.0000
C(39)	0.000693	0.000169	4.089452	0.0000
C(46)	-0.378186	0.046449	-8.141875	0.0000
C(52)	-0.764614	0.016839	-45.40777	0.0000
C(57)	1.374694	0.065466	20.99859	0.0000
C(61)	-2.710159	0.258770	-10.47322	0.0000
C(64)	3.838110	0.170251	22.54384	0.0000
C(66)	0.365679	0.027184	13.45218	0.0000
C(13)	1.101173	0.149332	7.373995	0.0000
C(14)	0.109195	0.164781	0.662664	0.5075
C(15)	-0.030909	0.030823	-1.002799	0.3160
C(16)	0.531738	0.163407	3.254074	0.0011
C(17)	0.574928	0.178338	3.223819	0.0013
C(18)	-0.011306	0.178371	-0.063383	0.9495
C(19)	-1.054896	0.445141	-2.369804	0.0178

C(20)	0.582609	0.233807	2.491834	0.0127
C(21)	-0.245665	0.160823	-1.527552	0.1266
C(23)	0.103798	0.055309	1.876689	0.0606
C(24)	-0.017056	0.011749	-1.451720	0.1466
C(25)	0.018730	0.053275	0.351564	0.7252
C(26)	0.131771	0.059619	2.210223	0.0271
C(27)	0.104444	0.052836	1.976773	0.0481
C(28)	-0.022792	0.128891	-0.176830	0.8596
C(29)	0.028865	0.063266	0.456248	0.6482
C(30)	-0.033066	0.054767	-0.603761	0.5460
C(32)	0.004577	0.015838	0.288969	0.7726
C(33)	0.114603	0.071211	1.609334	0.1075
C(34)	-0.302388	0.078045	-3.874540	0.0001
C(35)	-0.291485	0.052670	-5.534185	0.0000
C(36)	-0.549672	0.124373	-4.419560	0.0000
C(37)	0.170103	0.066267	2.566936	0.0103
C(38)	-0.087054	0.059110	-1.472733	0.1408
C(40)	0.004395	0.014556	0.301905	0.7627
C(41)	0.010696	0.015372	0.695791	0.4866
C(42)	-0.002133	0.011594	-0.184005	0.8540
C(43)	-0.045651	0.024529	-1.861136	0.0627
C(44)	-0.014425	0.011534	-1.250700	0.2110
C(45)	-0.002112	0.013896	-0.151980	0.8792
C(47)	0.072662	0.070882	1.025119	0.3053
C(48)	0.016528	0.060659	0.272480	0.7853
C(49)	-0.157826	0.143713	-1.098200	0.2721
C(50)	0.033699	0.060026	0.561414	0.5745
C(51)	0.157926	0.060484	2.611042	0.0090
C(53)	0.349793	0.064000	5.465467	0.0000
C(54)	-0.146523	0.147116	-0.995972	0.3193
C(55)	0.202863	0.066370	3.056565	0.0022
C(56)	-0.153887	0.067310	-2.286239	0.0222
C(58)	-0.411626	0.214755	-1.916722	0.0553
C(59)	0.253757	0.099156	2.559177	0.0105
C(60)	0.066538	0.065012	1.023476	0.3061
C(62)	-0.013599	0.272558	-0.049894	0.9602
C(63)	-0.480490	0.160967	-2.985013	0.0028

C(65)	0.195505	0.067479	2.897284	0.0038
C(301)	19.65243	0.817028	24.05357	0.0000
C(202)	0.004582	0.000177	25.88141	0.0000
C(302)	8.663597	0.711766	12.17198	0.0000
C(203)	0.002264	7.25E-05	31.22478	0.0000
C(303)	-16.12726	1.607359	-10.03339	0.0000
C(204)	0.003653	0.000104	35.12576	0.0000
C(304)	-21.74048	1.149659	-18.91038	0.0000
C(205)	0.000801	2.48E-05	32.35186	0.0000
C(305)	13.36784	0.247331	54.04845	0.0000
C(206)	0.002012	8.61E-05	23.37295	0.0000
C(306)	15.67412	1.130751	13.86169	0.0000
C(207)	0.004364	0.000114	38.15187	0.0000
C(307)	-46.83186	3.860579	-12.13079	0.0000
C(208)	0.000718	6.30E-05	11.40027	0.0000
C(308)	3.375377	0.250783	13.45934	0.0000
C(209)	0.002100	0.000157	13.40371	0.0000
C(309)	-3.519457	0.368151	-9.559832	0.0000
C(210)	0.001333	6.71E-05	19.85373	0.0000
C(310)	7.510474	0.445427	16.86129	0.0000
C(211)	0.001459	6.28E-05	23.21534	0.0000
C(311)	5.607911	0.412992	13.57873	0.0000
Determinant residual covariance		5.17E+23		

TABLE A.IV SYSTEM SPECIFICATION BY EQUATION
1. DIARY PRODUCTS

Observations: 27192

R-squared	0.176926	Mean dependent var	14.77081
Adjusted R-squared	0.174558	S.D. dependent var	20.16359
S.E. of regression	18.31939	Sum squared resid	9099124.
Durbin-Watson stat	1.913423		

2. MILK

Observations: 27192

R-squared	0.065383	Mean dependent var	13.07263
Adjusted R-squared	0.062694	S.D. dependent var	15.34215

S.E. of regression	14.85343	Sum squared resid	5981792.
Durbin-Watson stat	1.920316		

3. BEEF A
Observations: 27192

R-squared	0.140725	Mean dependent var	23.64339
Adjusted R-squared	0.138253	S.D. dependent var	27.49804
S.E. of regression	25.52652	Sum squared resid	17666918
Durbin-Watson stat	1.922437		

4. BEEF B

Observations: 27192

R-squared	0.166570	Mean dependent var	27.23747
Adjusted R-squared	0.164172	S.D. dependent var	30.42210
S.E. of regression	27.81299	Sum squared resid	20973600
Durbin-Watson stat	1.953531		

5. SWEETS

Observations: 27192

R-squared	0.048446	Mean dependent var	5.211254
Adjusted R-squared	0.045708	S.D. dependent var	10.81116
S.E. of regression	10.56119	Sum squared resid	3024150.
Durbin-Watson stat	1.867586		

6. CHICKEN

Observations: 27192

R-squared	0.069816	Mean dependent var	13.64308
Adjusted R-squared	0.067140	S.D. dependent var	19.46853
S.E. of regression	18.80361	Sum squared resid	9586503.
Durbin-Watson stat	1.955696		

7. WHEAT

Observations: 27192

R-squared	0.039462	Mean dependent var	42.29720

Adjusted R-squared	0.036698	S.D. dependent var	32.24211
S.E. of regression	31.64496	Sum squared resid	27151062
Durbin-Watson stat	1.832141		

8. RICE

Observations: 27192

R-squared	0.078220	Mean dependent var	2.791523
Adjusted R-squared	0.075568	S.D. dependent var	4.640872
S.E. of regression	4.462078	Sum squared resid	539823.7
Durbin-Watson stat	1.959542		

9. SUGAR

Observations: 27192

R-squared	0.057323	Mean dependent var	2.818778
Adjusted R-squared	0.054612	S.D. dependent var	5.480686
S.E. of regression	5.328930	Sum squared resid	769941.4
Durbin-Watson stat	1.964867		

10. APPLE

Observations: 27192

R-squared	0.112485	Mean dependent var	3.846431
Adjusted R-squared	0.109932	S.D. dependent var	6.091930
S.E. of regression	5.747334	Sum squared resid	895592.7
Durbin-Watson stat	1.943559		

11. OIL

Observations: 27192

R-squared	0.108827	Mean dependent var	4.923917
Adjusted R-squared	0.106264	S.D. dependent var	8.084478
S.E. of regression	7.642875	Sum squared resid	1583766.
Durbin-Watson stat	1.955992		

APPENDIX B
ECONOMETRIC ESTIMATION RESULTS
PARAGUAY

TABLE B.I IDENTIFICATION NUMBER FOR ESTIMATED COFFICIENTS - INCOME – CONSTANT TERM – CUMULATIVE DISTRIBUTION FUNCION

Product Equation	INCOME	CONSTANT	CDF
Maize	201	101	301
Dairy Prod.	202	102	302
Beef A	203	103	303
Beef B	204	104	304
Sweets	205	105	305
Chicken	206	106	306
Wheat	207	107	307
Rice	208	108	308
Sugar	209	109	309
Apple	210	110	310
Oil	211	111	311

TABLE B.II IDENTIFICATION NUMBER FOR ESTIMATED COFFICIENTS - PRICE COEFFICIENTS

Product Equation	**Maize**	**Dairy Prods.**	**Beef A**	**Beef B**	**Sweets**	**Chicken**	**Wheat**	**Rice**	**Sugar**	**Apple**	**Oil**
Maize	1	2	3	4	5	6	7	8	9	10	11
Dairy Prod.	2	12	13	14	15	16	17	18	19	20	21
Beef A	3	13	22	23	24	25	26	27	28	29	30
Beef B	4	14	23	31	32	33	34	35	36	37	38
Sweets	5	15	24	32	39	40	41	42	43	44	45
Chicken	6	16	25	33	40	46	47	48	49	50	51
Wheat	7	17	26	34	41	47	52	53	54	55	56
Rice	8	18	27	35	42	48	53	57	58	59	60
Sugar	9	19	28	36	43	49	54	58	61	62	63
Apple	10	20	29	37	44	50	55	59	62	64	65
Oil	11	21	30	38	45	51	56	60	63	65	66

TABLE B.III SYSTEM ESTIMATION OUTPUT

Estimation Method: Seemingly Unrelated Regression

Sample: 1 2682

Included observations: 2674

Total system (unbalanced) observations 29392

Iterate coefficients after one-step weighting matrix

Convergence achieved after: 1 weight matrix, 10 total coef iterations

	Coefficient	**Std. Error**	**t-Statistic**	**Prob.**
C(101)	12.05546	4.098147	2.941685	0.0033
C(1)	-0.001075	0.000491	-2.188488	0.0286

C(2)	-0.002428	0.000653	-3.720538	0.0002
C(3)	-0.000443	0.000304	-1.458729	0.1447
C(4)	-0.000684	0.000270	-2.537989	0.0112
C(5)	5.42E-05	1.72E-05	3.157414	0.0016
C(6)	0.000422	0.000253	1.665427	0.0958
C(7)	-0.000130	0.000329	-0.395085	0.6928
C(8)	-0.000212	0.000206	-1.026093	0.3049
C(9)	0.000690	0.000224	3.080741	0.0021
C(10)	-3.47E-05	0.000191	-0.181888	0.8557
C(11)	-0.000361	0.000108	-3.333184	0.0009
C(201)	7.85E-07	1.83E-07	4.292419	0.0000
C(102)	78.79738	5.949535	13.24429	0.0000
C(103)	-13.55022	2.928598	-4.626864	0.0000
C(104)	23.77193	2.910748	8.166949	0.0000
C(105)	15.93779	0.605567	26.31878	0.0000
C(106)	2.888179	2.715016	1.063780	0.2874
C(107)	51.66526	2.678396	19.28963	0.0000
C(108)	8.993048	2.233873	4.025766	0.0001
C(109)	14.92290	2.527665	5.903828	0.0000
C(110)	4.171685	2.099392	1.987092	0.0469
C(111)	8.687173	0.941804	9.223971	0.0000
C(12)	-0.006823	0.000537	-12.70583	0.0000
C(22)	0.002835	0.000253	11.20594	0.0000
C(31)	-0.000919	0.000271	-3.396723	0.0007
C(39)	-4.97E-06	1.94E-06	-2.556859	0.0106
C(46)	0.001454	0.000230	6.326501	0.0000
C(52)	-0.006366	0.000209	-30.47007	0.0000
C(57)	-0.000324	0.000183	-1.764672	0.0776
C(61)	-0.001985	0.000291	-6.821209	0.0000
C(64)	-0.000273	0.000142	-1.914991	0.0555
C(66)	-0.000132	1.23E-05	-10.72116	0.0000
C(13)	-0.000359	0.000473	-0.759441	0.4476
C(14)	-0.001110	0.000386	-2.877264	0.0040
C(15)	0.000123	4.00E-05	3.078965	0.0021
C(16)	-0.001770	0.000388	-4.566197	0.0000
C(17)	0.000881	0.000536	1.643361	0.1003
C(18)	-0.001243	0.000291	-4.271719	0.0000

C(19)	7.52E-05	0.000305	0.246727	0.8051
C(20)	0.000884	0.000262	3.377469	0.0007
C(21)	-0.000609	0.000174	-3.493435	0.0005
C(23)	-0.000437	0.000227	-1.926901	0.0540
C(24)	3.56E-05	2.16E-05	1.651136	0.0987
C(25)	0.000159	0.000194	0.819266	0.4126
C(26)	0.000609	0.000150	4.063076	0.0000
C(27)	0.000209	0.000218	0.958420	0.3379
C(28)	0.000120	0.000253	0.474573	0.6351
C(29)	-0.000251	0.000195	-1.292442	0.1962
C(30)	-0.000276	7.40E-05	-3.726760	0.0002
C(32)	1.49E-05	8.65E-06	1.726796	0.0842
C(33)	-0.000172	0.000174	-0.988778	0.3228
C(34)	0.000121	0.000162	0.748957	0.4539
C(35)	5.66E-05	0.000159	0.356916	0.7212
C(36)	-0.000211	0.000176	-1.195330	0.2320
C(37)	5.62E-05	0.000144	0.388911	0.6973
C(38)	6.27E-05	8.21E-05	0.763364	0.4453
C(40)	8.55E-06	4.51E-06	1.893667	0.0583
C(41)	8.03E-05	3.37E-05	2.381510	0.0172
C(42)	1.09E-05	3.64E-06	2.986366	0.0028
C(43)	5.31E-06	3.68E-06	1.442687	0.1491
C(44)	3.82E-05	7.67E-06	4.983399	0.0000
C(45)	2.16E-06	3.12E-06	0.692684	0.4885
C(47)	-0.000628	0.000173	-3.620699	0.0003
C(48)	4.72E-05	0.000137	0.345479	0.7297
C(49)	0.000144	0.000148	0.975699	0.3292
C(50)	0.000171	0.000133	1.280735	0.2003
C(51)	0.000229	6.49E-05	3.522632	0.0004
C(53)	-0.000255	0.000116	-2.194534	0.0282
C(54)	-0.000271	0.000128	-2.113685	0.0346
C(55)	0.000407	9.50E-05	4.280881	0.0000
C(56)	-0.000199	6.78E-05	-2.938245	0.0033
C(58)	-0.000626	0.000224	-2.795775	0.0052
C(59)	6.47E-05	0.000185	0.349849	0.7265
C(60)	8.03E-05	6.14E-05	1.307358	0.1911
C(62)	-0.000377	0.000254	-1.482904	0.1381

C(63)	0.000278	7.00E-05	3.973577	0.0001
C(65)	-0.000134	5.96E-05	-2.244605	0.0248
C(301)	31947.61	5604.965	5.699878	0.0000
C(202)	8.02E-06	3.78E-07	21.19068	0.0000
C(302)	-19219.03	12119.51	-1.585793	0.1128
C(203)	3.46E-07	4.52E-08	7.653942	0.0000
C(303)	-10997.59	886.1004	-12.41122	0.0000
C(204)	1.66E-06	8.78E-08	18.94881	0.0000
C(304)	-111420.9	5007.612	-22.25031	0.0000
C(205)	2.41E-07	1.32E-07	1.825166	0.0680
C(305)	-54354.27	7158.693	-7.592764	0.0000
C(206)	5.25E-07	1.01E-07	5.212846	0.0000
C(306)	-7494.288	8823.458	-0.849359	0.3957
C(207)	4.31E-06	2.59E-07	16.66470	0.0000
C(307)	-231440.2	30215.83	-7.659570	0.0000
C(208)	2.70E-07	7.04E-08	3.833185	0.0001
C(308)	-11110.94	3675.950	-3.022605	0.0025
C(209)	1.85E-07	8.15E-08	2.268096	0.0233
C(309)	-38171.72	4068.347	-9.382611	0.0000
C(210)	4.01E-07	4.70E-08	8.516377	0.0000
C(310)	-2949.620	1780.717	-1.656423	0.0976
C(211)	1.41E-07	4.36E-08	3.226086	0.0013
C(311)	-12863.40	3758.417	-3.422558	0.0006
Determinant residual covariance		1.01E+97		

TABLE B.IV SYSTEM SPECIFICATION BY EQUATION

1. MAIZE

Observations: 2674

R-squared	0.013590	Mean dependent var	15147.94
Adjusted R-squared	-0.016059	S.D. dependent var	30083.23
S.E. of regression	30323.82	Sum squared resid	2.39E+12
Durbin-Watson stat	1.687736		

2. DIARY PRODUCTS

Observations: 2674			
R-squared	0.188785	Mean dependent var	79606.86
Adjusted R-squared	0.164402	S.D. dependent var	70658.58
S.E. of regression	64589.75	Sum squared resid	1.08E+13
Durbin-Watson stat	1.819764		

3. BEEF A

Observations: 2673			
R-squared	0.269286	Mean dependent var	3513.598
Adjusted R-squared	0.247314	S.D. dependent var	15428.36
S.E. of regression	13385.26	Sum squared resid	4.65E+11
Durbin-Watson stat	1.792750		

4. BEEF B

Observations: 2672			
R-squared	0.400229	Mean dependent var	53732.55
Adjusted R-squared	0.382187	S.D. dependent var	67755.28
S.E. of regression	53256.36	Sum squared resid	7.35E+12
Durbin-Watson stat	1.834228		

5. BEEF C

Observations: 2674			
R-squared	0.124616	Mean dependent var	46119.50
Adjusted R-squared	0.098304	S.D. dependent var	48513.31
S.E. of regression	46067.11	Sum squared resid	5.51E+12
Durbin-Watson stat	1.866513		

6. CHICKEN

Observations: 2671			
R-squared	0.173875	Mean dependent var	35453.76
Adjusted R-squared	0.149014	S.D. dependent var	43315.70
S.E. of regression	39958.25	Sum squared resid	4.14E+12
Durbin-Watson stat	1.793643		

7. WHEAT

Observations: 2674

R-squared	0.000942	Mean dependent var	85071.88
Adjusted R-squared	-0.029087	S.D. dependent var	72392.20
S.E. of regression	73437.50	Sum squared resid	1.40E+13
Durbin-Watson stat	1.771802		

8. RICE

Observations: 2674

R-squared	0.065662	Mean dependent var	12597.44
Adjusted R-squared	0.037577	S.D. dependent var	14109.00
S.E. of regression	13841.37	Sum squared resid	4.97E+11
Durbin-Watson stat	1.633349		

9. SUGAR

Observations: 2673

R-squared	0.123616	Mean dependent var	15930.61
Adjusted R-squared	0.097264	S.D. dependent var	15037.87
S.E. of regression	14287.84	Sum squared resid	5.30E+11
Durbin-Watson stat	1.815664		

10. APPLE

Observations: 2667

R-squared	0.181500	Mean dependent var	6141.340
Adjusted R-squared	0.156831	S.D. dependent var	12322.17
S.E. of regression	11314.74	Sum squared resid	3.31E+11
Durbin-Watson stat	1.913462		

11. OIL

Observations: 2666

R-squared	0.049816	Mean dependent var	15680.24
Adjusted R-squared	0.021168	S.D. dependent var	15015.73
S.E. of regression	14855.96	Sum squared resid	5.71E+11
Durbin-Watson stat	1.800769		

APPENDIX C
ECONOMETRIC ESTIMATION RESULTS
BOLIVIA

TABLE C.I. IDENTIFICATION NUMBER FOR ESTIMATED COFFICIENTS - INCOME – CONSTANT TERM – CUMULATIVE DISTRIBUTION FUNCION

Product Equation	INCOME	CONSTANT	CDF
Maize	201	101	301
Dairy Products	202	102	302
Beef A	203	103	303
Beef B	204	104	304
Beef C	205	105	305
Chicken	206	106	306
Wheat	207	107	307
Rice	208	108	308
Sugar	209	109	309
Apple	210	110	310
Oil	211	111	311

TABLE C.II IDENTIFICATION NUMBER FOR ESTIMATED COFFICIENTS - PRICE COEFFICIENTS

Product Equation	**Maize**	**Dairy Prods.**	**Beef A**	**Beef B**	**Beef C**	**Chicken**	**Wheat**	**Rice**	**Sugar**	**Apple**	**Oil**
Maize	1	2	3	4	5	6	7	8	9	10	11
Dairy Products	2	12	13	14	15	16	17	18	19	20	21
Beef A	3	13	22	23	24	25	26	27	28	29	30
Beef B	4	14	23	31	32	33	34	35	36	37	38
Beef C	5	15	24	32	39	40	41	42	43	44	45
Chicken	6	16	25	33	40	46	47	48	49	50	51
Wheat	7	17	26	34	41	47	52	53	54	55	56
Rice	8	18	27	35	42	48	53	57	58	59	60
Sugar	9	19	28	36	43	49	54	58	61	62	63
Apple	10	20	29	37	44	50	55	59	62	64	65
Oil	11	21	30	38	45	51	56	60	63	65	66

TABLE C.III. ESTIMATION OUTPUT

System: LINQUAD_BOLIVIA
Estimation Method: Seemingly Unrelated Regression
Included observations: 2983
Total system (balanced) observations 32813
Iterate coefficients after one-step weighting matrix
Convergence achieved after: 1 weight matrix, 8 total coef iterations

	Coefficient	**Std. Error**	**t-Statistic**	**Prob.**
C(101)	1.077346	5.029980	0.214185	0.8304
C(1)	-2.352397	0.251044	-9.370471	0.0000
C(2)	0.132549	0.212647	0.623330	0.5331
C(3)	0.790896	0.138549	5.708419	0.0000
C(4)	0.046439	0.101059	0.459526	0.6459
C(5)	0.169614	0.090427	1.875697	0.0607
C(6)	-0.262174	0.170304	-1.539447	0.1237

C(7)	0.580347	0.119038	4.875290	0.0000
C(8)	0.986321	0.186941	5.276121	0.0000
C(9)	0.274796	0.150701	1.823455	0.0682
C(10)	1.522466	0.163220	9.327686	0.0000
C(11)	-0.193066	0.089424	-2.158988	0.0309
C(201)	-8.82E-07	0.000177	-0.004993	0.9960
C(102)	25.10214	4.986782	5.033736	0.0000
C(103)	-16.40256	4.353328	-3.767821	0.0002
C(104)	7.299974	3.853210	1.894518	0.0582
C(105)	42.72577	3.617713	11.81016	0.0000
C(106)	32.71477	7.318958	4.469867	0.0000
C(107)	20.86934	4.523523	4.613515	0.0000
C(108)	142.4507	9.682470	14.71222	0.0000
C(109)	44.79614	8.163676	5.487251	0.0000
C(110)	35.21835	6.712575	5.246623	0.0000
C(111)	79.21087	5.359143	14.78051	0.0000
C(12)	-0.903196	0.178974	-5.046523	0.0000
C(22)	0.840969	0.140609	5.980901	0.0000
C(31)	-0.939519	0.157444	-5.967322	0.0000
C(39)	-1.633411	0.146774	-11.12873	0.0000
C(46)	-2.024184	0.462309	-4.378426	0.0000
C(52)	-4.217106	0.245895	-17.15005	0.0000
C(57)	-23.05346	1.206149	-19.11329	0.0000
C(61)	-1.931823	1.066971	-1.810568	0.0702
C(64)	-9.508909	0.644407	-14.75606	0.0000
C(66)	-7.179473	0.353663	-20.30035	0.0000
C(13)	-0.299938	0.140358	-2.136943	0.0326
C(14)	0.031519	0.091134	0.345857	0.7295
C(15)	0.048033	0.124419	0.386061	0.6995
C(16)	-0.019382	0.215991	-0.089735	0.9285
C(17)	-0.155996	0.189819	-0.821819	0.4112
C(18)	-0.485051	0.306969	-1.580130	0.1141
C(19)	-0.449285	0.206661	-2.174024	0.0297
C(20)	0.012259	0.123705	0.099099	0.9211
C(21)	-0.170767	0.141301	-1.208534	0.2269
C(23)	0.014030	0.083631	0.167757	0.8668
C(24)	-0.242066	0.105522	-2.293990	0.0218
C(25)	0.201627	0.171336	1.176794	0.2393
C(26)	0.366789	0.135656	2.703810	0.0069
C(27)	-0.513332	0.276901	-1.853847	0.0638
C(28)	-0.300018	0.217296	-1.380688	0.1674
C(29)	0.373861	0.125561	2.977520	0.0029
C(30)	-0.305525	0.141965	-2.152113	0.0314
C(32)	-0.038730	0.086881	-0.445785	0.6558
C(33)	0.146169	0.152991	0.955411	0.3394
C(34)	0.635182	0.097431	6.519278	0.0000
C(35)	0.318975	0.259147	1.230865	0.2184
C(36)	0.370203	0.270856	1.366790	0.1717
C(37)	-0.138765	0.227020	-0.611247	0.5410
C(38)	-0.146496	0.161363	-0.907867	0.3640
C(40)	-0.447123	0.170128	-2.628160	0.0086

C(41)	-0.593554	0.125911	-4.714074	0.0000
C(42)	-1.706969	0.239083	-7.139656	0.0000
C(43)	-0.334885	0.184845	-1.811711	0.0700
C(44)	0.008233	0.152754	0.053899	0.9570
C(45)	-0.417798	0.117280	-3.562385	0.0004
C(47)	-0.143825	0.226514	-0.634949	0.5255
C(48)	-1.250003	0.435787	-2.868378	0.0041
C(49)	-0.706906	0.341083	-2.072535	0.0382
C(50)	0.227466	0.256886	0.885474	0.3759
C(51)	-0.438399	0.222019	-1.974599	0.0483
C(53)	0.730210	0.291795	2.502479	0.0123
C(54)	0.778038	0.212440	3.662389	0.0003
C(55)	0.446902	0.155736	2.869622	0.0041
C(56)	-0.067795	0.136232	-0.497641	0.6187
C(58)	-5.908671	0.615688	-9.596863	0.0000
C(59)	-0.726122	0.479683	-1.513754	0.1301
C(60)	-1.396301	0.373850	-3.734926	0.0002
C(62)	-0.068474	0.479765	-0.142725	0.8865
C(63)	-1.414420	0.415972	-3.400274	0.0007
C(65)	-0.681398	0.293103	-2.324776	0.0201
C(301)	-4.326736	6.781144	-0.638054	0.5234
C(202)	0.002162	0.000223	9.687179	0.0000
C(302)	-2.896577	4.275697	-0.677451	0.4981
C(203)	0.000798	9.58E-05	8.334608	0.0000
C(303)	46.48140	9.779002	4.753185	0.0000
C(204)	0.000257	8.00E-05	3.209259	0.0013
C(304)	17.60018	4.997357	3.521898	0.0004
C(205)	0.000623	0.000108	5.767261	0.0000
C(305)	-0.879094	6.875383	-0.127861	0.8983
C(206)	0.000660	0.000150	4.391781	0.0000
C(306)	36.72610	10.40190	3.530711	0.0004
C(207)	0.001432	0.000163	8.774794	0.0000
C(307)	-119.8756	10.39342	-11.53379	0.0000
C(208)	0.000475	0.000289	1.645167	0.0999
C(308)	4.032294	3.999117	1.008296	0.3133
C(209)	-0.000184	0.000215	-0.852456	0.3940
C(309)	8.338655	2.662325	3.132095	0.0017
C(210)	0.000138	8.42E-05	1.641909	0.1006
C(310)	-3.542760	2.924127	-1.211562	0.2257
C(211)	-0.000274	0.000151	-1.816804	0.0693
C(311)	22.05349	3.450061	6.392203	0.0000

Determinant residual covariance 1.59E+26

TABLE C.IV. SYSTEM SPECIFICATION BY EQUATION

1. MAIZE

Observations: 2983

R-squared	0.105668	Mean dependent var	1.091572

Adjusted R-squared	0.081647	S.D. dependent var	6.275099
S.E. of regression	6.013473	Sum squared resid	105014.0
Durbin-Watson stat	0.521178		

2. MILK

Observations: 2983

R-squared	0.121599	Mean dependent var	11.96003
Adjusted R-squared	0.098005	S.D. dependent var	31.36426
S.E. of regression	29.78771	Sum squared resid	2576741.
Durbin-Watson stat	1.492723		

3. BEEF A

Observations: 2983

R-squared	0.221595	Mean dependent var	14.13267
Adjusted R-squared	0.200688	S.D. dependent var	27.05645
S.E. of regression	24.18962	Sum squared resid	1699240.
Durbin-Watson stat	1.603135		

4. BEEF B

Observations: 2983

R-squared	0.092652	Mean dependent var	4.604635
Adjusted R-squared	0.068281	S.D. dependent var	12.21606
S.E. of regression	11.79162	Sum squared resid	403779.1
Durbin-Watson stat	1.713782		

5. BEEF C [5]

Observations: 2983

R-squared	0.116582	Mean dependent var	34.63782
Adjusted R-squared	0.092854	S.D. dependent var	45.92445
S.E. of regression	43.74039	Sum squared resid	5555995.
Durbin-Watson stat	1.479535		

6. CHICKEN

Observations: 2983

R-squared	0.076647	Mean dependent var	14.81945
Adjusted R-squared	0.051846	S.D. dependent var	32.20337
S.E. of regression	31.35744	Sum squared resid	2855472.
Durbin-Watson stat	1.651522		

7. WHEAT

Observations: 2983

R-squared	0.159525	Mean dependent var	62.36517
Adjusted R-squared	0.136950	S.D. dependent var	41.66064
S.E. of regression	38.70294	Sum squared resid	4349953.
Durbin-Watson stat	1.740232		

8. RICE

Observations: 2983

R-squared	0.176111	Mean dependent var	7.193563
Adjusted R-squared	0.153982	S.D. dependent var	16.32847
S.E. of regression	15.01881	Sum squared resid	655039.4

Durbin-Watson stat	1.493870		

9. SUGAR

Observations: 2983			
R-squared	0.085143	Mean dependent var	4.535141
Adjusted R-squared	0.060570	S.D. dependent var	8.584422
S.E. of regression	8.320382	Sum squared resid	201040.3
Durbin-Watson stat	1.888510		

10. APPLE

Observations: 2983			
R-squared	0.105575	Mean dependent var	1.131780
Adjusted R-squared	0.081551	S.D. dependent var	5.418198
S.E. of regression	5.192572	Sum squared resid	78299.97
Durbin-Watson stat	2.020717		

11. OIL

Observations: 2983			
R-squared	0.169059	Mean dependent var	5.291922
Adjusted R-squared	0.146740	S.D. dependent var	11.03363
S.E. of regression	10.19199	Sum squared resid	301657.8
Durbin-Watson stat	1.721349		