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An Analysis of Meat Demand in Argentina using Household Survey Data

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Abstract

This paper presents an empirical analysis of demand for meat using micro data from three household surveys conducted over the last two decades in Argentina. We present an estimation of a complete demand system for meat using a Quadratic AIDS model. Data of the three household surveys are used: 1996/97, 2004/05 and 2012/13. The Shonkwiler and Yen (1999) methodology is used to correct selection bias and endogeneity of the total expenditure is corrected using instrumental variables. Quality-adjusted prices were obtained following Cox and Wohlgenant methods (1986). Expenditure and price elasticities (compensated and uncompensated), for each period were obtained. We found that beef is the relatively most inelastic good with a higher elasticity observed in the last years. Poultry price elasticity decline 50% and the demand of pork has changed from relatively inelastic to elastic. Poultry appears as the main substitute for all types of meat.

Keywords: Meat consumption – Price and expenditure Elasticities - QUAIDS Model - Demand System Equations

JEL codes: C5, D1

1. Introduction

Meat consumption plays a major role in consumer's daily food intake. Argentina records one of the highest consumption of meat in the world. If the consumption of beef, poultry, pork[1] and lamb meat is considered altogether, an average of 100 *kg* annual per capita is reached. Such level has remained smooth during the last half century. Other countries with similar levels of consumption to Argentina's one are EEUU (which maintain values between 80 and 100 *kg)* for the 1960-2011 period and Brazil[2] (which has expanded its consumption from 25 in 1960 to 100 *kg* in 2011), although in both cases, the participation of beef does not exceeds Argentina's one. Figure 1 shows the per capita consumption of the four types of meat during 1950 and 2011. Although the level of total consumption has remained stable, its composition has changed. As can be seen, in general, consumption of poultry and pork, in lesser extent, has increased steadily and that of beef and lamb has fallen steadily.

Insert Figure 1

This change in the meat consumption patterns during the last 60 years can be attributed to a great variety of factors related to the distinctive features of each sector. In the case of the beef, a steep decline in consumption per capita is observed, recording a fall from 90-100kg. / year in 1950 to 60-65 in 2012. This means a decrease of 0.7% annual (see figure 2). A downward trend is observed in all the period, but with greater variability in the first decades. According to Reca and Lema (2014), this fall was due to strong cattle cycles, the shortage of the direct substitutes of the beef until the beginning of the nineties and the lack of anti-cyclical policies. In the last two decades (1992-2012) the improvement in the poultry industry contributed to increase the chicken supply, reducing its relative price. Price of beef has increased at a much faster rate than chicken and pork. And this have shifted consumption from beef towards chicken.

Insert Figure 2

Reca and Lema (2014) remarks that an important development of the aviculture in Argentina occurs at the end of the 20th century, with production growing at an average annual rate of 7.2% between 1990 and 2000. At the same time the relative price of chicken fell considerably: at the

[1] We placed emphasis only on the consumption of fresh meat. That means, cold meat and other by-products of porcine meat are not included.

[2] Brazil has reached the current level of consumption due to the solid growth in the purchasing power of the population and the development of the livestock industry during the last years (Reca and Lema, 2014).

beginning of the 90's, purchasing power of a *kg* of chicken was 0.6-0.7 kg of beef, falling to 0.3 kg in 2012.

In Argentina, porkmeat (one of the world's most widely consumed meats) has had less relative participation regarding the overall consumption of meat, basically due to its high relative price and the insufficient availability of fresh cuts in supermarkets and popular marketing channels. Porkmeat consumption in Argentina is still exceeding production even though during the last years some considerable changes have taken place, both in production as well as consumption. The main changes can be attributed to the improvement in the productive systems, health controls and greater relative efficiency in production. In 2005 the Argentine Association of Porcine Producers (*AAPP*) launched a plan aimed at promoting the consumption of pork meat providing information related to its properties among the consumers usign several mass media channels. The increase in the consumption of such meat after the plan denotes the importance of other factors, besides the relative prices, leading to a direct impact on the consumers' purchasing decisions, like the media and the product availability in the retail markets.

Given the significant changes in the consumption of meat in Argentina during the last 60 years and the substitution relations among the types of meat, an economic analysis on the demand is crucial to meat producers, meat sellers as well as policy makers. This study analyzed the overall meat consumption during the last 20 years (1996/2013) in Argentina using cross-section data from three large national household surveys.

In the last years, the government intervention in the beef cattle market was particularly intense. The rise in the price of meat due to several factors related from weather conditions to international trade has been a cause for concern that surpasses the field of households in order to be a matter of institutional concern.

During the period between 1996 and 2013, the Consumer Price Index increase 245.75%. However, the increase was proportionately higher (321.29%) in "Foods and Drinks"[3] expenditures. An increase in prices of such extent reduces the purchasing power not equally across households. The relatively poorest families with major number of children are those who, according to the Engel's law, spend a greatest share of their budgets in foods and therefore, they will be the most affected in real terms. Foods are, in general, basic needs and its non-consumption is not a viable alternative. So, householders had to develop strategies of consumption that enable them to suit new market conditions. The hypothesis is that the shifts in the consumption patterns observed are the response to these changes. Substitution effects among foods will be observed and it was expected

[3] The percentages indicate the variation of the Consumer Price Index (CPI) during the period between the first quarter of 1996 and the last quarter of 2013.

that the consumption of goods whose prices have raised less than others will have increased their consumption.

Under the utility´s maximization hypotesis demand theory provides the suitable methods to analyze the changes in the behavior of the consumer. Parameters of demand equations and its elasticities enable us to understand and explain the changes in quantities when relative prices changes. However, as long as more sets of goods are used, it will be more efficient to estimate a system of demands whose estimates are more consistent to economic theory compared to the ones obtained independently, equation by equation.

However, the estimation of a demand system is not an easy task to accomplish. The theory does not indicate the best functional form to use in the estimations, but it states the set of properties that any system obtained from a preference structure may include. Such properties are: homogeneity, adding-up and symmetry. The researcher has not only to choose a functional form but also the set of goods that define the demand system.

Although in Argentina the estimation of complete demand systems for food has been scarce, some studies with different functional forms may be found. Among them, we should mention the LA-AIDS system (Linear Approximation to Almost Ideal Demand System) estimated by Rossini *et. al.* (2008), the LES system (Linear Expenditure System) by Berges and Casellas (2007), the LINQUAD system by Depetris Guiguet *et al* (2008)[4] and Lema *et al* (2008) and the QUAIDS system (Quadratic Almost Ideal Demand System) for meat estimated by Monzani and Robledo (2011). All of them use data from Households Expenditure Survey (ENGH) for the 1996/97 period and, only the two last systems are quadratic in the logarithm of expenditure, such as Banks *et al* (1997) suggest.

The objective of this study is to estimate a complete demand system for the types of meat in Argentina in order to analyze and compare the results for the period between 1996/97 and 2012/13. The meat cuts are divided into four categories: beef, poultry, pork and fish. On the one hand, it is expected that the elasticity of the beef will increase for the 2012/13 period due to the greater availability of substitutes in the consumption. On the other, due to the development in the consumption of meat in Argentina, a considerable substitution relation between beef and poultry is expected to be found.

The estimates have a quadratic term in prices and income. Data of the three ENGH available for Argentina is used: 1996/97, 2004/05 and 2012/13. Moreover, Shonkwiler and Yen (1999) methods are used in order to correct the bias in the estimations caused by an excess of observations with zero in consumption value. The endogeneity of the total expenditure is corrected through

[4] This study applies only to dairy products.

estimation by instrumental variables. The quality-adjusted prices used in the estimation are obtained following Cox and Wohlgenant methods (1986). Finally, expenditure and price elasticities (compensated and uncompensated), for each period, are calculated and presented. The rest of the paper is organized as follows: section 2 presents the methodology and estimation procedures, section 3 describes de data, section 4 presents the estimation results. Finally, section 5 presents the principal findings and conclusions.

2. Methodology

2.1 Demand system

The QUAIDS model, developed by Blundell *et al* (1993) and Banks *et al* (1997) was proposed to achieve a better approach to the Engel's curves that fit empirical data. The authors show, through non parametric estimations, the existence of non-linear relations between consumed quantities and income or expenditure and base the need of including in the demand equations a non-linear term in the logarithm of income or expenditure. The QUAIDS model takes into account linear models such as AIDS by Deaton and Muellbauer (1980) or the Translog by Jorgenson and Lawrence (1975), but unlike them and by virtue of including a quadratic expression for the income variable, fits to the existence of goods that behave as luxury goods at given levels of income and as necessities at higher levels of income.

The system is estimated from the expenditure share of each type of meat over the total expenditure of meat (share form w_i), its prices (p_i) and the income or total expenditure (m)[5]. The parameters to estimate are $\alpha_i, \gamma_{ij}, \beta_i$ y λ_i. The QUAIDS system for *n* goods is given by [6]:

$$w_i = \alpha_i + \sum_{j=1}^{n} \gamma_{ij} \ln p_j + \beta_i \ln\left(\frac{m}{a(p)}\right) + \frac{\lambda_i}{b(p)}\left\{\ln\left[\frac{m}{a(p)}\right]\right\}^2 + \varepsilon_i \qquad (1)$$

where $a(p)$ y $b(p)$ have the same expression as in the AIDS model, that is:

$$\ln a(p) = \alpha_0 + \sum_{i=1}^{n} \alpha_i \ln p_i + \frac{1}{2}\sum_{i=1}^{n}\sum_{j=1}^{n} \gamma_{ij} \ln p_i \ln p_j \qquad (2)$$

$$b(p) = \prod_{i=1}^{n} p_i^{\beta_i} \qquad (3)$$

The AIDS model is a particular case of the QUAIDS model, in which $\lambda_i = 0$[7]. Moreover, the QUAIDS model preserves all the qualities of the AIDS model, that is to say, flexibility and consistency in the aggregation of consumers.

[5] The total expenditure in the food categories used in the system of equations is incorporated in order to obtain a complete system. That is to say, the budget's restriction is reached. This may be explained if we consider that assumption of the weak separability of preferences is fulfilled, through which the preferences for goods in each group are independent of the other group consumed quantities. The utility functions defined as such denote that the marginal relation of substitution between two goods of the same group is independent of the calculation of all the other groups' goods (Deaton and Muellbauer, 1980).

[6] Banks *et al.* (1997) have demonstrated that an indirect utility function compatible with this system may be written as follows: $\ln V = \{\left[\frac{\ln m - \ln a(p)}{b(p)}\right]^{-1} + \lambda(p)\}^{-1}$.

[7] Given that vector λ is statistically equal to zero, the set of considered goods has linear Engel's curves and the QUAIDS model is reduced to the AIDS model.

In order to ensure the consistency with the theory of demand, the restrictions imposed on the QUAIDS parameters are:

a) Adding-up

$$\sum_{i=1}^{n} \alpha_i = 1;\ \sum_{i=1}^{n} \gamma_{ij} = 0; \sum_{i=1}^{n} \beta_i = 0; \sum_{i=1}^{n} \lambda_i = 0 \quad (4)$$

b) Homogeneity

$$\sum_{j=1}^{n} \gamma_{ij} = 0 \quad (5)$$

c) Symmetry

$$\gamma_{ij} = \gamma_{ji} \quad (6)$$

To calculate QUAIDS model elasticities, differentiate equation (1) with respect to lnm and lnp_i, respectively, to obtain (Banks *et al* 1997):

$$\mu_i \equiv \frac{\partial w_i}{\partial \ln \mathrm{m}} = \beta_i + \frac{2\lambda_i}{b(p)}\left\{\ln\left[\frac{m}{a(p)}\right]\right\} \quad (7)$$

$$\mu_{ij} \equiv \frac{\partial w_i}{\partial \ln p_j} = \gamma_{ij} - \mu_i\left(\alpha_j + \sum\nolimits_k \gamma_{jk} \ln p_k\right) - \frac{\lambda_i \beta_j}{b(p)}\left\{\ln\left[\frac{m}{a(p)}\right]\right\}^2 \quad (8)$$

The expenditure elasticities are given by:

$$e_i = \frac{\mu_i}{w_i} + 1 \quad (9)$$

The uncompensated price elasticities are given by:

$$e_{ij} = \frac{\mu_{ij}}{w_i} - \delta_{ij} \quad (10)$$

where $\delta_{ij} = 0\ \forall\ i \neq j$ and $\delta_{ij} = 1\ \forall\ i = j$

Finally, with Slutsky equation, the set of compensated elasticities are calculated:

$$e_{ij}^{*} = e_{ij} + e_i w_j \quad (11)$$

2.2 Quality Adjusted Prices

The data come from a survey (ENGH) which does not reveal the prices of the goods acquired by households. Such survey only collects and records the quantities and expenditures in the several goods, as well as the socio-demographic information of the household. Therefore, the implicit prices (the ratio between the total expenditure and the consumed quantity for each good or group of products) are computed. However, the introduction of these prices poses additional problems due to the fact that they reflect "quality effects" that should be corrected before the estimation. The sources of variation of cross-sectional prices are: differences in the regions and price discrimination (changes in the supply); services acquired with the commodities; seasonal effects and differences in the quality due to the aggregate of non-homogeneous goods (Cox and Wohlgenant, 1986).

Following Cox and Wohlgenant (1986) approach, these differences are included by fitting the prices of each one of the groups of meat on variables that approach the appropriate "quality effect" for each household. The selected explanatory variables -following Berges and Casellas, (2007)- are included in the expression (12):

$$P_i = \beta_0 + \beta_1 age + \beta_2 gender + \beta_3 DhsE + \beta_4 DcE + \beta_5 size + \beta_6 income + \beta_7 income^2 + \beta_8 income * \text{size} + \beta_9 Dact + \beta_{10} Dsreg2 + \cdots + \beta_{11} Dsreg12 + \varepsilon_i \quad (12)$$

"P_i" indicates the implicit price for each group j of meat; "age" indicates the age of the householder; "$gender$" is a dummy variable that represents the gender of the householder (equals 1 if the householder is a woman); "$DhsE\ and\ DcE$" are dummies variables that values 1 if the householder has a high school degree and college degree respectively; "$size$" refers to the number of members in the household; "$income$" represents the household income -which is included also squared-; "$income * size$" corresponds to the product of the income and the size of the household; "$Dact$" represents the activity of the householder (equals 1 if the householder is employed); "*Dsreg2* to *Dsreg12*" are dummy variables for each one of the sub-regions assessed in the survey[8].

The quality-adjusted prices for households is $\hat{P}_i$. Finally, in the case of households with zero consumption, the adjusted price is equal to $\widehat{\beta_0}$ plus the estimated coefficient of the *dummy* variable indicating the sub-region of the household *(Dsreg).*

2.3 Bias correction and endogeneity of the total expenditure

In cross sectional data, especially when micro data such as the ENGHO data is used, a problem of censored answers is posed, known as selection bias. Such problem arises due to the fact that households report zero consumption during the period of the survey (Davidson and MacKinnon, 1993). The main causes of the zero consumption are the infrequency of purchase due to the short period of the survey[9]; consumers' preferences and the fact that consumers do not acquire certain goods at current prices and income levels (corner solutions).

When the dependient variable is censored[10], it only contains values equal to zero or greater, and it should be important to distinguish zero consumption due to no purchasing during the reference period, from the zero that indicates that a good is not consumed regularly in the household. Following the two-step procedure by Shonkwiler and Yen (1999), consider the system of equations with limited dependent variables:

[8] The sub-regions are: (1) Ciudad Autónoma de Buenos Aires; (2) Partidos del Gran Buenos Aires; (3) Córdoba and La Pampa; (4) Santa Fe and Entre Ríos; (5) Buenos Aires; (6) Jujuy, Salta and Tucumán; (7) La Rioja, Catamarca and Santiago del Estero; (8) Misiones and Corrientes; (9) Formosa and Chaco; (10) San Juan, Mendoza and San Luis; (11) Neuquén and Río Negro; (12) Chubut, Santa Cruz and Tierra del Fuego.

[9] Only the information related to the consumption of food in the reference week is required.

[10] The censored data is distinguished from the truncated one. A sample is considered to be truncated if some observations are systematically excluded of the sample. In the case of censored data, none observations is excluded, but some data is systematically altered.

$$q_{ij}^{*} = f(\eta_i, X_{ij}) + \omega_{ij}$$
$$d_{ij}^{*} = z_{ij}'\theta_i + v_{ij} \quad (13)$$

$$d_{ij} = \begin{cases} 1 & sid_{ij}^{*} > 0 \\ 0 & sid_{ij}^{*} \leq 0 \end{cases}; \quad q_{ij} = d_{ij} q_{ij}^{*} \quad (14)$$

with $i = 1, 2, \ldots, M$ and $j = 1, 2, \ldots, N$, where i indicates the equation and j the household; q_{ij} and d_{ij} are the observed dependent variables; q_{ij}^{*} and d_{ij}^{*} are corresponding latent variables; X_{ij} and z_{ij} are vectors of exogenous variables; η_i and θ_i are conformable vectors of parameters; ω_{ij} and v_{ij} are random errors terms. This model is a generalization of Amemiya's (1974) censored system in that censoring of each dependent variable is governed by a separate stochastic process. Later, Yen (2004) and Yen and Biing-Hwan (2005) suggest a censored two-step multivariate[11] procedure.

The two-step procedure implies that two dependent variables re analyzed: 1) a dichotomous variable that indicates whether or not an individual consumes a nonzero amount from a particular good, and 2) the actual quantity consumed for those who chose to consume. In the first stage a Probit model is used, where the $\phi(\cdot)$ and $\Phi(\cdot)$ are the probability density function and the cumulative distribution function obtained. Assume for each i the error terms $[\omega_{ij}, v_{ij}]'$ are distributed as bivariate normal distribution with $cov(\omega_{ij}, v_{ij}) = \delta_i$. Then, the conditional mean of y_{ij} is (Wales and Woodland, 1980):

$$E(q_{ij}|x_{ij}, z_{ij}; v_{ij} > -z_{ij}'\theta_i) = f(\eta_i, X_{ij}) + \delta_i \frac{\phi(z_{ij}'\theta_i)}{\Phi(z_{ij}'\theta_i)} \quad (15)$$

Because $E(q_{ij}|x_{ij}, z_{ij}; v_{ij} \leq -z_{ij}'\theta_i) = 0$, the unconditional mean of q_i is:

$$E(q_{ij}|x_{ij}, z_{ij}) = \Phi(z_{ij}'\theta_i) f(\eta_i, X_{ij}) + \delta_i \phi(z_{ij}'\theta_i) \quad (16)$$

Based on equation (16) for each i, the system of equations (13) and (14) can be written as:

$$q_{ij} = \Phi(z_{ij}'\theta_i) f(\eta_i, X_{ij}) + \delta_i \phi(z_{ij}'\theta_i) + \xi_{ij} \quad (17)$$

with $i = 1, 2, \ldots, M; j = 1, 2, \ldots, N$, where $\xi_{ij} = q_{ij} - E(q_{ij}|x_{ij}, z_{ij})$. The system (17) can be estimated by a two-step procedure using all observations: 1) obtain ML probit[12] estimates $\hat{\theta}_i$ of θ_i using the binary outcome d_{ij} for each i[13]; 2) calculate $\Phi(z_{ij}'\hat{\theta}_i)$ and $\phi(z_{ij}'\hat{\theta}_i)$ and estimate η_i and δ_i in the system:

$$q_{ij} = \Phi(z_{ij}'\hat{\theta}_i) f(\eta_i, X_{ij}) + \delta_i \phi(z_{ij}'\hat{\theta}_i) + \xi_{ij} \quad (18)$$

η_i: vector of parameters. $\eta_i = [\alpha_i, \gamma_{ij}, \beta_i, \lambda_i]$ for the QUAIDS model.

[11] The model leads improvement in the efficiency of the estimator.

[12] The used variables in the selection equation are those detailed in the assessment of the implicit quality-adjusted prices, plus the dummy variable which is 1 in case that minors of 14 were in the household (0 in other case) and a dummy variable which is 1 in case adults older than 65 were in the household (0 in other case).

[13] Estimation of the separate probit models implies the restriction $E(v_{ij}v_{kj}) = 0 \; \forall i \neq k$, without which the multivariate probit have to be estimated. With some loss in efficiency (relative to multivariate probit) these separate probit estimates are nevertheless consistent.

Because the ML probit estimators $\hat{\theta}_i$ are consistent, applying ML or SUR estimation to equation (18) produces consistent estimates in the second step. According to Shonkwiler and Yen (1999) method, the equations of the demand of the QUAIDS system corrected for zero consumption to be estimated, are:

$$w_i = \Phi\left(z'_{ik}\hat{\theta}_i\right)\left[\alpha_i + \sum_{j=1}^{n}\gamma_{ij}\ln p_j + \beta_i \ln\left(\frac{m}{a(p)}\right) + \frac{\lambda_i}{b(p)}\left\{\ln\left[\frac{m}{a(p)}\right]\right\}^2\right] + \delta_i\phi\left(z'_{ik}\hat{\theta}_i\right) + \varepsilon_i \quad (19)$$

Finally, to allow for the possibility of endogeneity (Coelho, 2006), expenditure was instrumented by income, its square, age of the householder, the activity of the householder, gender, educational level, number of members of the household and sub-regional dummies[14].

2.4 Elasticities with bias correction

The introduction of the bias correction in the estimation of the system modifies the equations used in the assessment of elasticities. The new expressions for the assessment of expenditure elasticities are:

$$\mu_i \equiv \frac{\partial w_i}{\partial \ln \mathrm{m}} = \Phi\left(Z_{ij}\theta_i\right)\left[\beta_i + \frac{2\lambda_i}{\mathrm{b(p)}}\left\{\ln\left[\frac{m}{a(\mathrm{p})}\right]\right\}\right] \quad (20)$$

$$e_i = \frac{\mu_i}{w_i} + 1 \quad (21)$$

So, the expressions for the uncompensated price elasticities are:

$$\mu_{ij} \equiv \frac{\partial w_i}{\partial \ln p_j} = \Phi\left(Z_{ij}\theta_i\right)\left[\gamma_{ij} - \mu_i\left(\alpha_j + \sum_k \gamma_{jk}\ln p_k\right) - \frac{\lambda_i\beta_j}{\mathrm{b(p)}}\left\{\ln\left[\frac{m}{a(\mathrm{p})}\right]\right\}^2\right] \quad (22)$$

$$e_{ij} = \frac{\mu_{ij}}{w_i} - \delta_{ij} \quad (23)$$

where $\delta_{ij} = 0\ \forall i \neq j$ and $\delta_{ij} = 1\ \forall i = j$.

The compensated price elasticities (e^*_{ij}) are obtained from the Slutsky equation:

$$e^*_{ij} = e_i w_j + e_{ij} \quad (24)$$

3. The Data

The ENGH was conducted by the National Institute of Statistics and Census of Argentina (INDEC) at a national level in three periods, 1996/97, 2004/05 and 2012/13. The analysis comprises the country and focuses on those households which present a positive consumption in at least one of the analyzed types of meat: 1) beef, 2) poultry; 3) Pork and 4) Fish, all of them measured in kilograms. The category of beef include all types of meat cuts, fresh as well as chilled; poultry

[14] In addition, a robust estimation of parameters is carried out in order to deal with a possible heteroscedasticity in the errors of the model.

includes the entire chicken, in fresh and chilled pieces; pork only includes pork and fishes include freshwater and saltwater fishes, and fresh and chilled shellfish.

Table 1 shows the total amount of households in each survey, and for each of them, the amount of positive expenditure in any of the types of analyzed meat. Due to the fact that the data do not show variations in time and that each household of the sample accounts for expenditures in food during the week in which the householders are interviewed, we should draw the inference that a downward trending the quantity of households which acquire meat may be observed. From 1996/97 to 2004/05, there was a decrease of 3 percentage point in number of household, while from 2004/05 to 2012/13 was just 1 point.

Insert Table 1

Table2 presents the households which register consumption of each one of the types of meat analyzed in each period. Beef is the type of meat with greater number of observations, although its participation falls during the given period. Then, poultry is the second in consumption, which has been rising during the last years covering a superior number of households. Thus, poultry consumption has risen from 50% in 1996/96 to 70% in 2012/2013. Fish is located in the third place, representing a stable number of households regarding consumption (almost 15% during the three periods). Finally, the pork consumption in households amounts to 6.70% in the 1996/97 period. Its participation dropped to 4% in 2004/05 and then rose to 6% during the last period.

Insert Table 2

These are three different periods: 1996/97 is the period under the "Convertibility Plan" and is characterized by price stability. Whereas, during the 2004/05 period considerable macroeconomic changes have occurred as well as the inertial inflation post devaluation in 2001. Lastly, the 2012/13 is marked by a sustained inflationary process. The expenditure variables, measured in currency units are expressed at constant prices to the last period of each one the surveys[15].

For each one of the groups of meat, implicit prices were calculated and with them the quality-adjusted prices (equation 12). Tables 3 to 5 shows, for the whole sample and for each type of meat, the average expenditures, average adjusted prices and average quantity per household.

[15] The CPI was used for them. The households expenditure included in each one of the ENGH were added in the final period of each survey; that is March, 1997; December, 2005 and March, 2013 respectively.

It has been a sharp decline in the expenditure of meat in 2004/05[16] compared with the period 1996/97. Afterwards, it has been observed a rebound in 2012/13. The highest expenditure belongs to beef, although its participation has declined due to the increase in the expenditure of poultry (15.86%, 18.65% and 24.42%) and to a less extent of pork (3%, 3.18% and 3.54%). Regarding the expenditure of fish, participation has dropped during the entire period (6.63%, 4.12% and 3.63%).

Insert Table 3

In terms of quantity, all consumptions have recorded a decline during the first half of the period. While in the second period, an increase of the 50% in the mean quantities of poultry has been observed. Also, a relatively steady behavior of consumption in other meats has been registered -a slight decline in beef and an increase in pork and fish-.

Insert Table 4

The average adjusted prices leveled off during the first two periods (1996/97 and 2004/05) except for the fish price which registered an increase of 34%. In the 2012/13 period, a steep increase in prices has been recorded (393%, 357%, 426% and 390% for each type of meat against 2004/05).

Taking as a reference the price of beef (based on the importance of this type of meat in the consumption basket in Argentina), the relative prices for poultry and pork are less than the unit, while the relative prices for the fish are superior to the unit. The evolution of such prices demonstrate that -see table 5- although in the first period the price of pork is lowered and the prices of poultry and pork are increased, in the second period prices accommodate in values closely related to the first one's obtained.

Insert Table 5

As a consequence of this type of changes in prices, the families' behavior has impacted directly on consumption basket, leading to an adjustment in front of the new market conditions. The estimation of the price and expenditure elasticities of the demand has contributed to the analysis of the changes in the consumption patterns. However, its results are hard to interpret. Some factors should be taken into consideration for the analysis. First, the change in prices is high enough so as

[16] The fall in the real expenditure of this period is related to other results which compare the consumption of food in constant *pesos* between ENGH 1996/97 and ENGH 2004/05.

to the concept of elasticity, which implies infinitesimal changes, will be directly applied to a change of such extent. Second, the time span between the surveys islong and coincides with periods of significant changes in the Argentine macroeconomic and political context. The first ENGH was carried out within the framework of price stability based on the convertibility plan of the nineties. The second survey was undertaken in the aftermath of the 2001 crisis, which marked the end of the convertibility and the beginning of an inflationary process during the last decade. Finally, the third survey was conducted during a high inflationary period and with active interventions in the meat industry (basically in the beef cattle sector). Therefore, the elasticities of each one of the periods are calculated separately in the case given that preferences remain steady.

4. Results

The estimation of the selection equations (first step) was carried out through a univariate Probit model. The system of demand equations (second step) was undertaken through instrumental variables, in order to take into account the endogeneity in the total expenditure[17]. Table 6 shows the parameters estimates[18] for the QUAIDS system for each one of the analyzed periods.

The fact that the parameters λ_i are statistically significant in all periods denotes that the analyzed expenditures do not present a linear relationship with the income. Therefore, the equations have to include a quadratic term (this implies that the underlying Engel's curves would not be linear).

Insert Table 6

The fact that the parameters δ_i are statistically significant implies the need of adjustment for zero observations. It has been observed that the higher the number of observations (household) with consumption in any category of meat, the higher the parameter of censorship adjustment. This implies a greater correction in the consumption level for such equation (increasing or reducing the level of consumption according to the positive or negative sign).

The parameter β of each equation is associated with the linear term for the income, while the parameter λ with the quadratic term for the income. Therefore, an increase in the real expenditure of meat results in an increase ($\beta > 0$) in the participation in the budget of meat, poultry and pork (at increasing rate, $\lambda > 0$). On the other hand, the participation in the budget of beef and fish will reduce ($\beta < 0$, at decreasing rate $\lambda < 0$). Such relations stand for each type of meat in the three

[17] The variables used as instruments of the total expenditure are: age of the householder, the activity of the householder, gender, level of degree, number of members of the household, total income of the household, total income and sub-regional dummies.

[18] The standard errors are not corrected by the two-step estimation of Shonkwiller and Yen (1999).

analyzed periods. The importance (in absolute value) of the linear term for the income increases in each one of the periods, while the quadratic term remains steady.

Insert Table 7

Table 7 presents the estimated expenditure and price elasticities (compensated and uncompensated) with the QUAIDS system for the three periods (the standard errors were calculated through the delta method).

The expenditure elasticities (e1-e4) are positive for all types of meat in the three periods. In the case of beef, an increase of almost 20% has been registered, during 2012/13. In the case of poultry, the expenditure elasticity falls to almost 40% in 2012/13 of the value registered in 1996/97. For fish, the drop amounts to 14%. For pork, the expenditure elasticity records an increase during the 2004/05 and in the end it registers an inferior value compared to the original in 2012/13.

The own-price compensated elasticities[19] are negative in all cases. Beef is the relatively most inelastic good with a slight increase in the coefficient of elasticity for 2012/13 after the fall in 2004/05. Poultry is the type of meat which has experienced one of the most notable changes in elasticity, registering a decline that amounts to 50% compared to the value recorded in 1996/97. The demand of pork has changed from relatively inelastic to elastic, with an increase of 25%. in absolute value. Fish is the relatively most elastic type of meat, with a marked increase (nearby 60%) in the coefficient of elasticity for the period of the analysis. The poultry appears as the main substitute for beef (e12), and for all types of meat; beef appears as the first substitute (e21c, e31c, e41c) in the consumption basket. In general, beef, poultry and pork are substitute goods in consumption. Given that the data of the consumption of meat is monthly based, it is possible to consider the results as the choice of monthly consumption of meat in households.

5. Conclusion

The macroeconomic performance of Argentina from 1996 to 2013 lead to a fall of both the households' purchasing power and a the real expenditure on food. This has an important impact on the choice of consumers who have adapted their structure of consumption to the new relative prices and incomes. Specifically in the meat consumption, the quantities drop in almost all meat types, except for poultry. Although the prices of food in general have increased by an average 321%[20] in this period, meat prices have climbed more than the general level (in all cases exceeds the 350%[21]).

[19] Price uncompensated elasticities are indicated with the suffix u and the compensated ones with the suffix c.
[20] The CPI percentage change 1996-2013.
[21] Variation in the meat price.

Our estimation of the QUAIDS demand system for meat indicates that the quadratic term in the income is statistically significant and that the nonlinearity of the underlying Engel's curves may be inferred. The expenditure elasticities are all positive, whereas the own-prices elasticities are negative. During the analyzed period, some changes of importance happened. First, we should consider the increase in the expenditure elasticity of beef and the reduction in the expenditure elasticity of poultry. To some extent, this implies that the higher the expenditure in meat, the higher the consumption of beef (which functions as a luxury good in the group). Second, the changes related to the greater compensated own-price elasticity of the demand of beef, pork and fish, and the decline in the own-price elasticity of poultry. This implies that relative prices have impacted directly on the choice of consumers, who develop a more flexible behavior towards the changes in the relatively more expensive goods of the group and less flexible towards the cheapest goods.

We found that the different types of meat acts as gross substitutes goods in the consumer preferences. Particularly, we found that a real change in the price of beef implies a higher change in the consumption of other types of meat, compared with the change in the consumption of beef relative to the variation of the price of substitutes.

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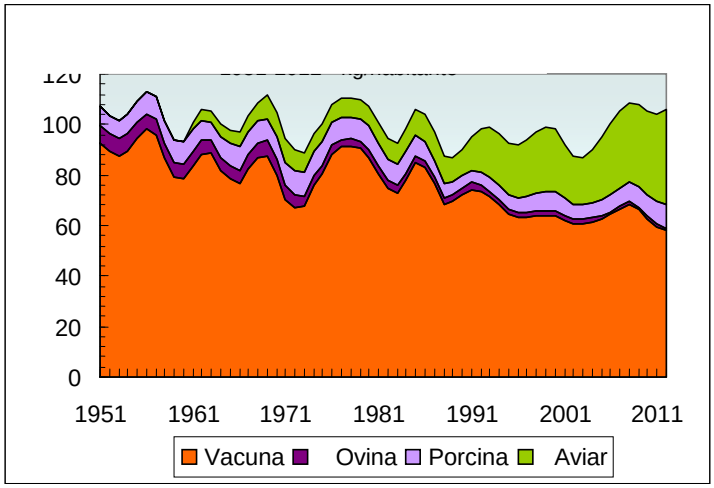
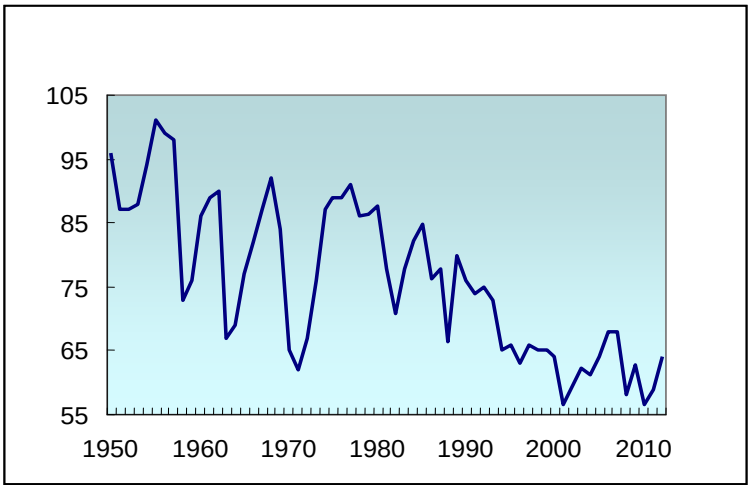
7. Tables and Figures

Figure 1: Per capita consumption of Meat. Argentina 1950-2012



Source: FAO

Figure 2: Per capita beef consumption Argentina 1950 – 2013 (kg)



Source: FAO

Table 1: Households with positive expenditure of meat

Households	1996/97		2004/05		2012/13	
	Nº household	%	Nº household	%	Nº household	%
Total household with positive expenditure in meat	24978	91,63	25488	88,51	18304	87,33
Total household in ENGH	27260	100,00	28796	100,00	20960	100,00

Source: ENGH (1996-97, 2004-05 y 2012-13).

Table 2: Household Consumption by type of meat*

Meat	1996/97 (n=24978)		2004/05 (n=25488)		2012/13 (n=18304)	
	# of Households	%	# of Households	%	# of Households	%
Beef	23997	96,07	24062	94,41	16795	91,76
Poultry	12658	50,68	13295	52,16	12898	70,47
Pork	1675	6,71	1066	4,18	1167	6,38
Fish	3844	15,39	3734	14,65	2907	15,88

* Number and percentage of households that reports consumption of beef, poultry, pork or fish.
Source: ENGH (1996-97, 2004-05 y 2012-13).

Table 3: Average monthly expenditures of households (in *pesos*, Deflated by CPI at December, 2013)

Meat	1996/97 (n=24978)		2004/05 (n=25488)		2012/13 (n=18304)	
	Mean	S.D.	Mean	S.D.	Mean	S.D.
Beef	448,38	348,45	178,00	161,67	412,36	379,59
Poultry	93,36	125,90	44,85	60,50	147,19	157,20
Pork	17,63	93,22	7,64	94,18	21,33	157,02
Fish	39,04	99,14	9,90	35,00	21,86	72,73
Total	588,41	433,63	240,40	215,29	602,74	477,30

Source: ENGH (1996-97, 2004-05 y 2012-13).

Table 4: Average monthly consumption (kg/household)

Meat	1996/97 (n=24978)		2004/05 (n=25488)		2012/13 (n=18304)	
	Mean	S.D.	Mean	S.D.	Mean	S.D.
Beef	17,13	13,24	12,67	11,39	12,18	44,26
Poultry	5,53	7,46	4,94	6,87	7,79	8,73
Pork	0,68	3,77	0,59	9,66	0,60	5,39
Fish	0,89	3,01	0,54	3,05	0,56	2,19

Souerce: ENGH (1996-97, 2004-05 y 2012-13).

Table 5: Adjusted prices

Meat	1996/97			2004/05			2012/13		
	Mean	S.D.	PR	Mean	S.D.	PR	Mean	S.D.	PR
Beef	7,51	1,31	1	7,38	1,15	1	37,03	6,19	1
Poultry	4,80	0,52	0.64	5,07	0,53	0.68	21,97	3,35	0.59
Pork	6,92	1,00	0.92	6,41	0,86	0.87	36,40	4,34	0.98
Fish	9,27	1,11	1.23	12,43	0,81	1.68	45,47	5,19	1.23

Source: ENGH (1996-97, 2004-05 y 2012-13).
Note: PR means relative prices.

Table 6: Parameter Estimates for the QUAIDS model

Parameter	1996/97		2004/05		2012/13	
	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.
α_1	0,9734***	0,0070	0,6059***	0,0152	0,4380***	0,0355
α_2	0,0014	0,0181	0,4904***	0,0336	0,6789***	0,0412
α_3	-0,0275**	0,0120	0,1046***	0,0099	0,3152***	0,0189
α_4	0,0526**	0,0227	-0,2009***	0,0234	-0,4323***	0,0191
β_1	-0,0061	0,0062	-0,1089***	0,0115	-0,1802***	0,0155
β_2	0,0531***	0,0178	0,2530***	0,0240	0,2948***	0,0182
β_3	0,0236**	0,0118	0,0338***	0,0065	0,0712***	0,0143
β_4	-0,0828**	0,0337	-0,3958***	0,0352	-0,5462***	0,0291
γ_{11}	-0,0327***	0,0013	0,0286***	0,0107	0,0242	0,0274
γ_{12}	0,0332***	0,0028	-0,0589**	0,0236	-0,0678*	0,0350
γ_{13}	0,0238***	0,0016	-0,0295***	0,0048	-0,1063***	0,0112
γ_{14}	-0,0243***	0,0024	0,0598***	0,0105	0,1499***	0,0085
γ_{21}	0,0332***	0,0028	-0,0589**	0,0236	-0,0678*	0,0350
γ_{22}	-0,0543***	0,0068	0,1327***	0,0491	0,1198***	0,0444
γ_{23}	-0,0282***	0,0033	0,0592***	0,0091	0,1328***	0,0141
γ_{24}	0,0493***	0,0060	-0,1330***	0,0221	-0,1847***	0,0117
γ_{31}	0,0238***	0,0016	-0,0295***	0,0048	-0,1063***	0,0112
γ_{32}	-0,0282***	0,0033	0,0592***	0,0091	0,1328***	0,0141
γ_{33}	0,0223***	0,0036	-0,0151***	0,0049	-0,0506***	0,0098
γ_{34}	-0,0180***	0,0045	-0,0144**	0,0059	0,0241**	0,0111
γ_{41}	-0,0243***	0,0024	0,0598***	0,0105	0,1499***	0,0085
γ_{42}	0,0493***	0,0060	-0,1330***	0,0221	-0,1847***	0,0117
γ_{43}	-0,0180***	0,0045	-0,0144**	0,0059	0,0241**	0,0111
γ_{44}	-0,0069	0,0074	0,0876***	0,0143	0,0106	0,0137
λ_1	-0,0036**	0,0014	-0,0143***	0,0020	-0,0183***	0,0026
λ_2	0,0159***	0,0041	0,0337***	0,0043	0,0303***	0,0032
λ_3	0,0068**	0,0027	0,0021*	0,0011	0,0058*	0,0030
λ_4	-0,0191***	0,0054	-0,0214***	0,0030	-0,0178***	0,0036
δ_1	0,6238***	0,0023	0,5384***	0,0031	0,6749***	0,0075
δ_2	0,1103***	0,0037	0,4371***	0,0109	0,2626***	0,0073
δ_3	0,0573***	0,0038	-0,0039	0,0033	-0,1068***	0,0054
δ_4	-0,0933***	0,0047	-0,1352***	0,0038	0,0616***	0,0063

1. Beef. 2. Poultry. 3. Pork. 4. Fish.

* Statistically Significant at the 0.10 level, ** Statistically Significant at the 0.05 level, *** Statistically Significant at the 0.01 level.

Source:Author's estimates based on ENGH (1996-97, 2004-05 y 2012-13).

Table 7: Price and Expenditure Elasticities

Elasticity	1996/97		2004/05		2012/13	
	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.
e1	1,0119***	0,0009	1,0170***	0,0077	1,2020***	0,0443
e2	0,9502***	0,0057	0,9083***	0,0402	0,3697***	0,1016
e3	0,9817***	0,0051	1,0387***	0,0092	0,9061***	0,1175
e4	0,9995***	0,0460	0,2778***	0,0721	0,1477	0,2534
e11u	-1,0516***	0,0017	-0,9915***	0,0158	-1,1356***	0,0406
e12u	0,0418***	0,0034	-0,0405	0,0316	-0,0767*	0,0463
e13u	0,0302***	0,0020	-0,0332***	0,0059	-0,1639***	0,0172
e14u	-0,0321***	0,0030	0,0151	0,0183	0,0402	0,0322
e21u	0,1298***	0,0092	-0,042	0,0703	0,2832***	0,0894
e22u	-1,1814***	0,0212	-0,8223***	0,1401	-0,8160***	0,1019
e23u	-0,0943***	0,0104	0,1373***	0,0239	0,3612***	0,0380
e24u	0,1738***	0,0197	-0,0535	0,0820	0,0808	0,0880
e31u	0,0759***	0,0049	-0,0689***	0,0121	-0,2560***	0,0424
e32u	-0,0926***	0,0103	0,1338***	0,0226	0,3073***	0,0530
e33u	-0,9325***	0,0104	-1,0389***	0,0121	-1,1657***	0,0302
e34u	-0,0483***	0,0129	-0,0176	0,0160	0,2211***	0,0784
e41u	-0,0881***	0,0103	0,2045***	0,0344	0,4289***	0,0615
e42u	0,1908***	0,0213	-0,2534***	0,0775	-0,2869***	0,0627
e43u	-0,0569***	0,0148	-0,0197	0,0196	0,2023***	0,0436
e44u	-1,0493***	0,0246	-0,9619***	0,0599	-1,6060***	0,1204
e11c	-0,2687***	0,0016	-0,2319***	0,0144	-0,3412***	0,0348
e12c	0,2052***	0,0035	0,1555***	0,0317	0,2537***	0,0429
e13c	0,0520***	0,0020	-0,0159***	0,0059	-0,1377***	0,0169
e14c	0,0116***	0,0030	0,0592***	0,0181	0,0912***	0,0306
e21c	0,8649***	0,0088	0,6362***	0,0690	0,5276***	0,0826
e22c	-1,0280***	0,0213	-0,6471***	0,1404	-0,7143***	0,0984
e23c	-0,0738***	0,0104	0,1527***	0,0239	0,3693***	0,0378
e24c	0,2150***	0,0197	-0,0141	0,0813	0,0965	0,0842
e31c	0,8354***	0,0060	0,7068***	0,0116	0,3428***	0,0615
e32c	0,0658***	0,0104	0,3341***	0,0232	0,5565***	0,0775
e33c	-0,9113***	0,0104	-1,0213***	0,0121	-1,1459***	0,0311
e34c	-0,0058	0,0129	0,0273*	0,0158	0,2595***	0,0739
e41c	0,6851***	0,0309	0,4120***	0,0727	0,5265***	0,1295
e42c	0,3522***	0,0217	-0,1998***	0,0716	-0,2462**	0,1100
e43c	-0,0353**	0,0149	-0,015	0,0198	0,2055***	0,0463
e44c	-1,0060***	0,0251	-0,9498***	0,0615	-1,5997***	0,1130

ei = expenditure elasticity; eiju = marshallian price elasticity (uncompensated); eijc = hicks elasticity (compensated)

1. Beef. 2. Poultry. 3. Pork. 4. Fish

* Statistically Significant at the 0.10 level, ** Statistically Significant at the 0.05 level, *** Statistically Significant at the 0.01 level.

Source: Author's estimates based on ENGH (1996-97, 2004-05 y 2012-13).