Estimation of a Censored Demand System in Stratified Sampling: An Analysis of Mexican Meat Demand at the Table Cut Level.

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Abstract

Evidence of meat trade in the form of table cuts suggests that consumer preferences and tastes vary across meat cuts. Unlike previous studies, this paper estimates demand elasticities at the table cut level from a Mexican survey of household incomes and expenditures, which is a stratified sample. The study uses the two-step estimation of a censored demand system proposed by Shonkwiler and Yen (1999) but incorporates stratification variables into the estimation procedure. Parameter estimates are reported and its standard errors are approximated by using the bootstrap procedure.

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Introduction

World meat consumption and trade liberalization are increasing. It is very important for the largest meat exporters to appropriately understand the most important foreign markets. Mexico is among the largest meat importers of the world and it imports 8% of the total world meat imports of 13,195,000 MT (United States Department of Agriculture, PSD Online Database, computed by authors). Additionally, Mexican meat imports more than doubled (increased by 147%) from 1997 to 2006 (United States Department of Agriculture, PSD Online Database, computed by authors). They went from 568,000 MT in 1997 to 1,405,000 MT in 2006 and experienced the fastest growth among the leading importing countries (United States Department of Agriculture, PSD Online Database, computed by authors).

In today's world meat market most meat trade is in the form of table cuts (Dyck and Nelson, 2003). Differences in the level of imports and exports of meat indicate that Mexican preferences and tastes may vary across meat cuts. For example, exports of Mexican bovine meat (except for bovine meat carcasses and half-carcasses) have increased drastically over the last five years while Mexican imports have remained stable (Figure 1). In the case of Mexican swine meat, only exports of boneless swine seem to be demanded by the international market, while Mexican demand for foreign swine hams, boneless swine meat and swine remains have slightly increased (Figure 2). In the case of Mexican chicken meat, exports have remained volatile but imports have experienced a drastic increase in boneless chicken, chicken legs and thighs, and whole chicken over the last five years (Figure

3). Additionally, Mexican imports of remains are greater than imports of other cuts of meat. For example, imports of remains of bovine animals are greater than imports of bovine meat carcasses and half-carcasses and other cuts of bovine meat with bone in. Similarly, imports of swine remains are greater than imports of boneless swine meat and swine meat carcasses and half-carcasses. Likewise, in the case of chicken, imports of other chicken cuts and offal are greater than imports of whole chicken.

Finally, Mexico is not only important because of the quantity it imports and its relatively high preference for animal remains, but also because its per capita meat consumption still remains low compared to the Unites States and Canada. For instance, from 1997 to 2006, Mexico averaged a per capita meat consumption of 60.78 kg, while the Unites States and Canada averaged 121.61 and 98.38 kg respectively (consumption from United States Department of Agriculture, PSD Online Database; population from International Monetary Fund, IFS Online Database). This suggests that Mexican per capita meat consumption could continue growing, and consequently, Mexico could still remain an important market for years to come.

Previous Mexican meat studies such as Erdil (2006), Malaga et al. (2006), Dong et al. (2004), Golan et al. (2001), Dong and Gould (2000), Garcia Vega and Garcia (2000), and Heien et al. (1989) have all aggregated Mexican meat into broad categories or analyzed meat as one product within a more general demand system (i.e., including cereals, meat, dairy, fats, fruit, vegetables, etc.). However, estimation of the meat demand elasticities using meat aggregates (i.e., beef, pork, and chicken) is not appropriate for Mexico when consumer tastes and preferences vary across meat cuts. In the United States, meat demand studies at the disaggregated level have provided additional insights about the nature of the demand for meat (see Yen and Huang, 2002, Taylor et al., 2008, and Medina, 2000). Unlike previous studies, this paper estimates demand elasticities at the table cut level (i.e., beefsteak, ground beef, pork steak, ground pork, chicken legs, thighs and breast, fish, etc.) and calculates expenditure, Marshallian and Hicksian price elasticities, which at this level of disaggregation are currently not available for Mexico. To accomplish this objective, a censored demand system is estimated in two steps using a stratified sample from a survey of Mexican household incomes and expenditures.

Data

Mexican data on household incomes and expenditures was obtained from *Encuesta Nacional de Ingresos y Gastos de los Hogares (ENIGH)*, which is a nation wide survey encompassing Mexico's 31 states and the Federal District. This data is cross-sectional and it is published by a Mexican governmental institution *(Instituto Nacional de Estadística, Geografía e Informática (INEGI))*. ENIGH is published since 1977 (e.g., see Heien et al., 1989); however, this study only uses the most recent survey, conducted from August to November 2006. The data is collected from each household during one week by performing direct interviews through a *stratified sampling method*. However, data on food, drinks, cigarettes and public transportation is recorded only when the household makes a purchase.[1]

It is important to analyze ENIGH as a stratified sample, which is different from a random sample. In stratified sampling the population is divided into subgroups (strata), which are often of interest to the investigator, and a simple random sample is taken from each stratum (Lohr, 1999, p. 24). According to ENIGH–*Síntesis Metodológica* (2006), ENIGH's sampling methods are probabilistic, multi-staged, stratified, and conglomerated. The sampling method is *probabilistic* because the sampling units have a probability of being selected, which is known and different from zero. Additionally, the sampling method is *multi-staged* because the sampling units are selected in multiple stages. It is *stratified* because the target population is divided into groups with similar characteristics, which form the strata. Finally, it is *conglomerated* because the sampling units (households) are made up from the observation units (household members). In ENIGH 2006, there was a nonresponse rate of 10.55% (ENIGH–*Síntesis Metodológica*, 2006, pp. 33–34). From the responding 20,875 households, information was collected and 16,909 households reported consumption of at least one meat cut. Table 1 reports the number of observations, the sum of weights, and the average household size per each stratum in ENIGH 2006. The weight variable is the number of households that the interviewed household represents nationally. Stratum 1 consists of households who live in cities or towns with a population of 100,000 people or more. Stratum 2 consists of households who live in cities or towns with a population between 15,000 and 99,999 people. Stratum 3 consists of households who live in

[1]For an additional explanation in English on ENIGH refer to Lopez (2008) for details refer to ENIGH in Spanish.

cities or towns with a population between 2,500 and 14,999 people. Finally, stratum 4 consists of household who live in cities or towns with a population of less than 2,500 people. Additionally, note that multiplying the sum of weights by the average household size will approximate the total population of Mexico that consumed meat during the week of interview. This number is less than the population of Mexico, which in 2006 was about 105 million (International Monetary Fund, IFS Online Database), because not all households reported consumption of at least one meat cut during the week of interview. Previous studies on Mexican meat demand (Malaga et al., 2006; Dong et al., 2004; Gould and Villarreal, 2002; Golan et al., 2001; Sabates et al., 2001; Garcia Vega and Garcia, 2000; Heien et al., 1989), which have used the same data source (ENIGH), have not taken into account the fact that the sample is stratified. Ignoring stratification variables (e.g., weight and strata) results in parameter estimates that may not be representative of the population or that may not capture potential differences among the subpopulations (Lohr, 1999, pp. 221–254). For example, not incorporating from ENIGH 2006 the variable weight into the analysis is equivalent to assigning a constant weight of 1,307.37 (i.e., 22,106,253/16,909) to each observation; therefore, assuming each household member represents the same number of households nationally. Figure 4, which depicts a histogram of the variable weight from ENIGH 2006, shows this is clearly not the case. Additionally, taking a random sample of 1,000 households from the 16,909 households and not incorporating the weight variable (e.g., see Golan et al., 2001) will only produce a sample that is representative of the 16,909 households assuming a constant weight, which is incorrect. Finally, Malaga et al. (2006) and Dong et al. (2004) restricted their analysis to only strata 1 and 2 (i.e., households that live in cities or towns with a population of 15,000 or more), which in ENIGH 2006 is equivalent to excluding 7,391,765 households of the target population. They claimed they should ignore strata 3 and 4 (i.e., households that live in cities or towns with a population of 14,999 or less) because of the problem of assigning a dollar value (i.e., a price) to the meat produced at home. In other words, to avoid the problem of "valuation of home-produced goods" (Dong et al., 2004, p. 1099). However, ENIGH does not record consumption transactions of home-produced goods when the households do not make a living by selling home-produced goods.[2] In addition, Malaga et al. (2006) and Dong et al. (2004) did not have an indicator in the data to demonstrate how many rural households who produced meat at home were not included in data. That is, they excluded a segment of the population based on their belief that many people from strata 3 and 4 consume meat produced at home. However, the urban sector has, as well, a chance of consuming home-produced goods. The fact that a household lives in an urban or rural location does not eliminate the possibility of consuming home-produced goods. To avoid complications of this matter, this study will not exclude any segment of the population.

Another issue that arises in ENIGH 2006 is that of *censored observations*. Censored

[2]If a household consumes a home-produced good during the week of interview, the transaction is recorded only if the household makes a living by selling home-produced goods to the public. That is, if a household consumes a home-produced good but the household does not make a living by selling home-produced goods to the public, then the transaction is not recorded (INEGI, personal communication).

observations are common in consumer survey data and they occur when the value of an observation is partially known. Because ENIGH records food consumption only when households make a purchase and because the collection period is only one week, weekly expenditures on many meat cuts are censored. Consequently, the value of the observations are partially known because even though consumption of some meat cuts are not recorded, you still have information about the households such as income, number of adults, etc. In ENIGH 2006, price and quantity are censored for the meat cuts that households did not buy during the week of interview.[3] To solve the problem of censored prices, similar to Malaga et al. (2006), a regression imputation approach was adopted for each of the eighteen meat cuts considered in this study. In particular, non-missing prices of each meat cut was regressed as function of total income, education level of the household decision maker, regional dummy variables, stratum dummy variables, the number of adult equivalents, a dummy variable for car, and a dummy variable for refrigerator. Each regression used the SURVEYREG procedure and incorporated the variables strata and weight as documented in SAS Institute Inc. (2004, pp. 4363–4418). This price imputation approach is preferred over a substitution of the missing price with the corresponding simple average of non-missing prices within each Mexican state and strata (e.g., Golan et al., 2001, p. 545 and Dong et al., 1998, p. 1099).[4] Table 2 shows the number of non-missing

[3]For the meat cuts that the 20,875 households did buy (and therefore recorded), only in 13 cases both price and quantity was not reported out of a total of 59,782 purchases (counting as different purchases any purchase of meat, as well as purchases of the same meat cut by the same household in different places).

[4]If you adopt the latter procedure, using four strata and Mexico's 31 states plus the Federal District will only provide 128 different values for price imputation and using two strata will only provide 64 different

and missing observations, as well as the average prices in 2006 Mexican pesos per kilogram (pesos/kg) of the eighteen meat cuts considered in this study before and after price imputation.[5] The mean before price imputation uses only non-missing observations to compute the average while mean after price imputation uses both non-missing observations and imputed (missing) observations. Finally, the high number of censored observations is common when meat is analyzed at the disaggregated level (see Taylor et al., 2008) and even when meat is analyzed at the aggregated level (see Golan et al., 2001; Dong et al., 1998). The 18 table cuts considered in this study, which are mentioned in Table 2, include beefsteak (beefsteak and Milanesa); ground beef (hamburger patty and ground beef); other beef cuts (brisket, tore shank, rib cutlet, strips for grilling, meat for stewing/boiling, and meat cut with bone); beef offal (head, udder, heart, liver, marrow, rumen/belly, etc.); pork steak; pork leg & shoulder (chopped leg, middle leg, clear plate, Boston shoulder, and picnic shoulder); ground pork; other pork (pork chops, upper leg, spareribs, and smoked pork chops); chorizo (a pork sausage highly seasoned especially with chili powder and garlic); ham, bacon & similar (ham, bologna , embedded pork, salami, and bacon); beef & pork sausages; chicken legs, thighs and breasts (with bone and boneless); whole chicken; chicken offal (wings, head, neck, gizzard, liver, etc.); chicken ham & similar (chicken sausages, ham, nuggets, bologna, etc.); fish (whole catfish, whole carp, whole tilapia, fish fillet, tuna, salmon, codfish, smoked fish, dried fish, fish nuggets, sardines, young eel, manta

values.

[5]Average prices also incorporate the variables strata and weight, and were computed using the SURVEYMEANS procedure (see SAS Institute Inc., 2004, pp. 4313–4362).

ray, ell, fish/crustaceous eggs, etc.); and shellfish (fresh shrimp, clam, crab, oyster, octopus, and processed shrimp).

A final issue incorporated into this study is that of using the number of adult equivalents rather than ignoring (Malaga et al., 2006) or using a simple count or proportion (Dong et al., 2004; Golan et al., 2001) of household members. Adult equivalence scales are used to compute the number of adult equivalents per households by taking into account how much an individual household member of a given age and sex contributes to household expenditures or consumption of goods relative to a standard household member. Adult equivalents were computed so that households consumption are comparable. For instance, meat consumption in different households cannot be directly compared without computing per capita meat consumption because bigger households will naturally have a tendency to consume more meat than smaller households. Therefore, this study used the National Research Council's recommendations of the different food energy allowances for males and/or females during the life cycle as reported by Tedford et al. (1986) to compute the number of adult equivalents and then compute per capita meat consumption (i.e., per adult-equivalent consumption).

Finally, to solve the problem of censored quantities this study used a censored regression model. This study will incorporate estimation techniques from stratified sampling with the two-step estimation of a censored system of equations proposed by Shonkwiler and Yen (1999) and later illustrated by Su and Yen (2000). Additionally, estimating standard errors of parameter estimates in complex surveys is different and more difficult than estimating standard errors of parameter estimates in simple random samples. Estimating them in the same manner is incorrect (Lohr, 1999, pp. 289–318 and 347–378). Consequently, this study will estimate standard errors of parameter estimates by using the nonparametric bootstrap procedure (see Cameron and Trivedi, 2005, p. 360 and SAS Institute Inc. or a brief review provided in Lopez, 2008, p. 108).

Theoretical Framework

In 1999, Shonkwiler and Yen proposed an alternative and consistent two-step estimation procedure to Heien and Wessells (1990). In their article, Shonkwiler and Yen (1999) explained Heien and Wessells (1990) procedure is not appropriate because it is based on a set of unconditional mean expressions for the censored dependent variables which are inconsistent. Shonkwiler and Yen (1999) mention several studies that have used Heien and Wessells (1990) procedure. Among the ones of interest, which are mentioned in this study, Malaga et al. (2006) used Heien and Wessells (1990) procedure.

For an arbitrary observation from the i^{th} equation, $i = 1, 2, \ldots, M$, the censored system of equations with limited dependent variables, proposed by Shonkwiler and Yen (1999), is written as follows:

$$(1) \quad \begin{aligned} y_i &= d_i y_i^*, \\ y_i^* &= \mathbf{x}_i' \boldsymbol{\beta}_i + \epsilon_i, \\ d_i &= \begin{cases} 1 & \text{if} \quad d_i^* > 0, \\ 0 & \text{if} \quad d_i^* \leq 0, \end{cases} \\ d_i^* &= \mathbf{z}_i' \boldsymbol{\alpha}_i + v_i, \end{aligned}$$

where y_i and d_i are (1×1) observed dependent variables, y_i^* and d_i^* are (1×1) corresponding latent or unobserved variables, $\mathbf{z}_i' = \begin{pmatrix} 1 & z_{i2} & \dots & z_{iK_1} \end{pmatrix}$ and $\mathbf{x}_i' = \begin{pmatrix} 1 & x_{i2} & \dots & x_{iK_2} \end{pmatrix}$ are $(1 \times K_1)$ and $(1 \times K_2)$ vector of explanatory variables respectively, $\boldsymbol{\alpha}_i = \begin{pmatrix} \alpha_{i1} & \alpha_{i2} & \dots & \alpha_{iK_1} \end{pmatrix}'$ is a $(K_1 \times 1)$ and $\boldsymbol{\beta}_i = \begin{pmatrix} \beta_{i1} & \beta_{i2} & \dots & \beta_{iK_2} \end{pmatrix}'$ are $(K_1 \times 1)$ and $(K_2 \times 1)$ vector of parameters, and ϵ_i and v_i are (1×1) random errors. Shonkwiler and Yen (1999) explain that if we assume that for each i the error terms $\begin{pmatrix} \epsilon_i & v_i \end{pmatrix}'$ are distributed as bivariate normal with $\text{Cov}(\epsilon_i, v_i) = \delta_i$; then, the unconditional mean of y_i is

$$(2) \quad \text{E}(y_i|\mathbf{x}_i, \mathbf{z}_i) = \Phi(\mathbf{z}_i'\boldsymbol{\alpha}_i)\mathbf{x}_i'\boldsymbol{\beta}_i + \delta_i\phi(\mathbf{z}_i'\boldsymbol{\alpha}_i).$$

Then, using equation (2), the system in equation (1) can be written as

$$(3) \quad y_i = \Phi(\mathbf{z}_i'\boldsymbol{\alpha}_i)\mathbf{x}_i'\boldsymbol{\beta}_i + \delta_i\phi(\mathbf{z}_i'\boldsymbol{\alpha}_i) + \xi_i, \quad i = 1, \dots, M,$$

where $\xi_i = y_i - \text{E}(y_i|\mathbf{x}_i, \mathbf{z}_i)$ and $\text{E}(\xi_i) = 0$.

Shonkwiler and Yen (1999) suggest the following two-step procedure for the system in equation (3): (i) obtain maximum-likelihood probit estimates $\hat{\boldsymbol{\alpha}}_i$ of $\boldsymbol{\alpha}_i$ for $i = 1, 2, \dots, M$ using the binary dependent variable $d_i = 1$ if $y_i > 0$ and $d_i = 0$ otherwise; (ii) calculate $\Phi(\mathbf{z}_i'\hat{\boldsymbol{\alpha}}_i)$ and $\phi(\mathbf{z}_i'\hat{\boldsymbol{\alpha}}_i)$ and estimate $\boldsymbol{\beta}_1, \boldsymbol{\beta}_2, \dots, \boldsymbol{\beta}_M, \delta_1, \delta_2, \dots, \delta_M$ in the system

$$(4) \quad y_i = \Phi(\mathbf{z}_i'\hat{\boldsymbol{\alpha}}_i)\mathbf{x}_i'\boldsymbol{\beta}_i + \delta_i\phi(\mathbf{z}_i'\hat{\boldsymbol{\alpha}}_i) + \xi_i, \quad i = 1, \dots, M,$$

by maximum likelihood (ML) or seemingly unrelated regression (SUR) procedure,[6] where

$$(5) \quad \xi_i = \epsilon_i + [\Phi(\mathbf{z}_i'\boldsymbol{\alpha}_i) - \Phi(\mathbf{z}_i'\hat{\boldsymbol{\alpha}}_i)]\mathbf{x}_i'\boldsymbol{\beta}_i + \delta_i[\phi(\mathbf{z}_i'\boldsymbol{\alpha}_i) - \phi(\mathbf{z}_i'\hat{\boldsymbol{\alpha}}_i)].$$

[6]For an applied review on seemingly unrelated regressions see Lopez (2008).

Su and Yen (2000) explain that differentiating the unconditional mean (Equation 2) with respect to a common variable in $\mathbf{x}_i$ and $\mathbf{z}_i$, say x_{ij}, gives

$$(6) \quad \frac{\partial \mathrm{E}(y_i|\mathbf{x}_i, \mathbf{z}_i)}{\partial x_{ij}} = \Phi(\mathbf{z}_i'\boldsymbol{\alpha}_i)\beta_{ij} + \mathbf{x}_i'\boldsymbol{\beta}_i\phi(\mathbf{z}_i'\boldsymbol{\alpha}_i)\alpha_{ij} - \delta_i(\mathbf{z}_i'\boldsymbol{\alpha}_i)\phi(\mathbf{z}_i'\boldsymbol{\alpha}_i)\alpha_{ij}.$$

Furthermore, Su and Yen (2000) explain, the elasticities can be derived from Equation (6). For example, the elasticities of commodity i with respect to price p_j, total meat expenditure m, and demographic variable r_l are (e.g., see Yen et al., 2002), respectively,

$$(7) \quad \begin{aligned} e_{ij} &= \frac{\partial \mathrm{E}(y_i|\mathbf{x}_i, \mathbf{z}_i)}{\partial p_j}\frac{p_j}{\mathrm{E}(y_i|\mathbf{x}_i, \mathbf{z}_i)}, \\ e_i &= \frac{\partial \mathrm{E}(y_i|\mathbf{x}_i, \mathbf{z}_i)}{\partial m}\frac{m}{\mathrm{E}(y_i|\mathbf{x}_i, \mathbf{z}_i)}, \\ e_{il} &= \frac{\partial \mathrm{E}(y_i|\mathbf{x}_i, \mathbf{z}_i)}{\partial r_l}\frac{r_l}{\mathrm{E}(y_i|\mathbf{x}_i, \mathbf{z}_i)}. \end{aligned}$$

Then, these elasticities can be evaluated using parameter estimates and sample means of explanatory variables. Since ENIGH is a stratified sample, means of explanatory variables are computed incorporating the variables strata and weight (see SAS Institute Inc., 2004, pp. 4313–4362). As explained by Su and Yen (2000, p. 736), the elasticity of commodity i with respect to demographic variable r_l is "not strictly defined... [but] allow convenient assessment of the significance of corresponding variables in a complex functional relationship." Finally, the compensated or Hicksian elasticities of commodity i with respect to price p_j can be obtained from Slutsky equation in elasticity form. That is,

$$(8) \quad e_{ij}^c = e_{ij} + e_i\left(\frac{p_j\,\mathrm{E}(y_i|\mathbf{x}_i, \mathbf{z}_i)}{m}\right).$$

Empirical Results

The univariate maximum-likelihood probit parameters $\boldsymbol{\alpha}_i$, $i = 1, 2, \ldots, M =$ beefsteak, ground beef, ..., shellfish, were estimated by weighting each observation by the value of the variable weight. That is, by multiplying "the contribution of each observation to the likelihood function... by the value of the weight variable" (SAS Institute Inc., 2004, p. 3754). Table 3 reports parameter estimates from the first five equations as well as their corresponding bootstrap standard errors.[7] The variable m stands for total meat expenditure, and the binary variables *NE*, *NW*, *CW*, *C* and *urban* stands for the Northeast, Northwest, Central-west, and Central regions, and the urban sector. Note that the excluded dummy variables from each equation are the Southeast region (*SE*) and the rural sector (*rural*). From a total of 450 parameters estimated in step 1 (25 parameters estimated at a time for 18 equations), 205, 158, and 137 parameters were statistically different from zero at the 0.20, 0.10, and 0.05 significance levels respectively. Considering only parameter estimates corresponding to binary variables, from a total of 90 parameters estimated, 69, 60, and 51 were statistically different from zero at the 0.20, 0.10, and 0.05 significance levels respectively. These significant determinants of the probability of consuming meat cut i can be read directly from Table 3.

Moreover, the partial effect of continuous variable z_{ik} (e.g., p_1, ..., p_{18} or m) on the probability of buying meat cut i, which is given by $\phi(\mathbf{z}_i'\boldsymbol{\alpha}_i)\alpha_{ik}$, can be estimated from

[7] The parameter estimates as well as their corresponding bootstrap standard errors for the other thirteen equations are available from the authors upon request.

Tables 2 and 3.[8] For example, an increase of one peso/kg in the price of shellfish in the rural sector of the southeast region decreases the probability of consuming beefsteak by 0.0071. Similarly, the partial effect of binary variable z_{ik} (e.g., *NE*, *NW*, *CW*, *C*, *urban*) changing from 0 to 1 on the prabibily of buying meat cut i is given by $\Phi(\alpha_{i1} + \alpha_{i2}z_{i2} + \ldots + \alpha_{i(k-1)}z_{i(k-1)} + \alpha_{ik}(1) + \alpha_{i(k+1)}z_{i(k+1)} + \ldots + \alpha_{iK_1}z_{iK_1}) - \Phi(\alpha_{i1} + \alpha_{i2}z_{i2} + \ldots + \alpha_{i(k-1)}z_{i(k-1)} + \alpha_{i(k+1)}z_{i(k+1)} + \ldots + \alpha_{iK}z_{iK_1})$. For instance, the probability of consuming pork steak in the urban sector of the Southeast region is about 0.0608 lower than the probability of consuming pork steak in the urban sector of the Northeast region.

The second step estimation of the system of censored demand equations was based on the full system of $M = 18$ equations because the parametric restriction of adding-up was not imposed in the model (see also Yen et al., 2002, p. 1801). Additionally, since in stratified samples the weighted estimator is consistent (Wooldridge, 2001, p. 464), all observations were weighted by the weight variable prior to estimation. However, "[if we] use weights w_i in the weighted least squares estimation, [we] will obtain the same point estimates...; however, in complex surveys, the standard errors and hypothesis tests the software provides will be incorrect and should be ignored" (Lohr, 1999, p. 355). Consequently, parameter estimates in this study were estimated using the bootstrap procedure. Table 4 presents the SUR parameter estimates for the first five equations as well as their corresponding bootstrap standard errors from the censored system of eighteen equations.[9]

[8] Average total meat expenditure is 33.04 pesos.

[9] The parameter estimates from the second step estimation as well as their corresponding bootstrap standard errors for the other thirteen equations are available from the authors upon request.

From a total of 468 parameter estimated in step 2; 204, 131, and 67 parameters were statistically different from zero at the 0.20, 0.10, and 0.05 significance levels respectively. Tables 5 and 6 report the Marshallian and Hicksian price elasticities respectively. Observe that the expected negative sign was obtained for all Marshallian and Hicksian price elasticities. In addition, there are as many positive elasticities (160 Marshallians and 179 Hicksians) as there are negative elasticities (164 Marshallians and 145 Hicksians). Positive cross-price elasticity suggest cases of substitutes meat cuts while negative elasticities suggest cases of complement meat cuts. Moreover, the sign of the Marshallian and Hicksian price elasticities was the same in all but 19 cases. For instance, examples of (gross and net) substitutes include beefsteak and pork steak (and vice versa); beef offal and chicken offal (and vice versa); and ham, bacon & similar beef & pork products and chicken ham & similar (and vice versa). Similarly, examples of (gross and net) complementarity include beefsteak and other beef (and vice versa); pork steak and pork leg & shoulder (and vice versa); and chicken legs, thighs & breasts and whole chicken (but not vice versa). Finally, since estimates of elasticities at this level are currently not available for Mexico, a comparison of elasticities is not possible.

Table 7 presents the expenditure elasticities. All expenditure elasticities have the expected positive sign, which means all the meat cuts are normal goods and that consumption of all meat cuts are expected to increase as the economy grows. Additionally, since all the expenditure elasticities are less than one, none of the meat cuts is considered a "luxury" commodity. The expenditure elasticities ranges from 0.1846 for ground pork to 0.9733 for beefsteak. In addition, observe that most pork cut's elasticities have a lower value (therefore more necessary goods) than most beef cut's elasticities and chicken cut's elasticities, except for processed beef and pork (i.e., chorizo; ham, bacon & similar; beef & pork sausages; and other processed beef & pork).

Conclusion

Mexico is an important market for meat trade because it is among the largest meat importers, has a relatively high preference for meat offal and a relatively low per capita meat consumption. Our findings indicate consumption on all meat cuts is expected to increase as the economy grows. In addition, all meat cuts are considered necessary commodities but pork appeared to have the more inelastic expenditure elasticities. Moreover, several cases of (gross and net) substitutability and complementarity were identified among the meat cuts.

Unlike previous studies on Mexican meat demand, this paper reported demand elasticities at the table cut level and took into account the fact that the sample is stratified. In addition, parameter estimates as well as its standard errors were reported. Moreover, data issues, such as censored observations and calculating the number of adult equivalents to compute per capita meat consumption, were incorporated into the analysis as well.

This study also has the advantage of using a consistent two-step estimation procedure of a censored demand system. Since the data used in the study consists of a stratified sample, the study incorporated estimation techniques from stratified sampling. For instance, it incorporated stratification variables (strata and weight) in preliminary data preparation, in each of the two-step estimation procedure, and in computing standard errors. Finally, this study also has the advantage of having used data at the household level, which provides additional insights about the nature of the demand for meat. "Taking individual households at the micro level, microeconomic models enable better estimation of demand parameters and improvement of forecasts over those assuming average effects for all members of the population based on aggregate data" (Yen and Huang, 2002, p. 321).

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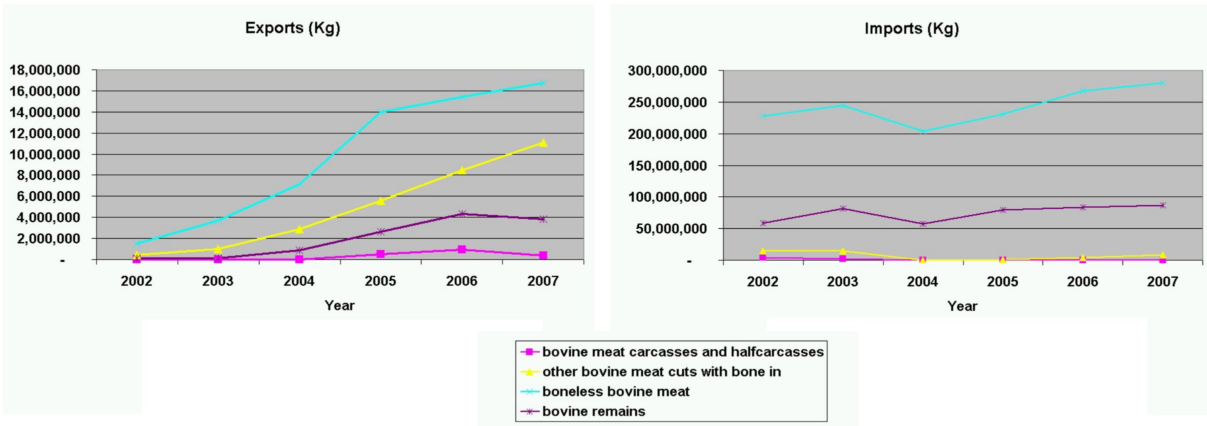

Figure 1. Mexican Exports and Imports of Bovine Meat

Note: Series were computed from chapter 2 (meat and edible meat offal) of the Harmonized System. At the 8-digit level of disaggregation, bovine meat carcasses and half-carcasses includes commodities 02011001 and 02021001. Bovine meat other cuts with bone-in includes commodities 02012099 and 02022099. Boneless bovine meat includes commodities 02013001 and 02023001. Bovine remains include commodities 02061001, 02062101, 02062201 and 02062999. All years are calendar years (Jan. to Dec.) except for 2002, which was reported from April to December.

Source: Mexican Ministry of Economy, SIAVI Database, computed by authors.

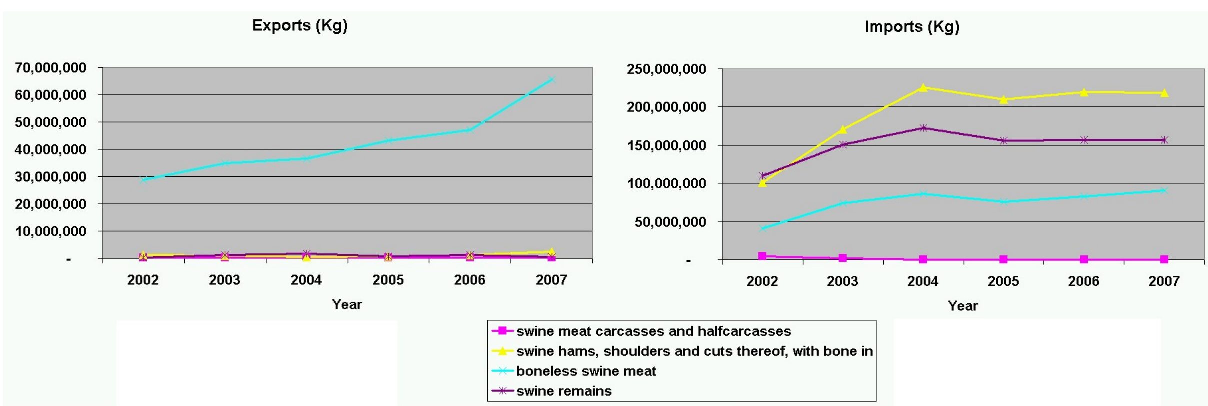

Figure 2. Mexican Exports and Imports of Swine Meat

Note: Series were computed from chapter 2 (meat and edible meat offal) of the Harmonized System. At the 8-digit level of disaggregation, swine meat carcasses and half-carcasses include commodities 02031101 and 02032101. Swine hams, shoulder and cuts thereof, with bone-in include commodities 02031201 and 02032201. Boneless swine meat includes commodities 02031999 and 02032999. Swine remains include commodities 02063001, 02063099, 02064101, 02064901 and 02064999. All years are calendar years (Jan. to Dec.) except for 2002, which was reported from April to December.

Source: Mexican Ministry of Economy, SIAVI Database, computed by authors.

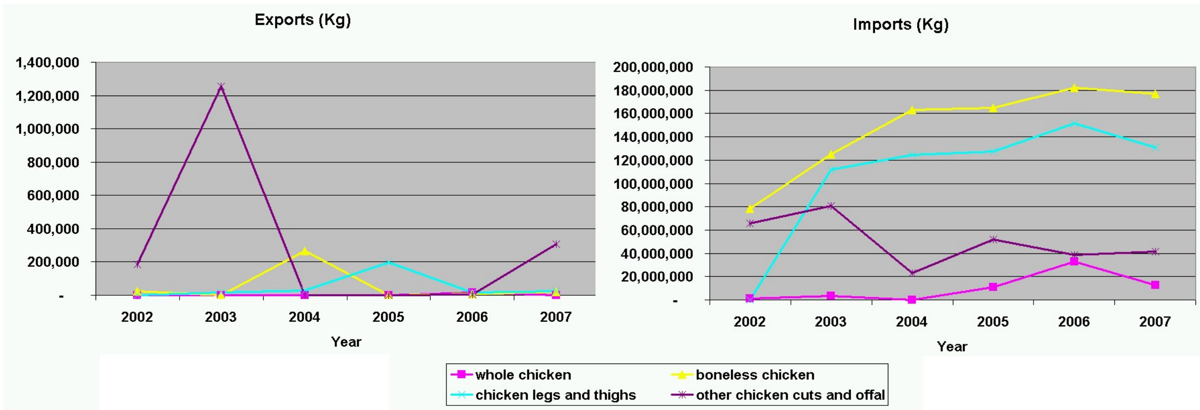

Figure 3. Mexican Exports and Imports of Chicken

Note: Series were computed from chapter 2 (meat and edible meat offal) of the Harmonized System. At the 8-digit level of disaggregation, whole chicken include commodities 02071101 and 02071201. Boneless chicken includes commodities 02071301 and 02071401. Chicken legs and thighs include commodities 02071303 and 02071404. Other chicken cuts and offal include commodities 02071302, 02071399, 02071402, 02071403 and 02071499. All years are calendar years (Jan. to Dec.) except for 2002, which was reported from April to December.

Source: Mexican Ministry of Economy, SIAVI Database, computed by authors.

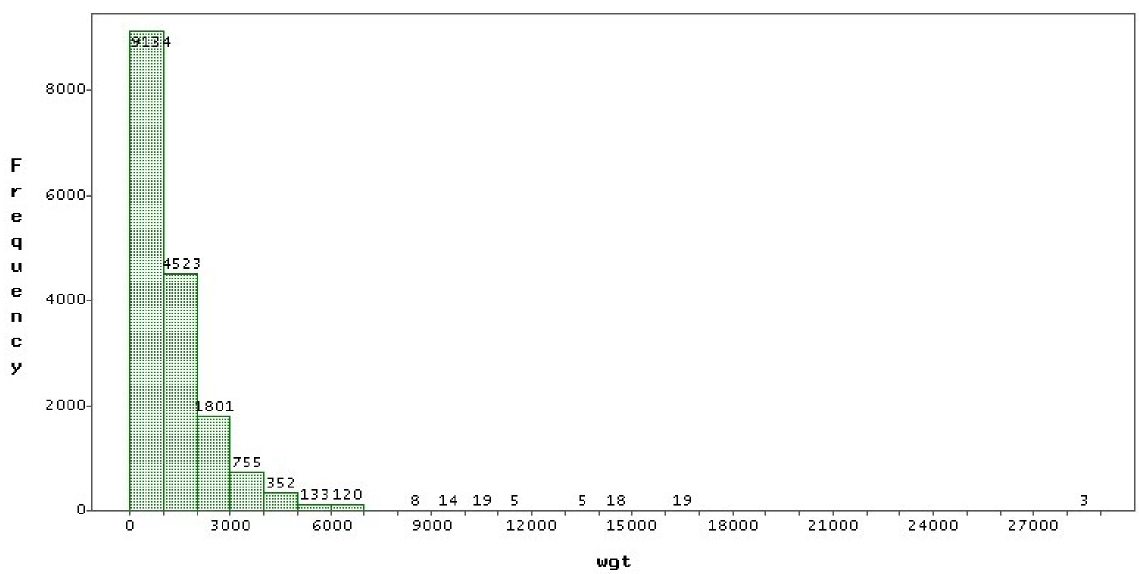

Figure 4. Histogram of the Weight Variable in ENIGH 2006
Source: ENIGH 2006 Database, computed by authors.

Table 1. Number of Observations, Sum of Weights and Average Household Size Per Stratum

Strata	No. of Obs.	Sum of Weights	Avg. hhsize
Str1	7,285	11,473,327	3.99
Str2	3,942	3,241,161	4.13
Str3	1,574	2,837,679	4.52
Str4	4,108	4,554,086	4.28
Total	16,909	22,106,253	4.14

Source: ENIGH 2006 Database, computed by authors.

Table 7. Expenditure Elasticities

i	e_i
Beefsteak	0.9733
Ground Beef	0.5228
Other Beef	0.7260
Beef Offal	0.6413
Pork Steak	0.3904
Pork Leg & Shoulder	0.5141
Ground Pork	0.1846
Other Pork	0.5776
Chorizo	0.6190
Ham, Bacon & Similar	0.4547
Beef & Pork Sausages	0.2728
Other Processed Beef & Pork	0.3570
Chicken Legs, Thighs & Breasts	0.6142
Whole Chicken	0.6761
Chicken Offal	0.6112
Chicken Ham & Similar	0.3354
Fish	0.6970
Shellfish	0.4361

Table 2. Number of Non-Missing and Missing Observations and Average Prices

Price of	Number Non-missing	Number Missing	Mean Before Price Imputed (Pesos/Kg)	Mean After Price Imputed (Pesos/Kg)
Beef				
Beefsteak	6,348	10,561	61.36	60.88
Ground beef	2,938	13,971	55.63	56.20
Other beef	2,795	14,114	52.00	51.41
Beef offal	734	16,175	36.84	35.81
Pork				
Pork steak	892	16,017	50.33	50.35
Pork leg & shoulder	1,506	15,403	47.10	46.95
Ground pork	366	16,543	48.64	47.97
Other pork	2,168	14,741	46.87	46.71
Processed Beef & Pork				
Chorizo	3,175	13,734	50.79	51.29
Ham, bacon & similar	4,156	12,753	50.53	48.79
Beef & pork sausages	2,384	14,525	31.27	31.45
Other processed beef & pork	2,626	14,283	72.51	73.88
Chicken				
Chicken legs, thighs & breast	5,057	11,852	35.24	34.69
Whole chicken	5,716	11,193	28.60	28.13
Chicken offal	760	16,149	22.43	24.88
Processed Chicken				
Chicken ham & similar	2,593	14,316	46.74	46.07
Seafood				
Fish	3,970	12,939	48.72	47.91
Shellfish	713	16,196	81.54	87.16

Note: Average exchange rate in 2006 is US $1 = 10.90 Pesos (Banco de México).

Source: ENIGH 2006 Database, computed by authors.

Table 3. ML Parameter Estimates from Univariate Probit Regressions (Step 1)

Var.	Beefsteak		Ground Beef		Other Beef		Beef Offal		Pork Steak	
	Param. Est.	Bootstr. Std. Err.	Param. Est.	Bootstr. Std. Err.	Param. Est.	Bootstr. Std. Err.	Param. Est.	Bootstr. Std. Err.	Param. Est.	Bootstr. Std. Err.
const.	-0.6046	0.5169	-0.7441†	0.4906	-0.2887	0.5569	-0.6048	0.6586	0.4161	0.7201
p_1	-0.0011	0.0016	0.0047*	0.0017	-0.0047*	0.0018	-0.0005	0.0026	-0.0016	0.0020
p_2	0.0012	0.0023	-0.0012	0.0033	-0.0063*	0.0025	-0.0019	0.0033	-0.0038	0.0032
p_3	-0.0010	0.0019	-0.0000	0.0018	-0.0005	0.0022	-0.0008	0.0032	0.0017	0.0025
p_4	-0.0028	0.0029	-0.0036	0.0035	0.0064‡	0.0036	0.0007	0.0060	-0.0067†	0.0043
p_5	0.0101‡	0.0058	-0.0007	0.0040	0.0057†	0.0039	-0.0079†	0.0062	0.0026	0.0073
p_6	-0.0091*	0.0031	-0.0032	0.0034	-0.0069*	0.0034	0.0016	0.0037	-0.0060	0.0050
p_7	0.0084	0.0066	0.0082	0.0062	0.0003	0.0083	0.0028	0.0083	-0.0046	0.0100
p_8	0.0030†	0.0021	-0.0019	0.0021	-0.0055*	0.0028	-0.0001	0.0045	-0.0007	0.0029
p_9	0.0011	0.0010	0.0002	0.0010	-0.0014†	0.0009	-0.0065*	0.0029	0.0003	0.0013
p_{10}	0.0012	0.0013	0.0015	0.0013	0.0011	0.0012	-0.0007	0.0023	-0.0067*	0.0023
p_{11}	0.0007	0.0025	0.0007	0.0027	-0.0070*	0.0026	-0.0020	0.0037	0.0031	0.0040
p_{12}	-0.0008	0.0009	-0.0021†	0.0014	0.0003	0.0008	-0.0030†	0.0020	-0.0024†	0.0017
p_{13}	-0.0011	0.0019	-0.0024	0.0019	-0.0007	0.0020	0.0005	0.0026	-0.0046†	0.0033
p_{14}	-0.0002	0.0021	0.0001	0.0029	0.0015	0.0022	-0.0018	0.0041	-0.0048	0.0037
p_{15}	0.0029	0.0034	0.0057	0.0039	0.0064	0.0045	0.0012	0.0048	0.0047	0.0043
p_{16}	-0.0057*	0.0019	-0.0057*	0.0021	-0.0016	0.0018	0.0005	0.0028	-0.0037†	0.0027
p_{17}	0.0000	0.0011	0.0009	0.0011	0.0006	0.0012	-0.0040‡	0.0021	0.0007	0.0011
p_{18}	-0.0092*	0.0020	-0.0128*	0.0020	-0.0062*	0.0018	-0.0016	0.0024	-0.0061*	0.0028
m	0.0112*	0.0027	0.0085*	0.0006	0.0097*	0.0006	0.0037*	0.0009	0.0045*	0.0007
NE	-0.2030‡	0.0998	-0.1764†	0.1256	0.2429*	0.1046	-0.0361	0.1626	-1.1071*	0.1617
NW	0.0207	0.1259	1.1140*	0.1447	0.6158*	0.1393	0.0177	0.2380	-1.3065*	0.2121
CW	0.3399*	0.1007	0.1291	0.1031	0.2278*	0.0925	-0.3667*	0.1408	-0.4446*	0.1182
C	0.1808‡	0.0967	0.2106‡	0.1051	0.2959*	0.1058	0.0590	0.1413	-0.1934†	0.1313
urban	0.4952*	0.0590	0.5259*	0.0601	0.1378*	0.0589	0.1952*	0.0902	0.3051*	0.0826

Note: Number of bootstrap resamples = 1,000. Bootstrap significance levels of 0.05, 0.10 and 0.20 are indicated by asterisks (*), double daggers (‡) and daggers (†) respectively.

Table 4. SUR Parameter Estimates from System of Equations (Step 2)

Variable	Beefsteak ($i=1$) Param. Est.	Beefsteak ($i=1$) Bootstr. Std. Err.	Ground Beef ($i=2$) Param. Est.	Ground Beef ($i=2$) Bootstr. Std. Err.	Other Beef ($i=3$) Param. Est.	Other Beef ($i=3$) Bootstr. Std. Err.	Beef Offal ($i=4$) Param. Est.	Beef Offal ($i=4$) Bootstr. Std. Err.	Pork Steak ($i=5$) Param. Est.	Pork Steak ($i=5$) Bootstr. Std. Err.
$\Phi(\mathbf{z}_i'\hat{\boldsymbol{\alpha}}_i)$	1.6951*	0.3939	0.6607	0.4387	2.0916*	0.7051	13.0161	16.0844	1.5472†	0.8903
$\Phi(\mathbf{z}_i'\hat{\boldsymbol{\alpha}}_i)\ p_1$	-0.0038*	0.0015	-0.0002	0.0007	-0.0038*	0.0022	-0.0057	0.0080	0.0051†	0.0040
$\Phi(\mathbf{z}_i'\hat{\boldsymbol{\alpha}}_i)\ p_2$	0.0000	0.0008	-0.0130*	0.0046	0.0053*	0.0031	0.0176	0.0230	0.0022	0.0069
$\Phi(\mathbf{z}_i'\hat{\boldsymbol{\alpha}}_i)\ p_3$	-0.0016*	0.0007	-0.0005	0.0006	-0.0109*	0.0040	0.0035	0.0090	-0.0019	0.0028
$\Phi(\mathbf{z}_i'\hat{\boldsymbol{\alpha}}_i)\ p_4$	0.0008	0.0013	0.0006	0.0016	-0.0019	0.0026	-0.0497*	0.0168	0.0075	0.0115
$\Phi(\mathbf{z}_i'\hat{\boldsymbol{\alpha}}_i)\ p_5$	-0.0067*	0.0024	0.0022†	0.0023	0.0044†	0.0050	0.0504	0.0884	-0.0235*	0.0105
$\Phi(\mathbf{z}_i'\hat{\boldsymbol{\alpha}}_i)\ p_6$	0.0050*	0.0021	0.0030‡	0.0016	0.0009	0.0044	-0.0061	0.0183	0.0027	0.0108
$\Phi(\mathbf{z}_i'\hat{\boldsymbol{\alpha}}_i)\ p_7$	-0.0072*	0.0021	-0.0011	0.0027	-0.0236*	0.0080	-0.0320	0.0333	-0.0017	0.0090
$\Phi(\mathbf{z}_i'\hat{\boldsymbol{\alpha}}_i)\ p_8$	-0.0020*	0.0007	0.0014	0.0011	-0.0036	0.0034	-0.0006	0.0036	0.0045‡	0.0025
$\Phi(\mathbf{z}_i'\hat{\boldsymbol{\alpha}}_i)\ p_9$	-0.0007*	0.0003	-0.0002	0.0002	0.0021	0.0022	0.0528	0.0738	-0.0024‡	0.0014
$\Phi(\mathbf{z}_i'\hat{\boldsymbol{\alpha}}_i)\ p_{10}$	-0.0009‡	0.0004	-0.0003	0.0004	-0.0003	0.0009	0.0035	0.0077	0.0062	0.0115
$\Phi(\mathbf{z}_i'\hat{\boldsymbol{\alpha}}_i)\ p_{11}$	-0.0007	0.0007	-0.0009	0.0007	0.0070*	0.0030	0.0208	0.0238	-0.0035	0.0055
$\Phi(\mathbf{z}_i'\hat{\boldsymbol{\alpha}}_i)\ p_{12}$	0.0005	0.0004	0.0007	0.0006	-0.0008†	0.0007	0.0192	0.0345	0.0028	0.0043
$\Phi(\mathbf{z}_i'\hat{\boldsymbol{\alpha}}_i)\ p_{13}$	-0.0014*	0.0008	0.0009	0.0011	-0.0025‡	0.0017	-0.0097†	0.0069	0.0052	0.0080
$\Phi(\mathbf{z}_i'\hat{\boldsymbol{\alpha}}_i)\ p_{14}$	-0.0002	0.0005	0.0017	0.0022	-0.0008	0.0011	0.0085	0.0202	0.0021	0.0087
$\Phi(\mathbf{z}_i'\hat{\boldsymbol{\alpha}}_i)\ p_{15}$	-0.0018†	0.0010	-0.0011	0.0009	-0.0006	0.0027	-0.0026	0.0171	-0.0043	0.0071
$\Phi(\mathbf{z}_i'\hat{\boldsymbol{\alpha}}_i)\ p_{16}$	0.0032*	0.0011	0.0014	0.0011	0.0019†	0.0014	-0.0053	0.0066	0.0090	0.0069
$\Phi(\mathbf{z}_i'\hat{\boldsymbol{\alpha}}_i)\ p_{17}$	-0.0002	0.0007	-0.0007‡	0.0004	-0.0016†	0.0010	0.0206	0.0455	-0.0009	0.0013
$\Phi(\mathbf{z}_i'\hat{\boldsymbol{\alpha}}_i)\ p_{18}$	0.0049*	0.0016	0.0021	0.0017	0.0014	0.0021	0.0162	0.0179	0.0058	0.0103
$\Phi(\mathbf{z}_i'\hat{\boldsymbol{\alpha}}_i)\ m$	-0.0003	0.0018	0.0005	0.0009	0.0010	0.0020	-0.0215	0.0410	-0.0033	0.0072
$\Phi(\mathbf{z}_i'\hat{\boldsymbol{\alpha}}_i)\ NE$	0.1933*	0.0552	0.1172*	0.0624	0.1733‡	0.1201	-0.2618	0.4762	0.9236	1.9232
$\Phi(\mathbf{z}_i'\hat{\boldsymbol{\alpha}}_i)\ NW$	0.0432	0.0487	-0.0280	0.1539	-0.0402	0.1721	-1.1865*	0.4623	1.4056	2.2352
$\Phi(\mathbf{z}_i'\hat{\boldsymbol{\alpha}}_i)\ CW$	-0.0888	0.0734	-0.0384	0.0437	-0.0149	0.0911	2.0145	4.2729	0.5291	0.7748
$\Phi(\mathbf{z}_i'\hat{\boldsymbol{\alpha}}_i)\ C$	-0.0698	0.0504	0.0683†	0.0541	0.1229	0.1251	-0.9158	0.7403	0.1874	0.3540
$\Phi(\mathbf{z}_i'\hat{\boldsymbol{\alpha}}_i)\ urban$	-0.2890*	0.0938	-0.1448†	0.0895	-0.0609	0.0614	-1.4360	2.2463	-0.2713	0.5124
$\phi(\mathbf{z}_i'\hat{\boldsymbol{\alpha}}_i)$	-0.8134*	0.2837	-0.1105	0.1768	-0.3410	0.3433	-8.2907	13.4497	-1.1200	1.9879

Note: Number of bootstrap resamples = 1,000. Bootstrap significance levels of 0.05, 0.10 and 0.20 are indicated by asterisks (*), double daggers (‡) and daggers (†) respectively.

Table 5. Marshallian Price Elasticities

Table entries are e_{ij}.

i\j	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1	-1.0270	0.1874	-0.4383	-0.1690	0.1565	-0.3042	-0.1590	0.0375	0.0174	-0.0030	-0.0186	-0.0346	-0.2778	-0.0361	0.0325	-0.1666	-0.0394	-0.6354
2	0.3941	-3.4594	-0.1164	-0.1068	0.4419	0.3923	0.3808	0.1548	-0.0236	0.0619	-0.0916	-0.0081	0.0032	0.2245	0.1064	-0.1294	-0.0950	-0.9724
3	-1.2609	0.2100	-1.7451	0.2404	1.2346	-0.5032	-3.3987	-1.0235	0.1885	0.0609	0.2369	-0.1490	-0.3109	0.0158	0.2704	0.1163	-0.1758	-0.6919
4	-1.8100	0.4889	-0.3440	-4.8186	-1.3840	0.8117	-1.5508	-0.2194	0.6108	-0.2380	0.5040	-0.7262	-0.6557	-0.4232	0.4998	-0.2088	-1.3958	1.1782
5	0.7866	-0.7295	0.0720	-0.2287	-4.4711	-1.1063	-1.6662	0.7246	-0.4432	-0.5834	0.0896	-0.1335	-0.1423	-0.5410	0.2138	0.8314	0.0147	-0.9145
6	-1.2086	-0.5236	0.0135	0.4876	-0.7959	-4.8375	0.9168	0.3153	-0.1748	-0.3171	0.0492	0.5835	0.1087	-0.4584	0.0094	0.1924	0.1516	0.3673
7	-2.4904	-0.5660	0.2482	0.1254	-1.9010	-0.8229	-15.9428	-0.2945	0.1764	-0.0677	0.6991	-1.4896	-0.2333	-0.5569	-0.3212	-0.6395	-0.4851	-0.6696
8	-0.1314	0.4929	0.3194	0.3868	1.4251	1.6971	-1.9708	-8.3019	0.6219	0.0730	0.5472	-0.4080	-0.2200	-0.3565	0.0529	-0.8650	-0.2177	0.4907
9	0.1705	-0.0911	0.1114	-0.0318	0.9794	-0.3901	0.0174	-0.1277	-1.2275	-0.6150	-0.0932	-0.3774	-0.1623	-0.2235	-0.3070	-0.3966	-0.0510	0.0536
10	0.2400	-0.7629	0.4232	-0.2591	0.1586	0.1704	-1.3375	0.1069	0.0478	-0.7832	0.2719	0.2156	0.0995	0.1305	-0.4764	0.2149	0.0845	0.4884
11	-0.3879	-0.1636	0.1905	-0.5674	1.0437	-0.8304	0.4634	0.6703	0.0787	-0.0091	-1.8406	-0.1287	-0.0014	-0.1101	-0.2771	0.3034	0.2344	0.6494
12	0.1538	-0.7593	0.0713	-1.2194	-2.2317	0.0021	0.5628	-0.3655	0.1009	-0.6053	0.0806	-3.1156	0.5946	-0.0236	-0.6132	0.2790	0.0330	0.3075
13	-0.2773	0.0030	0.0300	-0.4099	0.2920	0.3180	0.6752	-0.0566	0.0603	0.1820	-0.0051	0.1125	-1.2841	-0.1556	-0.0368	0.1865	0.0551	0.0615
14	0.3895	-0.3419	-0.2401	-0.1481	-0.0380	0.0698	-0.2241	0.0332	-0.0866	-0.2281	-0.1014	0.0320	0.0290	-1.2640	0.1768	-0.0120	-0.7013	-0.0068
15	0.0033	0.2217	0.0484	0.3276	0.7176	0.4577	-1.7283	0.1402	-2.0678	-2.6776	1.0031	0.2440	-0.1783	-0.2035	-9.1730	1.1161	-0.4770	-0.0833
16	-0.0592	0.2251	0.0547	0.1362	2.1079	0.2196	-1.7323	0.6956	0.0533	0.1333	0.2558	0.0448	0.2076	0.0365	0.1239	-1.2713	0.0404	0.1742
17	-0.0347	-0.1137	0.0638	-0.1373	0.9090	-0.6018	-1.6105	0.1549	-0.0718	0.2375	0.1125	0.0456	-0.0525	0.1371	0.2298	0.1382	-0.9825	0.6658
18	-1.0742	0.5885	-0.6597	0.1389	0.8832	0.3021	0.2106	-0.5493	0.0255	0.2046	0.4451	0.0774	-0.1591	-0.0278	0.1831	1.1353	-0.0001	-7.5997

Note: $i, j = 1, 2, \ldots, 18$, where 1 = Beefsteak, 2 = Ground Beef, 3 = Other Beef, 4 = Beef Offal, 5 = Pork Steak, 6 = Pork Leg & Shoulder, 7 = Ground Pork, 8 = Other Pork, 9 = Chorizo, 10 = Ham, Bacon & Similar Product from Beef & Pork, 11 = Beef & Pork Sausages, 12 = Other Processed Beef & Pork, 13 = Chicken Legs, Thighs & Breasts, 14 = Whole Chicken, 15 = Chicken Offal, 16 = Chicken Ham & Similar, 17 = Fish, 18 = Shellfish.

Table 6. Hicksian Price Elasticities

Table entries are e^c_{ij}.

i\j	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1	-0.8317	0.3678	-0.2734	-0.0541	0.3180	-0.1536	-0.0051	0.1874	0.1820	0.1535	0.0823	0.2024	-0.1665	0.0541	0.1123	-0.0188	0.1143	-0.3558
2	0.4311	-3.4253	-0.0851	-0.0850	0.4725	0.4208	0.4099	0.1832	0.0076	0.0915	-0.0725	0.0367	0.0242	0.2416	0.1215	-0.1014	-0.0659	-0.9194
3	-1.1835	0.2814	-1.6797	0.2860	1.2986	-0.4435	-3.3377	-0.9642	0.2537	0.1229	0.2569	-0.0550	-0.2668	0.0516	0.3020	0.1749	-0.1149	-0.5811
4	1.7919	0.5057	-0.3286	-4.8079	-1.3690	0.8257	-1.5365	-0.2055	0.6261	-0.2234	0.5134	-0.7042	-0.6453	-0.4149	0.5072	-0.1950	-1.3816	1.2042
5	0.7945	-0.7222	0.0787	-0.2241	-4.4646	-1.1003	-1.6600	0.7306	-0.4366	-0.5771	0.0937	-0.1240	-0.1378	-0.5374	0.2170	0.8374	0.0209	-0.9032
6	-1.1882	-0.5048	0.0307	0.4996	-0.7791	-4.8218	0.9328	0.3310	-0.1576	-0.3008	0.0597	0.6082	0.1203	-0.4490	0.0177	0.2078	0.1676	0.3965
7	-2.4891	-0.5648	0.2494	0.1262	-1.9000	-0.8219	-15.9417	-0.2934	0.1776	-0.0666	0.6998	-1.4879	-0.2325	-0.5563	-0.3206	-0.6385	-0.4841	-0.6676
8	-0.0883	0.5327	0.3558	0.4122	1.4607	1.7303	-1.9368	-8.2689	0.6582	0.1075	0.5695	-0.3557	-0.1954	-0.3366	0.0705	-0.8324	-0.1837	0.5525
9	0.1971	-0.0665	0.1340	-0.0162	1.0014	-0.3696	0.0384	-0.1072	-1.2050	-0.5937	-0.0795	-0.3450	-0.1471	-0.2112	-0.2961	-0.3764	-0.0301	0.0917
10	0.2692	-0.7360	0.4478	-0.2419	0.1828	0.1929	-1.3145	0.1293	0.0724	-0.7598	0.2870	0.2510	0.1160	0.1440	-0.4645	0.2370	0.1074	0.5302
11	-0.3748	0.1515	0.2016	0.5597	1.0545	-0.8204	0.4742	0.6804	0.0897	0.0014	-1.8339	-0.1129	0.0061	-0.1040	-0.2718	0.3132	0.2447	0.6681
12	0.1686	-0.7457	0.0838	-1.2107	-2.2195	0.0135	0.5745	-0.3542	0.1133	-0.5934	0.0882	-3.0977	0.6030	-0.0168	-0.6071	0.2902	0.0446	0.3286
13	-0.1127	0.1549	0.1689	-0.3130	0.4281	0.4449	0.8049	0.0697	0.1989	0.3139	0.0799	0.3123	-1.1904	-0.0795	0.0305	0.3111	0.1846	0.2972
14	0.5599	-0.1846	-0.0963	-0.0479	0.1029	0.2012	-0.0899	0.1640	0.0569	-0.0916	-0.0134	0.2387	0.1261	-1.1853	0.2465	0.1169	-0.5672	0.2371
15	0.0311	0.2473	0.0718	0.3439	0.7394	0.4791	-1.7064	0.1615	-2.0445	-2.6553	1.0175	0.2776	-0.1625	-0.1907	-9.1617	1.1371	-0.4551	-0.0436
16	-0.0401	0.2427	0.0707	0.1473	2.1236	0.2343	-1.7173	0.7102	0.0693	0.1486	0.2656	0.0679	0.2184	0.0453	0.1317	-1.2569	0.0553	0.2014
17	0.0549	-0.0310	0.1395	-0.0846	0.9832	-0.5326	-1.5399	0.2237	0.0037	0.3093	0.1588	0.1544	-0.0014	0.1785	0.2664	0.2060	-0.9119	0.7942
18	-1.0640	0.5979	-0.6511	0.1449	0.8916	0.3099	0.2186	-0.5414	0.0341	0.2128	0.4503	0.0898	-0.1533	-0.0231	0.1873	1.1430	0.0079	-7.5851

Note: $i, j = 1, 2, \ldots, 18$, where 1 = Beefsteak, 2 = Ground Beef, 3 = Other Beef, 4 = Beef Offal, 5 = Pork Steak, 6 = Pork Leg & Shoulder, 7 = Ground Pork, 8 = Other Pork, 9 = Chorizo, 10 = Ham, Bacon & Similar Product from Beef & Pork, 11 = Beef & Pork Sausages, 12 = Other Processed Beef & Pork, 13 = Chicken Legs, Thighs & Breasts, 14 = Whole Chicken, 15 = Chicken Offal, 16 = Chicken Ham & Similar, 17 = Fish, 18 = Shellfish.