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Household demand elasticities for meat products in Uruguay

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Abstract

This article analyzed the demand for meats at household level over the past decade in Uruguay, a country that exhibits a very high per capita consumption of these products. In particular, the consumption of beef is one of the highest in the world and only comparable to Argentina. The analysis involved a two-step estimation of an incomplete system of censored demand equations using household data from the last available national income and expenditure survey (2005/06). Thirteen meat products were included in the analysis: six broad beef products (deboned hindquarter cuts, bone-in hindquarter cuts, ground beef, rib plate, bone-in forequarter cuts, and other beef cuts), four products from other meats (sheep, pork, poultry, and fish), and three generic mixed-meat products. A complete set of short-term income, own-price and cross-price elasticities were computed and reported along with their 90% confidence intervals (CI). The results were consistent with both economic theory and empirical evidence as well as with the expected behavior, considering the relevance of these products, particularly beef, in the diet of Uruguayan consumers. All meat items were necessary goods and evidenced income-inelastic responses, which was expected given their high consumption level. All meats behaved as normal goods although exhibiting different reactions to changes in price. In general, beef cuts were more price elastic than other more broadly defined products. The more specific and disaggregated the meat product the higher its corresponding direct price elasticity. The complement/substitute relationships found in this study were highly depended on the specific product combinations.

Additional key words: food; consumption; expenditures; incomplete systems; two-step estimation.

Introduction

Uruguay exhibits a very high per capita consumption of meat, with an absolute predominance of beef. In contrast, the predominant meats in the rest of the world are pork and poultry, in the Western hemisphere, and fish and seafood, in Asia and the Pacific. With important fluctuations, beef intake in Uruguay has exhibited a downward trend over the last 50 years while the demand for other meats such as fish, pork and especially poultry have grown during the same period. However, the consumption of beef alone still exceeds by far the intake of all other meats together (Suppl. Fig. 1 [pdf online]). According to the statistics published by FAO (http://faostat.fao.org/), beef consumption in Uruguay is comparable only to that of Argentina.

Considering only the last two decades (1990-2010), total meat consumption averaged a little bit more that 95 kg per person in Uruguay. About 60% of this quantity corresponded to beef (56 kg). Poultry has occupied the second place in the consumer preference

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Abbreviations used: AEQ (adult equivalent units); AGE (age of household head); BFQ (bone-in forequarter); BGD (ground beef); BHB (bone-in hindquarter); BHD (deboned hindquarter); BOC (other beef cuts); BRP (rib plate); CI (confidence intervals); EDS (education level superior to primary school); ED1 (primary school); ED2 (complete high school); ED3 (other technical careers); ED4 (university and graduate school); FSM (fish and other seafood); HH (household); HSZ (number of members); LH (LaFrance & Hanemann); INCW (weekly income); LWI (logarithm of weekly income); MLE (maximum likelihood); MPM (ready-to-eat carry meal); MSC (meat for cooking); MSF (meat for fresh consumption); MVD (Montevideo); OVI (sheep); O64 (number of members over 64 years old); POR (pork); PTY (poultry); P18 (presence of members under 18 years old); P64 (presence of members over 64 years old); SY (Shonkwiler & Yen); U18 (number of members under 18 years old); VAR (vector autorregression model); WMN (household commanded by a woman).

with almost 15% of the share. On average, pork and sheep represented 9% each while fish and seafood captured the remaining 8%. These numbers highlight how meats in general and particularly beef are traditional food items and basic components in the diet of Uruguayan consumers. Uruguay is considered a middle-income country, where meats take an important share of household food expenditures.

The significance of these food items in the economy contrasts with the scarcity of empirical studies engaged in estimating demand elasticities for specific meat products in Uruguay. One of the exceptions is the work of Sáder (2000), who estimated short and long run income and price elasticity of beef demand in Montevideo for the period 1990-99. This author used a vector autorregression model (VAR) that included annual average household income and beef consumption, and average retail prices for both aggregate beef and poultry. The reported short run responses showed that income and own-price elasticities for beef were 0.305 and –0.237, respectively, while cross-price elasticity with respect to poultry was 0.034. The corresponding long run elasticities were 0.81, –0.39, and 0.43.

Lanfranco *et al.* (2006) investigated consumption patterns of Uruguayan consumers for four basic staples (beef, flour, rice, and dairy) using 1994-95 survey data. They found that beef consumption, taken as a broad category, showed a small response to changes in both income and prices. The values of income and price elasticity were respectively 0.05 and –0.04. The same study also computed demand elasticities for three more specific but still widely defined beef categories. The respective values of income and own-price elasticity were 0.786 and –0.805 for ground beef, 0.114 and –0.789 for hind and forequarter bone-in cuts. For deboned cuts, price elasticity was –0.817 while income elasticity was not statistically different from zero.

In the international literature, estimated price and income or expenditure elasticities for meat products vary substantially among studies. The diversity of models, econometric methods, and data sets make difficult the comparison of results, not only among them but also with those obtained in this research. Most of works have employed single equation models. Some used time series while others used cross-section survey data at the household level. In most cases, they only considered broad meat categories, such as beef, pork, poultry, and occasionally fish or lamb.

Table 1 summarizes the results of some selected demand studies that estimated income/expenditure elasticity (η) and own-price elasticities (ε) for these broad products. The literature is vast and this list is not exhaustive by any means. It considers different studies carried out over different time periods in several countries other than Uruguay. They used different theoretical and empirical approaches for estimating demand elasticities. Although some of the listed works included cross price elasticities, the table only presents own-price estimates from uncompensated demand equations.

At this level of disaggregation, all the selected studies found that meats behaved as normal goods (η > 0) with only few exceptions. The product with the highest response to changes in income was beef, reporting as a luxury good (η > 1) in some of the articles. In general, poultry and pork reported η less than one; in some works, the former exhibited greater η than the latter. In the remaining studies, poultry was the most income inelastic meat. When computed, the estimated η for fish consistently appeared between the other two. With regard to price elasticity, the referred studies showed that meat products behaved as ordinary goods (ε > 0) at this level of disaggregation.

On the other hand, only few studies considered more disaggregate meat products. Among them, four stand out enough in order to be mentioned in a brief review. Eales & Unnevehr (1988), who computed η and ε elasticities for chicken, whole and portioned cuts, hamburgers and beef table cuts, and pork cuts. In turn, Capps (1989) reported own and cross-price elasticities at retail level using scanner data for disaggregate meat products Nayga & Capps (1994) reported estimates of η for various beef, pork, and chicken disaggregated products. More recently, Davis *et al.* (2007) computed price and total meat expenditure elasticities at household level for a wide variety of meats, including beef, pork, chicken, and fish products.

Most of the demand studies found in the literature refer to conditions where the relevance of meats, especially beef, is much lower in both absolute and relative terms with respect to other food products. In general, animal protein is more expensive than vegetable protein. In addition, protein from ruminant species is more expensive than protein from monogastric. This may not be the case in some domestic markets like Argentina and Uruguay. One might expect that demand estimates derived in these cases will differ substantially from those found in most other common situations. This brings an extra research interest in conducting meat demand studies in the context of societies exhibiting such different patterns.

Table 1. Demand elasticity estimates for broad meat categories in selected articles

Authors	Place & Period	Income/Expenditure (η) and Own Price (ε) Elasticity							
		Beef / Lamb		Pork		Poultry		Fish	
		η	ε	η	ε	η	ε	η	ε
George & King (1971)	USA, post-war	1.27	–0.96	0.33	–0.51	0.33	–0.78	—	—
Eales & Unnevehr (1988)	USA, 1965-85	0.34	–0.57	0.28	–0.76	0.53	–0.28	—	—
Hayes *et al*. (1990)	Japan, 1965-86	2.49	–0.46	0.53	–0.76	0.21	–0.59	0.15	–0.70
Moschini & Meilke (1989)	USA, 1967-83 USA, 1971-87	1.22 1.39	–0.98 –1.05	1.04 0.85	–1.02 –0.84	0.24 0.21	–0.09 –0.10	0.43 0.31	–0.14 –0.20
Chalfant *et al*. (1991)	Canada, 1960-88	—	–0.95 / –0.96	—	–0.72 / –0.73	—	–0.89 / –0.93	—	–0.12 / –0.55
Park *et al*. (1996)	USA, 1987-88	0.48 / 0.62	–0.44 / –0.45	0.49 / 0.61	–0.44 / –0.49	0.36 / 0.61	–0.22 / –0.35	0.47 / 0.74	–0.58 / –0.61
Cortez & Senauer (1996)	USA, 1980-90	0.65 / 1.80	—	0.50 / 1.50	—	0.50 / 1.50	—	0.60 / 1.60	—
Huang (1996)	USA, 1953-90	0.39	–0.62	0.66	–0.73	0.08	–0.37	0.43	—
Golan *et al*. (2001)	Mexico, 1992	1.31	–0.60	1.15	–0.42	0.75	–0.40	1.25	–2.09
Fraser & Moosa (2002)	UK, 1960-94	—	–0.96 / –1.32	—	–0.54 / –0.85	—	–0.57 / –0.85	—	—
Dong *et al*. (2004)	Mexico, 1998	1.31	–0.63	1.17	–0.13	1.17	–0.83	1.16	–0.63
Thompson (2004)	Japan 1981-2000 Japan, 2000	0.36 0.34	–1.28 –1.19	0.06 0.05	–0.91 –0.92	0.05 0.04	–0.73 –0.71	— —	— —
Mazzocchi (2006)	USA, 1982-99	1.05 / 1.22	–0.81 / –1.03	0.55 / 1.05	–0.65 / –0.82	0.66 / 1.18	–0.48 / –0.84	—	—
Yen & Lin (2006)	China, 2000	0.77	–0.33	0.85	–0.28	1.08	–0.51	1.16	–0.53
Lema *et al*. (2006)	Argentina, 1996-97	0.21 / 0.22	–0.36 / –0.37	—	—	0.15	–0.09	—	—
	Paraguay, 2000-01	0.03 / 0.25	–0.003 / –0.44	—	—	0.11	—	—	—
	Bolivia, 2003-04	0.14 / 0.24	–3.35 / –5.29	—	—	0.12	–2.76		
Hupkova & Bielik (2009)	Slovakia, 93-07	0.91	–0.47	0.23	–0.98	1.09	–1.00	—	—
Alboghdady & Alashry (2010)	Egypt 1990-2005	0.75	–0.42	—	—	1.65	–0.70	1.35	–0.79
Resende Filho *et al*. (2012)	Brazil, 1975-08	0.07	–016	–0.19	–0.05	0.11	–0.47	—	—
Motallebi & Pendell (2013)	Iran, 1982-2007	1.36 / 1.71	–1.00 / –1.15	—	—	1.40 / 1.48	–1.44 / –1.53	1.07 / 1.30	–1.72

Note: All the elasticity values were rounded to two decimal points for readability. Non-significant values were omitted when specified.

The aim of the present study was estimating the demand for meats of Uruguayan households. The correct assessment of the determinants of this consumption pattern and the responses to price and income changes is a key element for private agents involved in the meat industry as well as for decision makers in charge of drawing public policies.

Material and methods

Two-step estimation of incomplete demand systems

Lanfranco (2001) performed a simultaneous estimation of an incomplete system of censored demand equations by integrating the theory of the incomplete demand systems approach and weak integrability from LaFrance & Hanemann (1989) with the econometric features of the two-step model of censored equations proposed by Shonkwiler & Yen (1999). This combining approach, named LH-SY from now, was utilized with variations by Lanfranco *et al*. (2002; 2006), García (2006), Lema *et al*. (2006), Depetris *et al*. (2008). Due to the lack of space, this paper will present only a concise overview of LH-SY approach. A complete derivation was developed by Lanfranco (2001; 2004).

In essence, simultaneous estimation of incomplete demand systems (the LH part) implies that a subset of demand equations for the commodities of interest can be treated as a complete system by artificially augmenting the incomplete system with a composite *numèraire* commodity representing total expenditure on all other goods. By this means, the weak integrability approach is sufficient to permit the usual tasks of applied economic analysis, and it can be used in almost any practical applications. Nothing has to be assumed a priori about the structure of preferences in addition to usual properties.

Having an appealing theoretical foundation, the second part consists in postulating a sound statistical technique for doing an empirical work that, while robust, do not collide with the economic theory. Here is where estimation of a two-step decision process comes into account (the SY part). As pointed out by Guilkey *et al*. (1990), models involving a two-stage process imply that two dependent variables are analyzed: [1] a dichotomous variable that indicates whether or not an individual consumes a nonzero amount from a particular food group, and [2] the actual quantity consumed for those who chose to consume. The two-stage decision for the t^{th} person is described by the following equations:

$$d_t^* = v_t'\varphi + e_t^* \quad \text{Dichotomous or decision equation [1]}$$

$$q_t^* = f\left(\mathbf{w}_t, \theta\right) + u_t^* \quad \text{Regression or level equation [2]}$$

The unobserved dependent variable d_t^* in [1] is a reservation value. The observed binary realization d_t, takes the value $d_t = 1$ (yes) when $d_t^* > 0$, and $d_t = 0$ (no) when $d_t^* \leq 0$. The dependent variable in [2] contains the consumption information of those individuals for which $d_t = 1$ (yes), that is $q_t = q_t^*$ when $d_t^* > 0$, otherwise their consumption is zero ($q_t = 0$). The variables included respectively in [1] and [2] constitute the elements of vectors $\mathbf{v}_t$, with dimension H × 1, and $\mathbf{w}_t$, with dimension L × 1. They may or may not contain variables in common, so that H and L may be different, and θ and φ are their associated parameters. The term $f(\mathbf{w}_t, \theta)$ is a general deterministic component that can be nonlinear in θ.

Under the hypothesis of selectivity bias, the disturbances of Eqs. [1] and [2] are assumed to be correlated through a correlation coefficient ρ (rho), following a bivariate normal distribution. The estimation is carried out through a two-step procedure using the complete sample, comprised by T observations (individuals) that include both the individuals who consume and do not consume a particular food product.

In the first step, the parameters φ_k of the K *probit* equations in [1] were consistently estimated by maximum likelihood (MLE). The estimates of φ were used to compute ϕ and F as a "correction factor" for the second step. The derivative of the i^{th} probit equation with respect to its h^{th} regressor represents the change in the probability of spending on the product of interest due to a unit change in v_{ih}. For $h = 1, \ldots,$ H regressors and $i = 1, \ldots,$ K equations:

$$\frac{\partial P_i}{\partial v_{ih}} = \varphi_h \times \phi\left(\mathbf{v}_i'\varphi\right) \quad [3]$$

In the second step, there are K equations (commodities). To avoid a common type of heteroskedasticity that arises if the model is estimated with q_{kt} in the left hand side of [2], deflated expenditure, denoted by e_{kt}, was used as dependent variable instead of physical quantities, by multiplying both sides of the equation by its corresponding price. Dropping the t subscripts for individual observations, the Eq. [2] can be rewritten as:

$$e_k = p_k\left\{\Phi\left(\mathbf{v}_k'\hat{\varphi}_k\right)\times f\left(\mathbf{w}_k,\theta_k\right)+\delta_k\phi\left(\mathbf{v}_k'\hat{\varphi}_k\right)\right\}+u_k \qquad k=1,\ldots,K, \quad [4]$$

The term $\phi(\mathbf{v}_t'\varphi)$ is the standard normal probability density function of the decision (*probit*) equation, $\phi(\mathbf{v}_t'\varphi)$ is the cumulative distribution function, $\delta = \rho\sigma_u$ is an additional parameter to be estimated, and u_{tk} is the error term. The functional form of term $\phi(\mathbf{w}_k, \theta_k)$ was the so-called LinQuad model. The model also allows the inclusion of Z demographic and socioeconomic variables in order to investigate their effects on demand. Denoting the z^{th} socioeconomic variable as g_z and its associate parameter in the k^{th} equation as χ_{kz}, the final expression of the LinQuad function plugged into [4] is:

$$f\left(\mathbf{w}_k,\theta_k\right)=\alpha_k+\sum_{i=1}^{K}\beta_{ki}p_i+\sum_{z=1}^{Z}\chi_{kz}g_z+\gamma_k\left[y-\sum_{i=1}^{K}\alpha_i p_i-\frac{1}{2}\sum_{j=1}^{K}\sum_{i=1}^{K}\beta_{ji}p_j p_i-\sum_{i=1}^{K}\sum_{z=1}^{Z}\chi_{iz}p_i g_z\right] \quad [5]$$

This function is linear in deflated income and linear and quadratic in deflated prices. It also meets all the required integrability conditions (Lanfranco, 2001; 2004). The only requirement consists in deflating all prices (**p**) and income (y) by $\pi(\mathbf{r})$, a function of all other prices (**r**). The specific form of $\pi(\mathbf{r})$ does not substantially influence the structure of the conditional preferences for the **q** commodities of interest.

The system equations are jointly estimated by MLE to obtain consistent but inefficient estimates for the θ_k and δ_k parameters because the error term in [4] is zero-meaned but heteroskedastic. The correct variance-covariance matrix Σ of the parameters is obtained by extending the results of Murphy & Topel (1985) with the contributions of Yen & Kan (2000).

Finally, the complete set of income (η_i), direct price (ε_{ii}) and cross-price (ε_{ij}) elasticities, were computed from the estimated model. For i, j = 1, …, K and defining $\bar{p}$, $\bar{q}$, and $\bar{y}$ as the sample means for p, q, and y respectively, the income and uncompensated price elasticities at the means were estimated as:

$$\eta_i = \Phi\left(\mathbf{v}_i'\varphi_i\right)\times\gamma_i\times\frac{\bar{y}}{\bar{q}_i} \quad [6]$$

$$\varepsilon_{ij} = \Phi\left(\mathbf{v}_i'\varphi_i\right)\times\left[\beta_{ij}-\gamma_i\times\left(\alpha_j+\sum_{k=1}^{K}\beta_{kj}\bar{p}_j+\sum_{l=1}^{L}\chi_{kl}\bar{g}_l\right)\right]\times\frac{\bar{p}_j}{\bar{q}_i} \quad [7]$$

The point elasticities were computed at the means of the data, while the corresponding lower and upper bounds for the 90% CI were constructed using the "delta method" (Hogg & Craig, 1995).

Definition of the data set and construction of the variables

The data set used in this study was selected from the last national household's income and expenditure survey (2005-2006) conducted by the Instituto Nacional de Estadísticas (INE, 2008). This survey provides detailed information about defined consumer units, along with their characteristics and demographics, including the information of income and total expenditures on food and non-food products. The data were aggregated at the household (HH) level. Only those who completed all the information needed for the research were considered. This determined a sample of T = 6,931 households for the analysis.

Thirteen meat products were included in the analysis (K = 13). Only in the case of beef it was possible to disaggregate six different basic cuts: deboned hindquarter (BHD), bone-in hindquarter (BHB), ground beef (BGD), rib plate (BRP), bone-in forequarter (BFQ), and other beef cuts (BOC). The other meats had to be handled as broad aggregate products: sheep (OVI), pork (POR), poultry (PTY), and fish and other seafood (FSM). The remaining three products can be regarded as 'mixed meats'; two of them include hams and other cold cuts, sausages and canned meat, either for fresh consumption (MSF) or for cooking (MSC). The last one was a generic meat product consisting of ready-to-eat carry meals (MPM).

Each observation contained information about HH income, prices and expenditures on each of the thirteen meat products, and several demographic and socioeconomic variables hypothesized to affect demand. Capps & Havlicek (1987) explained that these kinds of variables can be introduced into any system of demand equations. In turn, Deaton & Muellbauer (1980) pointed out that households differ in size, age composition, educational level and other characteristics, which are expected to influence consumption patterns. They stated that differences in behavior can be modeled by making demand depend not only on prices and total expenditure but also on some list of HH characteristics. Although HH composition, the number, types, and ages of HH members are the most frequently used in empirical work, any other characteristic can be included (Deaton & Muellbauer, 1980).

Income and expenditure values were constructed on a weekly basis. Reported annual, before-tax HH income for the previous twelve months was used as a proxy for actual income. It included income received by all HH members from any source. Annual income was transformed into weekly income (INCW) by dividing by 52. Variable CPI stands for a non-food consumer price index used as the deflator $\pi(\mathbf{r})$, a function of prices of all other goods.

The dichotomous variable in the left-hand-side of each of the $k = 1, 2,\ldots, 13$ decision equations in [1] took the value one when the HH consumed a positive quantity of the meat product and zero otherwise. H = 8 independent variables were used in this step, including the vector of ones denoted by C and used as a constant for the regression. A variable accounting by the logarithm of weekly income (LWI) was defined, along with a binary variable identifying HH located in Montevideo (MVD), a discrete variable accounting by the number of HH members (HSZ), and two binary variables denoting HH composition, stating the presence of members under 18 years old (P18) and members above 64 years old (P64).

The two remaining binary values identified characteristics of the HH head or reference person. The head of the HH is defined as the person who is recognized as such by members of the HH (INE, 2008). Criteria associated with the economic contribution appear as a second option only when it is not possible to define a head using the first criterion. The first variable related to HH head denoted if this person was a woman (WMN) and the second stated if its education level was superior to primary school (EDS).

Eight socioeconomic and demographic characteristics were included in the demand functions (Z = 8). The choice for representing HH size through a measure of adult equivalent units (AEQ) recalled on the Amsterdam scale due to its simplicity (Deaton & Muellbauer, 1980). The age composition of the HH was characterized by two discrete variables used in the second step, in addition to the dummies P18 and P64 used in the decision equations. The first one reported the number of HH members under 18 years old (U18) while the other represented the number over 64 years old (O64).

Six variables were used to depict the characteristics of the HH head. The first one corresponded to her age, in years (AGE). The same dummy used in the decision step was used again to identify if the HH was headed by a female (WMN). Finally, a set of four dummies were created to represent education level. Variable ED1 identified HH heads whose education level reached up to primary school, including persons that did not receive formal education.

Variable ED2 represented HH headed by a person that indicated up to complete high school, as her maximum level. Variable ED3 included persons with further studies beyond high school and having reached, as a maximum of a two-year college or equivalent, military, school teachers and high school teachers. Finally, variable ED4 represented HH heads with at least one or more years of college education, completed a degree, attended or completed a degree from graduate school. To avoid collinearity problems, the dummy for HH headed by persons that completed only primary school (ED1) was dropped.

Solving the system of 13 demand equations defined in this research work determined the estimation of L = 234 independent parameters, including 13 parameters δ, 91 parameters β, 13 parameters α, 13 parameters γ, and 104 parameters χ.

Results

Basic statistics of the sample

Some basic descriptive statistics characterizing the sample are presented in first place. A total of 2,605 HH (37.6%) were located in the Departamento (province) of Montevideo whereas the remaining 4,326 were located in the rest of the country (66.4%). A total of 2,514 HH out of 6,931 (36.3%) stated that the HH head was a female, leaving the remaining 4,417 HH identified as headed by a male (63.7%). The average age of head of HH was of 53 years old. For the HH whose head was a female, the average age was 56 years old while that when it was male reached to 51 years old.

Table 2 presents the distribution of HH according to the level of education reached by the HH head. Each category indicates the maximum level declared in the survey. ‘Primary school’ included persons that neither received formal education nor attended or completed kindergarten, initial education, or primary school. This situation represented almost half of the total sample. HH included in the ‘High school’ category were second in number and included those HH heads that attended or completed secondary education.

‘Other technical careers’ included technical and two-tear colleges, primary and high school teachers

Table 2. Highest education level achieved by household (HH) head

Highest education level achieved by the head of the HH	Number and proportion of HH		According to HH head gender	
	Number	Proportion	Female	Male
Primary school	3,167	45.7%	44.1%	47.1%
High school (1st to 6th Sec. grade)	1,996	28.8%	30.6%	27.5%
Other technical careers[1]	945	13.6%	12.6%	14.1%
University	823	11.9%	12.7%	11.3%
All households	6,931	100.0%	100.0%	100.0%

[1] Includes technical and two-year colleges, primary and high school teachers and military school.

Table 3. Average size and composition of the household (HH), total and by sex of household head

Gender of household head	Composition of the HH according to gender of head and total			
	HH size measured through		Proportion of HH with members:	
	Number of members (HSZ)	Adult equivalents (AEQ)	Under 18 years old (P18)	Over 64 years old (P64)
Female	2.48	2.07	37%	42%
Male	3.16	2.65	48%	30%
All households	2.92	2.44	44%	33%

and military school, while the last category ('University') denoted HH whose heads were currently pursuing, attended in the past or obtained a four-year university degree or graduate school degree. In addition, it is observed that women in charge of HH tend to exhibit higher education levels than their male counterparts.

As noted in Table 3, HH led by females tended to be smaller in size that HH led by males regardless of the measurement unit. In terms of total number of members (HSZ), HH commanded by a man were on average 27.4% larger than HH commanded by a woman. Measured through the AEQ, this proportion reached 28%.

On average, HH headed by men had a greater proportion of members less than 18 years old than those headed by women. On the contrary, HH commanded by women declared a greater proportion of members over 64 years old.

Frequency of acquisition of meat products

Table 4 presents number and proportion of HH declaring the purchase of the selected meat products during the week of the survey. It does not necessarily mean that the product is consumed in greater quantity. In principle, a product purchased in large quantities by fewer HH could end up showing greater consumption than other bough by more HH in tiny quantity. In most cases, however, it is likely that global consumption of a meat product would be related to the frequency at what it is acquired.

The results confirm the high levels of meat consumption in Uruguay. Nine out of ten surveyed HH purchased at least one meat product during the reference period. Two thirds of the total HH bought at least some quantity of beef. From each four HH purchasing at least on meat product, three included beef in their basket. For those who spent money on meat, the expenditures represented 7.7% of total HH expenditures and 38.1% of food expenditures.

Individually, none of the selected meat products was acquired by much more than 40% of the HH. A mixed product, MSF, ranked as the most preferred by consumers, in terms of purchase frequency. It was followed by BGD, which was the most popular beef product. Setting aside the mixed products, poultry was the most preferred type other than beef; PTY ranked third in the product list. Another product that includes different kinds of meats, MSC, came in fourth place, while a second beef product (BHD) completed the top-5 list. The remaining eight meat products considered were

Table 4. Households (HH) that consumed meat products during the reference period (2005-2006)

Consumption of meat products			HH		
			Nº	%	#
1	BHD	Beef: Boneless or deboned hindquarter cuts, fresh or frozen	1,740	25.1	5th
2	BHB	Beef: Bone-in hindquarter cuts, fresh	480	6.9	11th
3	BGD	Beef: Ground (minced) beef, all qualities	2,513	36.3	2nd
4	BRP	Beef: Rib plate cuts, with or without flank, short ribs	1,038	15.0	9th
5	BFQ	Beef: Bone-in forequarter cuts	1,259	18.2	6th
6	BOC	Beef: Fancy meats and other cuts, no included in the other 5 defined products	582	8.4	10th
7	OVI	Ovine meat: Lamb, sheep, whole or cuts	442	6.4	12th
8	POR	Swine meat: Pork, hogs, piglets and sucking pig, whole or cuts	199	2.9	13th
9	PTY	Poultry meat: Chicken and broiler, whole or cuts	2,196	31.7	3rd
10	FSM	Fish, shellfish and other sea foods, fresh, frozen or canned	1,215	17.5	7h
11	MSF	Mixed meats: Hams, cold meats, sausages and canned meat for eating fresh	2,798	40.4	1st
12	MSC	Mixed meats: Hams, cold meats, sausages and canned meat for cooking	2,005	28.9	4th
13	MPM	Mixed meats: Ready-to-eat meals prepared on the basis of meats	1,211	17.5	8h
All households			6,931	100	
Households consuming at least one meat product			6,161	88.9	
Households consuming at least one beef product			4,523	65.3	

purchased by less than 20% of the HH. Half of them, including pork (POR) and sheep (OVI), where consumed by less than 10% of the HH.

The decision to spend on meat products

The model assumed that when the head or any other member of the HH goes shopping, she first decides whether or not to buy a product, and secondly, she decides how much to buy if so. The reasons for the decision of these two decisions do not have to be the same. When assessing the relevant variables impacting the likelihood of buying a certain product, an effort was made to identify which ones showed a significant effect in this decision, as well as the sign and the magnitude of this effect, in favor or against a positive consumption decision.

The estimated coefficients in a probit model do not provide a marginal interpretation *per se*. For that reason and due to the lack of space, coefficients, standard errors and *p*-values are not presented in this article although they are available upon request. In return, the marginal effects of the variables hypothesized to determine the probability of purchasing a specific meat product (geographic location, income, size, and age composition of the HH, sex, age and education of the head of HH) were computed and reported in Table 5.

In any case, the specific change-in-probability values only appear in the table when found to be statistically different from zero at least at the 10% significance level. Only in those cases, there was evidence supporting that chosen demographic and socioeconomic characteristics of the HH had some influence on the probability of consuming meat products.

Depending on the considered product, this influence varied in value and even in sign, although the magnitudes tend to be relatively low. Through its positive sign, LWI showed a positive effect over the probability of purchasing some positive amount of meat products in most cases. The exceptions were BFQ, which had negative sign, BGD, BOC and OVI, where the marginal effect was not significant. In the way they are consumed in Uruguay, it is not expected that the demand of these products would increase with the level of income.

Confirming prior belief, an increase in the size of the HH also increased the probability of consuming meat products. Statistical evidence of this relationship was found for BGD, BRP, BFG, BOC, POR, PTY, MSF, MSC, and MPM. With regard to the age of HH members, it was found that the presence of P18 only increased the probability of acquiring BGD, MSC, and MPM. The presence of P64 was associated with an increase in the probability of demanding BHD, BFQ, BOC, POR, PTY, and FSM, and a decrease in the probability of consuming MSF, MSC, and MPM.

Table 5. Effects of socio household characteristics on marginal probability of consuming meat products

Meat product[1]	Socioeconomic and demographic characteristics of the households[2]						
	LWI	MVD	HSZ	P18	P64	WMN	EDS
BHD	0.117	0.059	—	—	0.039	—	0.025
BHB	0.027	–0.029	—	—	—	—	—
BGD	—	—	0.062	0.030	—	0.027	0.031
BRP	0.050	–0.217	0.008	—	—	–0.032	–0.020
BFQ	–0.022	–0.018	0.028	—	0.032	–0.027	–0.043
BOC	—	—	0.012	—	0.020	—	—
OVI	—	–0.092	—	—	—	–0.014	–0.034
POR	0.014	—	0.004	—	0.017	—	—
PTY	0.020	—	0.011	—	0.071	—	—
FSM	0.061	0.081	—	—	0.029	—	0.029
MSF	0.108	0.113	0.020	—	–0.023	—	0.086
MSC	0.049	0.056	0.031	0.025	–0.062	—	0.034
MPM	0.046	0.033	0.013	0.032	–0.046	—	0.048

[1] See Table 4. [2] LWI: logarithm of weekly income, MVD: Montevideo, HSZ: number of members, P18: presence of members under 18 years old, P64: presence of members over 64 years old, WMN: household commanded by a woman, EDS: highest education level achieved by household head. Values indicate the magnitude and sign of the marginal effect of the h^{th} characteristic on the probability of consuming any positive amount of the k^{th} meat products. A positive sign (+) means an increase in probability while a negative sign (–) means a decrease in probability. Cells with only a hyphen (—) means that value was non-significant.

MVD, which is the highest urbanized region of the country, accounting by half of the total population, exhibited a lower probability of consuming meat products such as BHB, BRP, BOC, and OVI, than HH located in other regions. HH located in MVD also showed a greater probability consuming positive amounts of more expensive and diversified meats as BHD, FSM, MSF, MSC, and MPM. It should be noted that the effects showed by EDS were very similar, which could not be unexpected since one may think that more urbanized people would be, on average, more educated. In addition, some similarity was also observed in the case of WMN, where the coefficients reported a lower probability of consuming BRP, BFQ, and OVI and a greater probability of consuming BGD.

The level of consumption: income and price elasticity

Concavity was the only theoretical restriction not imposed in the model. This condition was checked ex-post by calculating the eigenvalues of the matrix **b**. The results of the test showed that all the eigenvalues had negative sign, which means that the substitution matrix was negative definite and the demand elasticities computed in this study came from demand functions derived, in turn, from a strictly concave cost function.

The MLE estimation of the system of thirteen LinQuad demand equations involved the estimation of 234 independent parameters. As a consequence, the estimated coefficients, standard errors, t-statistics and *p*-values are not presented herein. The complete estimation results, along with the usual cross-section statistical tests and the characteristics root text are available from the authors upon request. The complete set of income (η_i) and direct price elasticities (ε_{ii}) are presented in Table 6, for the $i = 1, 2,\ldots, K = 13$ meat products. They are reported with their respective lower and upper bounds built for a 90% CI.

In all cases in which the point estimate was positive, its magnitude was less than the unit and the corresponding meat product behaved as a normal good ($0 < \eta < 1$). However, only two products exhibited values statistically different from zero at the chosen significance level (10%). Nothing really can be said about the other 11 products about this matter, as in all these cases, the zero belonged to the 90% CI. The most responsive product to changes in HH income was OVI. The elasticity was greater than 0.5. In turn, the income elasticity estimated for BOC was statistically significant but very low in magnitude.

Table 6. Point estimates and 90% confidence interval (CI) for income and direct price elasticities, 13 selected meat products

Meat product[1] (i)	Income elasticity (η_i)			Own-price elasticity of demand (ε_{ii})		
	Lower limit	Point estimate	Upper limit	Lower limit	Point estimate	Upper limit
BHD	–0.036	0.038	0.112	–1.670	**–1.467**	–1.324
BHB	–0.103	0.053	0.209	–2.332	**–1.946**	–1.561
BGD	–0.014	0.009	0.032	–2.362	**–2.211**	–2.059
BRP	–0.102	–0.032	0.039	–1.172	**–0.992**	–0.813
BFQ	–0.072	0.152	0.376	–1.598	**–1.386**	–1.174
BOC	0.013	**0.052**	0.091	–0.113	**–0.094**	–0.075
OVI	0.263	**0.516**	0.768	–2.389	**–1.970**	–1.551
POR	–0.002	0.030	0.062	–1.135	**–0.813**	–0.491
PTY	–0.017	–0.006	0.005	–0.474	**–0.438**	–0.402
FSM	–0.023	0.010	0.043	–0.516	**–0.460**	–0.403
MSF	–0.008	0.027	0.061	–0.104	**–0.090**	–0.077
MSC	–0.036	0.007	0.049	–1.262	**–1.183**	–1.105
MPM	–0.009	0.071	0.151	–0.213	**–0.191**	–0.168

[1] See Table 4. Point elasticity estimates are presented along with the corresponding lower and upper limits for a 90% CI. Values in bold letter are significantly different from zero as the sign do not change along the entire interval.

All thirteen meat items exhibited direct price elasticity with negative sign all along the 90% CI, confirming that all behaved as ordinary goods ($\varepsilon < 0$). With regard to the magnitudes, seven products (BRP, BOC, POR, PTY, FSM, MSF, and MPM) reported absolute values less than one ($|\varepsilon| < 1$). However, in the case of BRP the response was almost unit elastic ($|\varepsilon| \approx 1$). The remaining six exhibited a magnitude greater than one in absolute value ($|\varepsilon| > 1$). The most responding product to changes in its own price was BGD. Although different qualities can be found in retail stores, this beef product is probably the most specific item among the 13 selected meat products chosen for this research. One would expect that as more detailed commodities are distinguished and the range of potential substitutes widens, price responses will be larger. This same logic applies in the case of the other beef products, which are more disaggregated than the products regarding mixed meats and other meats (poultry, pork, fish, and sheep).

In fact, five of the six beef products appeared to be the most responsive to changes in their own price ($|\varepsilon| \geq 1$). The only exception was BOC, a minor category with a reduced budget share. The other beef products exhibited price elasticities that place them between BGD and BRP in terms of responsiveness to price changes. The only non-purely beef product exhibiting a more than one elastic price response was MSC.

The complete set of uncompensated Marshallian price elasticities of demand is depicted in Table 7. Direct or own-price elasticities were again included in bold text only for illustration purposes, as they constitute the diagonal of the elasticity matrix. The value of price elasticity ε_{ij} shall be read as the marginal change in demand of product i (row headings) with respect to changes in price j (column headings).

The off-diagonal elements call now the attention as they represent cross-price elasticities ($i \neq j$). The sign established the relationships between pairs of goods. Being derived from uncompensated demand functions, they do not provide net but only gross substitute/complement (S-C) relationships, and the term 'gross' can be omitted from now on. Thus, commodity i is considered a substitute for commodity j when $\varepsilon_{ij} > 0$, and a complement when $\varepsilon_{ij} < 0$. However, it is possible for product i to be a substitute for good j, while the good j is a complement of good i, when the sign of ε_{ij} is different than the sign of ε_{ji}. Only point elasticities statistically different from zero at 10% significance level are presented herein. Not significant values were omitted for readability and hyphens were placed instead.

It is not possible to establish an obvious pattern of S-C relationships from these results as most products

Table 7. Matrix of uncompensated (Marshallian) price elasticities, 13 selected meat products

Meat product[1]	Price elasticity (ε_{ij}) of product *i* (row headings) with respect to price *j* (column headings)												
	BHD	BHB	BGD	BRP	BFQ	BOC	OVI	POR	PTY	FSM	MSF	MSC	MPM
BHD	**–1.467**	0.256	—	0.189	—	–0.068	0.306	—	—	—	—	—	—
BHB	0.379	**–1.946**	—	—	—	—	—	—	—	—	—	—	—
BGD	0.123	–0.047	**–2.211**	—	—	—	0.538	0.220	—	0.093	—	0.084	–0.054
BRP	0.222	–0.010	–0.012	**–0.992**	—	—	0.268	—	–0.209	–0.100	—	–0.058	–0.124
BFQ	–0.124	–0.094	0.064	–0.009	**–1.386**	—	—	—	0.107	0.102	–0.068	—	—
BOC	–0.134	–0.141	0.020	–0.061	–0.086	**–0.094**	–0.233	–0.174	–0.012	–0.075	—	—	–0.094
OVI	0.108	—	0.111	0.051	0.032	–0.028	**–1.970**	–0.440	0.081	–0.065	–0.011	—	0.145
POR	0.071	0.075	0.089	–0.004	–0.013	–0.062	–0.731	**–0.813**	0.068	–0.046	0.020	—	—
PTY	–0.022	–0.011	–0.020	–0.187	0.086	–0.006	0.251	0.102	**–0.438**	0.027	—	—	–0.043
FSM	0.122	–0.040	0.082	–0.132	0.117	–0.059	–0.230	–0.100	0.039	**–0.460**	–0.005	0.095	–0.015
MSF	0.002	–0.032	–0.035	0.060	–0.138	–0.023	–0.035	0.079	–0.024	—	**–0.090**	–0.084	–0.063
MSC	0.103	—	—	–0.091	–0.072	–0.009	0.051	–0.020	—	0.111	–0.053	**–1.183**	–0.049
MPM	0.100	–0.040	–0.046	–0.155	–0.072	–0.067	0.471	0.036	–0.060	—	–0.032	–0.042	**–0.191**

[1] See Table 4. The price elasticity measures marginal change in demand of product *i* (row headings) with respect to changes in prices *j* (column headings). Diagonal values in bold correspond to own-price elasticity ($i = j$). Off-diagonal values correspond to cross-price elasticity ($i \neq j$). All the values are significantly different from zero within 90% confidence interval. The hyphen (—) means that value was non-significant.

varied in their responsiveness to changes in the price of the other items. However, for any pair of meat products, if one was a complement for the second, the converse was also true, that is, the second was a complement for the first. The same occurred with the substitution relationship.

Complement relationships predominated over substitution relationships, both within the different cuts of the beef category and among the different meats. This may suggest some diversity in the eating habits of the HH, with different meat products constituting its diet. With the exception of BOC, all the other beef products, which are precisely the most specific, showed less number of S-C relationships than the other meats but without a clear pattern.

Although most of their cross elasticities were not statistically significant, BHD and BHB tended to be substitutes to other beef products. BGD showed more S than C relationships, mainly with respect to other met products. Among the non-beef products, POR behaved as a substitute for some beef cuts such as BHD, BHB, and BGD, as well as for PTY and MSF but a complement for BRP, BFQ, BOC, OVI and FSM. In turn, OVI was a substitute for BHD, BGD, BRP, BFQ, PTY, and MPM, while a complement for BOC, POR, FSM, and MSF. On the contrary, PTY was a complement for BHD, BHB, BGD, BRP, BOC, and MPM, and a substitute for BFQ, OVI, POR, and FSM. The other broad meat category, MPM, was a substitute for BHD, OVI and POR but a complement for the remaining beef products, as well as for PTY, MSF and MSC.

Other factors affecting the demand for meats

The effect of some relevant socioeconomic household characteristics chosen for this study over the demand of meat products are presented in Table 8. This effect is described by the sign of the corresponding coefficient estimates of the system regression level. The size of the household, measured in adult equivalent units (AEQ) always showed a positive effect on demand, when statistically significant. The same pattern was observed in the case of the age of HH head (AGE). The effects have been always negative in the case of HH commanded by women (WMN) when significant. The remaining characteristics were positively related to the consumption of some meat products and negatively related to others.

Discussion

A first empirical result emerged from this study was given by the computations of the change in the probability of purchasing each selected meat product as a consequence of different characteristics of consumers. Another one is a complete set of household-level

Table 8. Effects over meat demand of relevant household characteristics, 13 selected meat products

Meat product[1]	Socioeconomic characteristics of the households[2]							
	AEQ	**U18**	**O64**	**WMN**	**AGE**	**ED2**	**ED3**	**ED4**
BHD	↑	—	↓	—	↑	—	—	↑
BHB	—	—	↓	—	↑	—	↓	—
BGD	↑	↓	—	↓	—	↑	↑	↑
BRP	↑	↓	—	—	—	—	—	↓
BFQ	—	—	—	—	—	—	—	↓
BOC	↑		—	—	—	—	—	↓
OVI	—		—	—	—	—	—	↓
POR	—	—	—	↓	—	—	↓	↓
PTY	↑	—	↓	↓	↑	↑	—	—
FSM	↑	—	↓	↓	↑	—	↑	↑
MSF	↑	↓	—	↓	—	—	—	—
MSC	—	↓	↑	—	↑	—	—	—
MPM	↑	—	↓	—	—	↑	—	—

[1] See Table 4. [2] AEQ: household size expressed in adult equivalent, U18: number of members under 18 years old, U64: number of members over 64 years old, WMN: household commanded by a woman, AGE: age of household head, ED2: high school, ED3: other technical careers, ED4: university and graduate school, ED1: primary school is the vaue by default. Arrows indicate the direction of the effect of the characteristic over the demand of the meat product for a 10% significance level. Up arrows (↑) indicate a positive effect on demand while down arrows (↓) indicate a negative effect. The hyphen (—) indicates a non-statistically significant effect (neutral) at 10% significance level.

income and price elasticities of demand, all of them reported with the lower and upper bounds corresponding to their 90% CIs. This represents an additional benefit with respect to most economic studies that only report point elasticities. Without this supplementary information, nothing can be said about the significance of the elasticity estimates even when derived from statistically significant regression coefficients. The impacts of some relevant socioeconomic and demographic household characteristics on the quantities demanded of the products of interest completed the full set of results.

As a general remark, the results were in harmony with the economic theory as well as with the empirical evidence gathered over decades of empirical demand analysis. First, increasing levels of household income and household size derived in higher probability of spending on meat products. The magnitude of these effects depended on the specific product. However, the effects of the remaining household characteristics, including those related to household heads, were specific to each ‘household characteristic/meat product’ combination. Cultural and educational differences helped to explain the diverse diet choices made by households. These findings were consistent with those obtained by Lanfranco (2001) and Lanfranco *et al*. (2002) in the USA, and Lanfranco *et al*. (2006) in Uruguay.

With regard to the levels of consumption, the majority of the meat demand studies usually estimate expenditure or income elasticity for broad meat categories such as beef, pork, poultry and fish. One important thing to note is that, at the same or similar disaggregation level, the absolute value of both income and price elasticity tends to me lower in the market where the product is cheaper and consumed in higher proportions. This is confirmed by comparing the results for beef as a whole category published by Lanfranco *et al*. (2006) for Uruguay, and Lema *et al*. (2006) from Argentina, Paraguay and Bolivia.

On the other hand, the more disaggregated a product, the greater the elasticity in absolute value, as verified by Lanfranco *et al*. (2006) for beef demand in Uruguay. Another characteristic of the current study is that it reports short run elasticities, which usually tend to be lower in magnitude than their long-term counterparts, as illustrated by Sáder (2000) also with beef consumption in this country. These issues, along with the diversity of models and functional forms, econometric procedures, time periods, and targeted populations make difficult a useful comparison with the results obtained in this research.

Besides Argentina, which has similar meat consumption patterns than Uruguay, the most comparable situation would be likely the USA, as its per capita beef consumption is the third largest in the world after these two countries (USDA, 2013). Studies conducted over the last four decades have suggested that chicken and pork products are more income inelastic than beef products for USA consumers (George & King, 1971; Moschini & Meilke, 1989; Cortez & Senauer, 1996; Mazzocchi, 2006).

In accordance with most studies reviewed in this article, all the income elasticities estimated in this research were less than one in absolute value so that no meat item was regarded as a luxury good. However, they were statistically significant at the chosen significance level only in the case of sheep meat (0.52) and other beef products (0.05). The other meat that showed statistically significant income elasticity estimates (‘other beef products’, ‘fish’ and ‘mixed meats’) reported magnitudes not far from 0.1.

All the meat items in this study behaved as normal goods when price elasticities were evaluated at the 90% confidence level. In general, the more specific the meat product the higher the magnitude of its own price elasticity. As a product definition becomes more generic, implying a higher aggregation level, there is room for possible substitutions among its own components, being for that reason less responsible for changes in its price index.

On the contrary, as more detailed commodities are distinguished and the range of potential substitutes widens, price effects tend to be larger. In fact, own-price response was elastic for five of the six beef products included in the study. While rib plate was unitary elastic in price (–0.99), ground beef (–2.21), boneless and bone-in cuts from both hindquarter and forequarter showed a more than elastic response (from –1.39 to –1.95).

With regard to meat products other than beef, it was noted that the most inelastic response was observed for poultry (–0.44), followed by pork (–0.81), while the most elastic one was verified for sheep (–1.97). This is coherent with the frequency of consumption reported by Uruguayan households during the survey period. The same pattern was found with the ‘mixed meat’ products. In fact, hams, cold and canned meats to be eaten fresh constituted the most frequently acquired product, being also the most inelastic (–0.09). On the contrary, sausages and other mixed meats for cooking exhibited an important response to price changes (–1.18), while ready-to-eat meals based on meats showed a low one (–0.17).

The same five beef products reported a lower number of statistically significant substitution/complement relationships toward the remaining meat products. The converse was not true. Most non beef items tended to be complements to beef cuts, except for boneless hindquarter cuts. Sheep meat showed a response almost twice of the unit while one of the mixed products (hams, sausages, and cold meats for cooking) a more than proportional response to changes in their own price. All other meats exhibited a less than elastic response.

In Uruguay, beef is consumed in almost every household, every time. It more than doubles the consumption of all other meats combined. This helps to explain why changes in income do not importantly affect its consumption in the short run. Consumer’s response to price variations becomes more apparent when elasticity is computed over more specific products. In this study, this was possible in the case of beef but not with the other meats. As the presence of poultry, pork and fish meats are achieving more relevance in the diet of Uruguayan consumers, especially in recent years, a full comparison will likely possible in the near future, once the new income and expenditure survey planned for 2015 is conducted.

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