Forecast and Simulation Analysis of Mexican Meat Consumption at the Table Cut Level: Impacts on U.S. Exports.

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Abstract

An analysis of current and forecasted Mexican meat consumption and imports is presented at the table cut level of disaggregation. Unlike previous studies, this study uses adult equivalence scales, a price imputation approach, a consistent censored demand system, and estimation techniques from stratified sampling. The results indicate that most Mexican consumption and imports of table cuts of meats grow at different rates. In addition, Mexico seems to be following the U.S. preferences for beef cuts, but it does not seem to be following the U.S. preferences for chicken cuts. The study may help U.S. and Canadian meat exporters in forecasting future exports to Mexico, conducting long-term meat investment decisions, or identifying trends in the consumption of specific table cuts of meats.

Key words: forecast of Mexican meat consumption, forecast of Mexican imports, U.S. meat exports to Mexico, Mexican meat demand elasticities, meat analysis at the table cut level, censored demand system, two-step estimation procedure, stratified sampling

JEL classification: Q11

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Introduction

The Mexican meat market is very important for U.S. and Canadian meat exporters because it is relatively large and rapidly expanding, it has a high preference for animal remains, and because its per capita meat consumption still remains low compared to the equivalent in the Unites States and Canada. Better understanding of Mexican meat consumption will benefit U.S. meat exporters, policy makers, and researchers to appropriately comprehend Mexicans response to price changes, current and future trends and growth rates in specific table cuts of meat, current and future structure of Mexican meat consumption, and the nature of Mexican meat preferences for table cuts of meat.

Mexico currently imports most of its meat from the United States and Canada. For instance, from 2002 to 2007, 79%, 84%, and 92% of the total volume of Mexican imports of bovine meat, swine meat, and chicken respectively, came from the United States (Figure 1, Figure 2, and Figure 3). Similarly, 15%, 14%, and 0.1% of the total volume of Mexican imports of bovine meat, swine meat, and chicken respectively, came from the Canada (Figure 1, Figure 2, and Figure 3). On the other hand, only a fraction of U.S. and Canadian meat exports go to Mexico. For instance, from 2002 to 2007, 50%, 34%, and 12% of the total volume of U.S. exports of beef and veal, swine meat, and poultry meat respectively, went to Mexico (Figure 1, Figure 2, and Figure 3). Similarly, from 2002 to 2007, 9%, 6%, and 0.2% of the total volume of Canadian exports of beef and veal, swine meat, and poultry meat respectively, went to Mexico (Figure 1, Figure 2, and Figure 3).

However, the Mexican meat market is rapidly expanding. From 1997 to 2006, Mexican swine meat imports grew 449% (United States Department of Agriculture, PSD Online Database, computed by authors). Mexican swine imports went from 82,000 MT in 1997 to 450,000 MT in 2006. Similarly, Mexican poultry meat imports more than double from 1997 to 2006 (United States Department of Agriculture, PSD Online Database, computed by authors). Mexican poultry meat imports went from 283,000 MT in 1997 to 590,000

MT in 2006. Mexican beef imports also experienced a high growth rate, 80% (United States Department of Agriculture, PSD Online Database, computed by authors). Mexican beef imports went from 203,000 MT in 1997 to 365,000 MT in 2006.

An analysis of Mexican imports by meat cuts, at 8-digit level of disaggregation of the harmonized system, reveals that the most imported bovine meat is boneless bovine meat, average share of 75%, (Mexican Ministry of Economy, SIAVI Database, computed by authors). It is followed by imports of bovine remains (average share of 22%). Imports of other bovine meat cuts with bone-in and bovine meat carcasses and halfcarcasses have average shares of only 2% and 0.3% respectively. When analyzing swine meat, the most imported cut is swine hams, shoulders and cuts thereof, with bone-in, average share of 46%, (Mexican Ministry of Economy, SIAVI Database, computed by authors). It is followed by swine remains (36%), boneless swine meat (18%) and swine meat carcasses and halfcarcasses (0.2%). Finally, the most imported chicken cut is boneless chicken, average share of 47%, (Mexican Ministry of Economy, SIAVI Database, computed by authors). It is followed by chicken legs and thighs (34%), other chicken cuts and offal (16%), and whole chicken (3%). In addition, Mexican imports of remains are greater than imports of other meat cuts. 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, the Mexican meat market is not only important because it is large and rapidly expanding, and because it has a relatively high preference for animal remains, but also because its per capita meat consumption still remains low compared to the equivalent in the United 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 2008, IFS Online Database). This suggests Mexican per capita meat consumption could continue growing and consequently Mexico could remain an important international market for years to come.

Consequently, because Mexico is a very important market for large meat exporters, the general objective of this study is to provide an in-depth analysis of Mexican meat consumption while using a theoretically sound research approach that updates Mexican meat demand elasticities. This study presents an in-depth analysis because it considers table cut of meats (i.e., beefsteak; ground beef; pork steak; ground pork; chicken legs, thighs and breast; fish, etc.) rather than meat aggregates such as beef, pork, and chicken (e.g., Erdil 2006; Malaga, Pan, and Duch-Carvallo 2006; Dong, Gould, and Kaiser 2004; Golan, Perloff, and Shen 2001; Dong and Gould 2000; Garcia Vega and Garcia 2000; Heien, Jarvis, and Perali 1989). In addition, it not only presents estimates of elasticities but also identifies trends in consumption and imports. Additionally, the study presents a theoretically sound research approach because it uses the entire target population rather than using a segment of the target population that may not be representative (e.g., Malaga, Pan, and Duch-Carvallo 2006; Dong, Gould, and Kaiser 2004; Gould et al. 2002). It also incorporates adult equivalence scales to compute the number of adult equivalents rather than ignoring (Malaga, Pan, and Duch-Carvallo 2006) or using a simple count or proportion of household members (Dong, Gould, and Kaiser 2004; Golan, Perloff, and Shen 2001). In addition, it uses a price imputation approach to account for censored prices, which 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, Perloff, and Shen 2001; Dong, Shonkwiler, and Capps 1998). It uses a consistent censored demand system estimated in two steps to account for censored quantities. Finally, it incorporates estimation techniques from stratified sampling into the analysis because the data sample is not a simple random sample.

Data

Mexican data on household income and expenditures was obtained from *Encuesta Nacional de Ingresos y Gastos de los Hogares (ENIGH) (2006)*, which is a nation-wide survey ecompassing Mexico's 31 states plus one Federal District (a territory which belongs to all states). ENIGH is a *cross-sectional data* sample 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, Jarvis, and Perali 1989); however, this study only uses the 2006 survey. 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]

Because ENIGH records food consumption only when households make a purchase and because the collection period from each household is only one week, missing observations on many meat cuts are generated as a result. Consequently, in ENIGH 2006, price and quantity are censored for the meat cuts that the households did not buy during the week of interview. This generates a missing price and a zero quantity for the meat cuts that the household did not buy during the week of interview. Price is censored because for the meat cuts that the household did not buy during the week of interview, the price that households would have been willing to pay is not known. Quantity is censored because for the meat cuts that the households did not buy during the week of interview, it is not known whether the household did not have a chance to buy or if they never buy those meat cuts.

To solve the problem of censored prices (i.e., observations with missing prices), similar to Malaga, Pan, and Duch-Carvallo (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 a constant, total household income per month, education level of the household decision maker, regional dummy variables,

stratum dummy variables, the number of adult equivalent, 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, Perloff, and Shen 2001, p. 545 and Dong, Shonkwiler, and Capps 1998, p. 1099).[2] Table 1 shows the number of non-missing 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.[3] The mean before price imputation uses only non-missing observations to compute the average while the mean after price imputation uses both non-missing observations and imputed (missing) observations. Finally, the high number of censored observations is common in household surveys where meat is analyzed at the disaggregated level (see Taylor, Phaneuf, and Piggott 2008) and, in some cases, even when meat is analyzed at the aggregated level (see Golan, Perloff, and Shen 2001; Dong, Shonkwiler, and Capps 1998).

Table 2 reports the average per capita consumption per week (kg) of the eighteen meat cuts considered in this study when including and excluding the zero observations. To solve the problem of censored quantities (i.e., observations with zero quantities) this study uses a censored regression model. In addition, this study incorporates 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). However, 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. 2008 or a brief review provided in Lopez 2008, p. 108).

Besides taking into account censored observations, this study uses the number of adult equivalents rather than ignoring (Malaga, Pan, and Duch-Carvallo 2006) or using a simple count or proportion of household members (Dong, Gould, and Kaiser 2004; Golan, Perloff, and Shen 2001). 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 gender 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 per household cannot be directly compared without computing per adult-equivalent meat consumption because the age and gender of each household member as well as the total number of members increases or decreases the consumption per household. 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, Capps, and Havlicek (1986) to compute the number of adult equivalents and then compute per capita meat consumption (i.e., per adult-equivalent consumption).

Finally, 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). ENIGH is a survey of household incomes and expenditures. If ENIGH applies a stratified sampling technique is probably because they think households in the same stratum tend to be more similar than randomly selected elements from the whole population. Consequently, precision could be increased by a using a stratified sample to analyze household expenditures (e.g., meat consumption). Furthermore, ENIGH recommends incorporating stratification variables when using the data (Instituto Nacional de Estadística y Geografía , personal communication).

Previous studies on Mexican meat demand (Malaga, Pan, and Duch-Carvallo 2006; Dong, Gould, and Kaiser 2004; Gould et al. 2002; Gould and Villarreal 2002; Golan, Perloff, and Shen 2001; Sabates, Gould, and Villarreal 2001; Garcia Vega and Garcia 2000; Heien, Jarvis, and Perali 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).

This study implemented the DuMouchel and Duncan's (1983) test to investigate further about the importance of incorporating stratification variables into the analysis. DuMouchel and Duncan (1983, p. 538) recommend that the data passes this test before using the unweighted estimator over the weighted estimator. In DuMouchel and Duncan's (1983) test, the null hypothesis favors the use of the unweighted estimator while the alternative hypothesis favors the use of the weighted estimator (DuMouchel and Duncan 1983, p. 539).

DuMouchel and Duncan's (1983) test is implemented by performing an F test for $\gamma = 0$ in the following regression model estimated by ordinary least squares,

$$(1) \qquad \mathbf{Y} = \mathbf{X}\alpha + \mathbf{W}\mathbf{X}\gamma + \varepsilon,$$

where $\mathbf{Y}$ is a $(n \times 1)$ vector of observations in the dependent variable, $\mathbf{X}$ is a $(n \times p)$ matrix of observations in the independent variables, $\mathbf{W}$ is a $(n \times n)$ diagonal matrix whose i^{th} diagonal element is the sample weight w_i, α and γ are vector of parameters, ε is a random error with $E(\varepsilon) = 0$ and $\text{var}(\varepsilon) = \sigma^2 \mathbf{I}_n$, and $\mathbf{Z} = \mathbf{W}\mathbf{X}$, where the columns of $\mathbf{Z}$ are further (perhaps unobserved) predictors that should have been included in the regression but were not.

The F test statistic (following "Method A" in DuMouchel and Duncan 1983, p. 539) is

$$F_{p,(n-p)} = \frac{(\mathrm{ESS}_R - \mathrm{ESS}_{UR})/p}{\mathrm{ESS}_{UR}/(n-p)}, \quad (2)$$

where $\mathrm{ESS}_R = (\mathbf{Y} - \mathbf{X}\hat{\alpha})'(\mathbf{Y} - \mathbf{X}\hat{\alpha})$ and $\mathrm{ESS}_{UR} = (\mathbf{Y} - \mathbf{X}\hat{\alpha} - \mathbf{Z}\hat{\gamma})'(\mathbf{Y} - \mathbf{X}\hat{\alpha} - \mathbf{Z}\hat{\gamma})$.

Table 3 shows the result from eighteen DuMouchel and Duncan's (1983) tests that were performed (one test at a time) by using as dependent variables q_i, $i = 1, 2, \ldots, 18$, and as independent variables a constant, p_1, p_2, ..., p_{18}, m, *NE*, *NW*, *CW*, *C*, and *urban*. At the 0.05 significance level, sixteen out of eighteen tests reject the null hypothesis of using the unweighted estimator. Consequently, it is important to incorporate stratification variables into the analysis to analyze ENIGH as a stratified sample.

To perform the forecasts and simulation analysis, additional data was obtained from International Monetary Fund (2008), IFS Online Database; FAPRI (2008); and FAPRI (2009b). Data on Mexican GDP, Mexican GDP deflator, Mexican population, exchange rate (pesos/dollar), and U.S. GDP deflator for the period 2006-2008 was obtained from International Monetary Fund (2008), IFS Online Database. Data on Mexican real GDP growth projection, Mexican population growth projection, Mexican nominal exchange rate growth projection, U.S. GDP deflator growth projection, and Mexican GDP deflator growth projection for the year 2007 and the period 2008-2018 was obtained from FAPRI (2008) and (2009b) respectively. This information was used to obtain the Mexican per household real GDP growth projection and the Mexican real exchange rate growth projection.

Model

The eighteen table cuts considered in this study are 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; other processed beef and pork (shredded meat, pork skin/chicharron, crushed and dried meats, stuffing, smoked/dried meat, etc.); chicken legs, thighs and breasts (with bone and boneless); whole chicken; chicken offal (wings, head, neck, gizzard, liver, etc.); chicken ham & similar products (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 ray, ell, fish/crustaceous eggs, etc.); and shellfish (fresh shrimp, clam, crab, oyster, octopus, and processed shrimp). Hence, we would like to estimate a censored system of eighteen equations ($M = 18$), using the two-step estimation of a censored demand system proposed by Shonkwiler and Yen (1999), but incorporating stratification variables into the estimation procedure. Each equation contains $K_1 + K_2 = 25 + 25 = 50$ regression coefficients and a data sample of $T = 16,909$ observations for each equation.

The i^{th} equation of the t^{th} household, in the censored system, can be written as (see Shonkwiler and Yen 1999)

$$(3) \quad q_i(t) = \Phi[\mathbf{z}_i'(t)\alpha_i]\mathbf{x}_i'(t)\beta_i + \delta_i\phi[\mathbf{z}_i'(t)\alpha_i] + \xi_i(t), \quad i = 1,\ldots,18,$$

where $q_i(t)$ is a (1×1) observed dependent variable; $\Phi[\mathbf{z}_i'(t)\alpha_i]$ is the standard normal cumulative distribution function (cdf) evaluated at $\mathbf{z}_i'(t)\alpha_i$, which is a (1×1) scalar; $\phi[\mathbf{z}_i(t)'\alpha_i]$ is the standard normal probability density function (pdf) evaluated at $\mathbf{z}_i'(t)\alpha_i$, which is a (1×1) scalar;

$$\begin{aligned} \mathbf{z}_i'(t) &= \begin{pmatrix} z_{i1}(t) & z_{i2}(t) & \ldots & z_{iK_1}(t) \end{pmatrix} \\ &= \begin{pmatrix} 1 & p_1(t) & \ldots & p_{18}(t) & m(t) & NE(t) & NW(t) & CW(t) & C(t) & urban(t) \end{pmatrix} \end{aligned}$$

is $(1 \times K_1) = (1 \times 25)$ vector of explanatory variables;

$$\begin{aligned} \mathbf{x}_i'(t) &= \begin{pmatrix} x_{i1}(t) & x_{i2}(t) & \dots & x_{iK_2}(t) \end{pmatrix} \\ &= \begin{pmatrix} 1 & p_1(t) & \dots & p_{18}(t) & m(t) & NE(t) & NW(t) & CW(t) & C(t) & urban(t) \end{pmatrix} \end{aligned}$$

is $(1 \times K_2) = (1 \times 25)$ vector of explanatory variables; $\alpha_i = \begin{pmatrix} \alpha_{i1} & \alpha_{i2} & \dots & \alpha_{iK_1} \end{pmatrix}'$ is a $(K_1 \times 1) = (25 \times 1)$ vector of parameters; $\beta_i = \begin{pmatrix} \beta_{i1} & \beta_{i2} & \dots & \beta_{iK_2} \end{pmatrix}'$ is a $(K_2 \times 1) = (25 \times 1)$ vector of parameters; δ_i is a (1×1) parameter; and $\xi_i(t)$ is a (1×1) random error. In addition, $q_1(t)$, $q_2(t)$, ..., $q_{18}(t)$ are (1×1) observations on per capita consumption in kilograms (kg) of beefsteak, ground beef, ..., and shellfish respectively; $p_1(t)$, $p_2(t)$, ..., $p_{18}(t)$ are (1×1) observations on the nominal price in Mexican pesos per kilogram (nominal pesos/kg) of beefsteak, ground beef, ..., and shellfish respectively; $m(t)$ is a (1×1) observation on total per capita expenditure on all meat cuts (beefsteak, ground beef, ..., and shellfish) in Mexican pesos (nominal pesos); *NE*(t), *NW*(t), *CW*(t), *C*(t), and *SE*(t) are (1×1) observations from regional dummy (or zero-one) variables taking the value of "1" if the observation belongs to the Northeast, Northwest, Central-West, Central or Southeast region respectively, "0" otherwise; and *urban*(t) and *rural*(t) are (1×1) observations from urbanization level dummy variables, which take the value of "1" if the observation belongs to the urban or rural sector respectively, "0" otherwise. Additionally, note that the omitted observations are *SE*(t) and *rural*(t). This is necessary to avoid perfect multicollinearity.

Equation (3) is estimated in two steps. First, we obtain maximum-likelihood probit estimates $\hat{\alpha}_i$ of α_i for $i = 1, 2, \dots, 18$ using the binary dependent variable $d_i(t) = 1$ if $q_i(t) > 0$ and $d_i(t) = 0$ otherwise. That is, estimate the following probit models by maximum likelihood

$$(4) \quad P[d_i(t) = 1 | \mathbf{z}_i(t)] = \Phi[\mathbf{z}_i'(t)\alpha_i], \quad i = 1, \dots, 18.$$

However, to incorporate the stratification variable *wgt* into the analysis, we multiply "the contribution of each observation to the likelihood function... by the value of the weight variable" (SAS Institute Inc. 2004, p. 3754).

Second, calculate $\Phi[\mathbf{z}_i'(t)\hat{\alpha}_i]$ and $\phi[\mathbf{z}_i'(t)\hat{\alpha}_i]$ and estimate β_1, β_2, …, β_M, δ_1, δ_2, …, δ_M in the system,

$$(5) \quad q_i(t) = \Phi[\mathbf{z}_i'(t)\hat{\alpha}_i]\mathbf{x}_i'(t)\beta_i + \delta_i\phi[\mathbf{z}_i'(t)\hat{\alpha}_i] + \xi_i(t), \quad i = 1,\ldots,18,$$

by seemingly unrelated regression (SUR) procedure. That is, apply the procedure explained by Zellner (1962) to obtain SUR estimates $\hat{\beta}_i$ and $\hat{\delta}_i$ of β_i and δ_i respectively for $i = 1,2,\ldots,18$.[4] However, since in stratified samples the weighted estimator is consistent (Wooldridge 2001, p. 464), all observations need to be weighted by the weight variable prior to estimation. "[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 are estimated by applying the bootstrap procedure in SAS software. The bootstrap is a resampling method that can be used to estimate standard errors of parameter estimates when other estimation methods are inappropriate or not feasible. Finally, in the second step, the estimation of the system of censored demand equations needs to be based on the full system of $M = 18$ equations because the parametric restriction of adding-up is not imposed in the model (see also Yen, Kan, and Su 2002, p. 1801).

Subsequently, the unconditional means of $q_i(t)$, $i = 1,2,\ldots,18$, are estimated by

$$(6) \quad \hat{q}_i(t) = \Phi[\mathbf{z}_i'(t)\hat{\alpha}_i]\mathbf{x}_i'(t)\hat{\beta}_i + \hat{\delta}_i\phi[\mathbf{z}_i'(t)\hat{\alpha}_i], \quad i = 1,\ldots,18.$$

Differentiating the unconditional mean (Equation (6)) with respect to a common variable in $\mathbf{x}_i(t)$ and $\mathbf{z}_i(t)$, say $x_{ij}(t)$, gives

$$(7) \qquad \frac{\partial \hat{q}_i(t)}{\partial x_{ij}} = \Phi(\mathbf{z}_i'(t)\hat{\alpha}_i)\hat{\beta}_{ij} + \mathbf{x}_i'(t)\hat{\beta}_i\phi(\mathbf{z}_i'(t)\hat{\alpha}_i)\hat{\alpha}_{ij} - \hat{\delta}_i(\mathbf{z}_i'(t)\hat{\alpha}_i)\phi(\mathbf{z}_i'(t)\hat{\alpha}_i)\hat{\alpha}_{ij}.$$

Then, uncompensated or Marshallian price elasticities, meat expenditure elasticities, and artificial elasticities for binary variables[5] are respectively estimated by (see Yen, Kan, and Su 2002),

$$\begin{aligned}
\hat{e}_{i(j-1)}(t) &= \frac{\partial \hat{q}_i(t)}{\partial x_{ij}} \times \frac{x_{ij}(t)}{\hat{q}_i(t)}, \quad i = 1,\ldots,18, \quad j = 2,\ldots,19, \\
\hat{e}_i(t) &= \frac{\partial \hat{q}_i(t)}{\partial x_{ij}} \times \frac{x_{ij}(t)}{\hat{q}_i(t)}, \quad i = 1,\ldots,18, \quad j = 20, \\
\hat{e}_{ij}(t) &= \frac{\partial \hat{q}_i(t)}{\partial x_{ij}} \times \frac{x_{ij}(t)}{\hat{q}_i(t)}, \quad i = 1,\ldots,18, \quad j = 21,\ldots,25.
\end{aligned}$$

These elasticities need to be evaluated using sample means of explanatory variables.[6] However, the elasticity of commodity i with respect to a binary is "not strictly defined... [but] allow convenient assessment of the significance of corresponding variables in a complex functional relationship" (Su and Yen 2000, p. 736).

Once elasticities are evaluated using sample means of explanatory variables, they can be used to perform the forecasts and simulation analysis. However, to better estimate the effect of real per household income on Mexican meat consumption and imports, expenditure elasticities are transformed into income elasticities as follows

$$(8) \qquad \hat{\eta}_i(t) = e_i(t)\frac{\partial m(t)}{\partial inc(t)}\frac{inc(t)}{m(t)}.$$

To estimate $\frac{\partial m(t)}{\partial inc(t)}$, this study regressed total per capita expenditure per week on a constant and total household income per week.

Results and Projections

Table 4 depicts the estimates of the Marshallian own-price and cross-price elasticities.[7] Observe that the expected negative sign was obtained for all Marshallian own-price

elasticities. In addition, there are slightly more positive cross-price elasticities (160) than negative cross-price elasticities (146). A positive cross-price elasticity suggests a case of substitutes meat cuts while a negative cross-price elasticity suggest a case of complement meat cuts. For example, cases of (gross) substitutes include beefsteak and pork steak, and vice versa (i.e., $\hat{e}_{0105}$ and $\hat{e}_{0501}$); beef offal and chicken offal, and vice versa (i.e., $\hat{e}_{0415}$ and $\hat{e}_{1504}$); and ham, bacon & similar beef & pork products and chicken ham & similar products, and vice versa (i.e., $\hat{e}_{1016}$ and $\hat{e}_{1610}$). Similarly, examples of (gross) complementarity include beefsteak and other beef, and vice versa (i.e., $\hat{e}_{0103}$ and $\hat{e}_{0301}$); pork steak and pork leg & shoulder, and vice versa (i.e., $\hat{e}_{0506}$ and $\hat{e}_{0605}$); and whole chicken is a (gross and net) substitute of chicken legs, thighs & breasts, but not vice versa (i.e., $\hat{e}_{1314}$ but not $\hat{e}_{1413}$).

Estimates of elasticities at the table-cut level of disaggregation are currently not available for Mexico. Therefore, only an indirect comparison is possible. However, when comparing elasticities, it important to remember that model functional forms, sample sizes, time period under consideration, and underlying assumptions influence elasticities to differ from one study to another. In general, disaggregating elasticities allowed this study to further identify cases of gross substitutability and complementarity within the traditional categories (i.e., beef, pork, chicken, and fish).

For example, the *Marshallian beef-beef elasticity* in previous studies ranges from -1.4300 in Malaga, Pan, and Duch-Carvallo (2006) to -0.4610 in Erdil (2006). However, in this study, there are sixteen Marshallian beef-beef elasticities ($\hat{e}_{ij}$, $i, j = 1,2,3,4$) and most of their values range from $\hat{e}_{0401} = -1.8100$ (excluding $\hat{e}_{0404} = -4.8186$ and $\hat{e}_{0202} = -3.4594$ whose values are much lower than the other estimates) to $\hat{e}_{0402} = 0.4889$ (Table 4). The *Marshallian beef-pork elasticity* in previous studies range from -0.1014 in Dong, Gould, and Kaiser (2004) to 0.0300 in Malaga, Pan, and Duch-Carvallo (2006). In contrast, Marshallian beef-pork price elasticities in Table 4 ($\hat{e}_{ij}$, $i = 1,2,3,4$, $j = 5,6,7,8$) range from $\hat{e}_{0407} = -1.5508$ (excluding $\hat{e}_{0307} = -3.3987$ whose value is much lower than

the other estimates) to $\hat{e}_{0406} = 0.8117$ (excluding $\hat{e}_{0305} = 1.2346$ whose value is much higher than the other estimates). The *Marshallian beef-chicken* elasticity in previous studies ranges from 0.0680 in Dong, Gould, and Kaiser (2004) to 0.2700 in Malaga, Pan, and Duch-Carvallo (2006). Similarly, the sixteen beef-chicken elasticities ($\hat{e}_{ij}$, $i = 1,2,3,4$, $j = 13,14,15,16$) in Table 4 have a slightly wider range of values. The minimum beef-chicken elasticity value is $\hat{e}_{0413} = -0.6557$ and the maximum beef-chicken elasticity value is $\hat{e}_{0415} = 0.4998$ (Table 4). In general, disaggregating elasticities allowed this study to further identify cases of gross substitutability and complementarity within traditional categories (i.e., beef, pork, chicken, and fish). Furthermore, it was found that within a specific category, usually there are as many negative elasticities as there are positive elasticities. All these findings allow to understand better the Mexican meat consumption.

Table 5 and Table 6 present the expenditure and income elasticities. All expenditure and income elasticities have the expected positive sign, which means that all the meat cuts are normal goods and that consumption on all meat cuts is expected to increase as the economy grows. Additionally, since all the expenditure and income 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 (Table 5). Likewise, the income elasticities ranges from 0.1245 for ground pork to 0.6563 for beefsteak (Table 6). In general, most pork cuts elasticities have a lower value (therefore more necessary goods) than must beef cuts elasticities and chicken cuts elasticities, except for processed beef & pork (i.e., chorizo; ham, bacon & similar; beef & pork sausages; and other processed beef & pork).

The income elasticities combined with the Mexican per household real GDP growth projection allows to forecast the Mexican per capita consumption by meat cut. Then, the per capita consumption by meat cut combined with the Mexican population projection allow to forecast the total Mexican consumption by meat cut (Figure 4, Figure 5 and

Figure 6). The consumption of beef and veal, pork, and broiler by FAPRI, which is illustrated in Figure 4, Figure 5 and Figure 6 respectively, are the projections reported in FAPRI (2009b, p. 342) and FAPRI (2009a). On the other hand, the consumption of beef, pork and chicken (q_{beef}, q_{pork}, and $q_{chicken}$) in Figure 4, Figure 5 and Figure 6, are the projections obtained in this study (using FAPRI (2009b) baseline assumptions). The projections q_{beef}, q_{pork}, and $q_{chicken}$ are obtained from the sum of the corresponding meat cuts. That is, $q_{beef} = \sum_{i=1}^{4} q_i$, $q_{pork} = \sum_{i=5}^{8} q_i$, $q_{chicken} = \sum_{i=13}^{16} q_i$. The index is computed by dividing all values in a series by its value in year 2006. Consequently, the index shows the growth rate from year 2006 to any year.

Our results in Panel (a) of Figure 4 indicate that Mexican beef consumption is expected to be greater than the values predicted by FAPRI (2009b, p. 342). In addition, beefsteak is expected to continue to be the most consumed beef cut, followed by other beef, ground beef and beef offal. Furthermore, Panel (b) in Figure 4 shows that beefsteak consumption is expected to be the fastest growing beef cut (2006-2018 growth rate of 41%), while ground beef consumption is expected to be the slowest growing beef cut (2006-2018 growth rate of 28%), and other beef and beef offal consumption are expected to have growth rates of 34% and 31% repectively. This indicates that Mexican beef consumption seems to be following the U.S. preferences for beef cuts, where the most expensive meat is consumed the most (i.e., beefsteak) and the cheapest meat is consumed the least (i.e., beef offal).

In the case of Mexican pork consumption (Figure 5), pork leg & shoulder is expected to continue to be the most consumed pork cut (Panel (a)), but the second fastest growing pork cut (Panel (b)). In addition, pork leg & shoulder (q_6) is expected to grow at the same rate as the total pork consumption (q_{pork}). The other three pork cuts considered, whose consumption is far much lower than the consumption of pork leg & shoulder (Panel (a)), are expected to grow at different growth rates (Panel (b)). The most rapidly growing is

expected to be other pork (2006-2018 growth rate of 29%) and the slowest growing is expected to be ground pork (2006-2018 growth rate of 18%).

In the case of chicken (Figure 6), the consumption of chicken offal, whole chicken, and chicken legs, thighs & breasts are expected to be about the same (Panel (a)) and to grow at about the same rate, 2006-2018 growth rate of 15% (Panel (b)). Hence, unlike the case of beef consumption, Mexican chicken consumption does not seem to be following the U.S. preferences for chicken cuts, where there is high preference for chicken breasts and low preference for chicken offal. Finally, chicken ham & similar products, which is consumed at the lowest level (Panel (a)), is also expected to grow at the lowest rate (Panel (b)). Finally, our results indicate that chicken consumption is expected to be lower than what is predicted by FAPRI (2009b, p. 342).

Now, the income and the Marshallian own-price elasticities combined with the Mexican per household real GDP growth projection and the real exchange rate growth projection allow to forecast total Mexican imports by meat cut. Because Mexican imports of beef and pork are currently not reported by meat cut, this studies assumes the structure of the Mexican beef and pork consumption by meat cut is the same as the structure of the Mexican beef and pork imports by meat cut (i.e., assuming the import structure is the same as the consumption structure that is obtained from column six of Table 2). Even though this is a strong assumption that may not represent the current situation, this information is known by U.S. meat exporters. Consequently, the analysis for beef and pork imports by meat cuts could be easily modified with the real structure. In the case of chicken, however, it is possible to recover the import structure of three of the meat cuts used in this study. That is, of the total Mexican imports of chicken in 2006, approximately 82.41% are chicken legs, thighs & breast; 8.11% is whole chicken; and 9.48% is chicken offal (Mexican Ministry of Economy, SIAVI Database, computed by authors; see also Lopez and Malaga 2009, p. 21).

Similar to the consumption analysis, imports of beef and veal, pork and broiler by FAPRI in Figure 7, Figure 8 and Figure 9 respectively, are the projections reported in FAPRI (2009b, pp. 325, 327, and 329) and FAPRI (2009a); while q_{beef}, q_{pork}, and $q_{chicken}$ are the projections obtained in this study (using FAPRI (2009b) baseline assumptions). The projections q_{beef}, q_{pork}, and $q_{chicken}$ are obtained from the sum of the corresponding meat cut imports. The index shows the growth rate from year 2006 to any year.

The Mexican beef imports projections presented in this study are very similar to FAPRI (2009b, p. 325) projections from 2006 to 2014 but slightly lower (about 7%) from 2015 to 2018 (Panel (a) in Figure 7). On the contrary, the Mexican pork import projections in this study are moderately greater than FAPRI (2009b, p. 327) projections from 2006 to 2009 (about 9%), widely greater from 2010 to 2014 (about 38%), and slightly lower from 2015 to 2018 (about 3%), Panel (a) in Figure 8. Finally, the Mexican chicken imports in this study are moderately greater than FAPRI (2009b, p. 329) projections from 2006-2009 (about 13%), and gradually becoming more different from 2011 to 2018 (1% in 2011 to 18% in 2018), Panel (a) in Figure 9. However, this study has the advantage that it reports import projections and growth rates of the different table cuts of meats.

In the case of Mexican chicken imports (Figure 9), chicken legs, thighs & breasts is the most imported chicken cut (Panel (a)), but the fastest growing chicken cut is chicken offal (Panel (b)). The 2006-2018 import growth rate of chicken offal is 77%, while for whole chicken and chicken legs, thighs & breasts the import growth rates are 25%. In addition, chicken offal imports experiences a volatile growth rate while whole chicken and chicken legs, thighs & breasts imports presents a smoother growth rate.

Conclusion and Discussion

Previous Mexican meat demand studies 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.). On the contrary, this study presents an analysis at the table cut level of disaggregation. Our results indicate that Mexican consumption of table cuts of meats grow at different rates within each meat category (except for the chicken category where only chicken ham & similar products has a lower growth rate). Similarly, it was found that Mexican imports of table cuts of meats grow at different rates.

For example, Mexican consumption of beefsteak is the fastest growing but consumption of pork steak is not. On the contrary, Mexican consumption of ground beef and ground pork are the slowest growing. In addition, Mexican consumption of processed meat (chorizo, ham & bacon & similar products from beef & pork, beef & pork sausages, other processed beef & pork, and chicken ham & similar products) is neither the fastest growing nor the slowest growing. Furthermore, our results indicate that Mexico seems to be following the U.S. preferences for beef cuts, but it does not seem to be following the U.S. preferences for chicken cuts. However, this does not mean that Mexican imports of chicken legs, thighs and breast will not continue growing. In fact, Mexican imports of chicken legs, thighs and breast are expected to continue to be the most imported chicken cuts.

Therefore, it would be more appropriate and useful to perform an analysis of Mexican meat consumption at the table cut level. In addition, projections may be more precise if meat cuts, instead of aggregated categories, are considered. However, much effort is needed to keep record of imports and exports at the table cut level. The current categories of the harmonized system (specially in the case of beef and pork) does not allow to analyze imports and exports of meat at the table cut level. Consequently, this study assumed that the structure of the Mexican beef and pork consumption by meat cut is the same as the structure of the Mexican beef and pork imports by meat cut.

Large U.S. and Canadian exporting companies, which already known how much of each meat cut they export to Mexico, will benefit from this study. In particular, this study

may help in forecasting future exports to Mexico, conducting long-term meat investment decisions, or identifying trends in specific table cuts of meats. However, it is important to understand that this analysis is based on elasticity estimates and FAPRI baseline assumptions. A sensitivity analysis based on FAPRI baseline assumptions could be performed to evaluate how Mexican consumption and imports of table cuts of meats change.

Notes

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

[2]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 values.

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

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

[5]Artificial elasticities are obtained by treating binary variables are as continuous variables.

[6]Since the data sample used in this study (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).

[7]Maximum-likelihood parameter estimates from univariate probit regressions (step 1), SUR parameter estimates from the system of equation (step 2), and Hicksian price elasticities are available at Lopez and Malaga (2009) or upon request.

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Figures

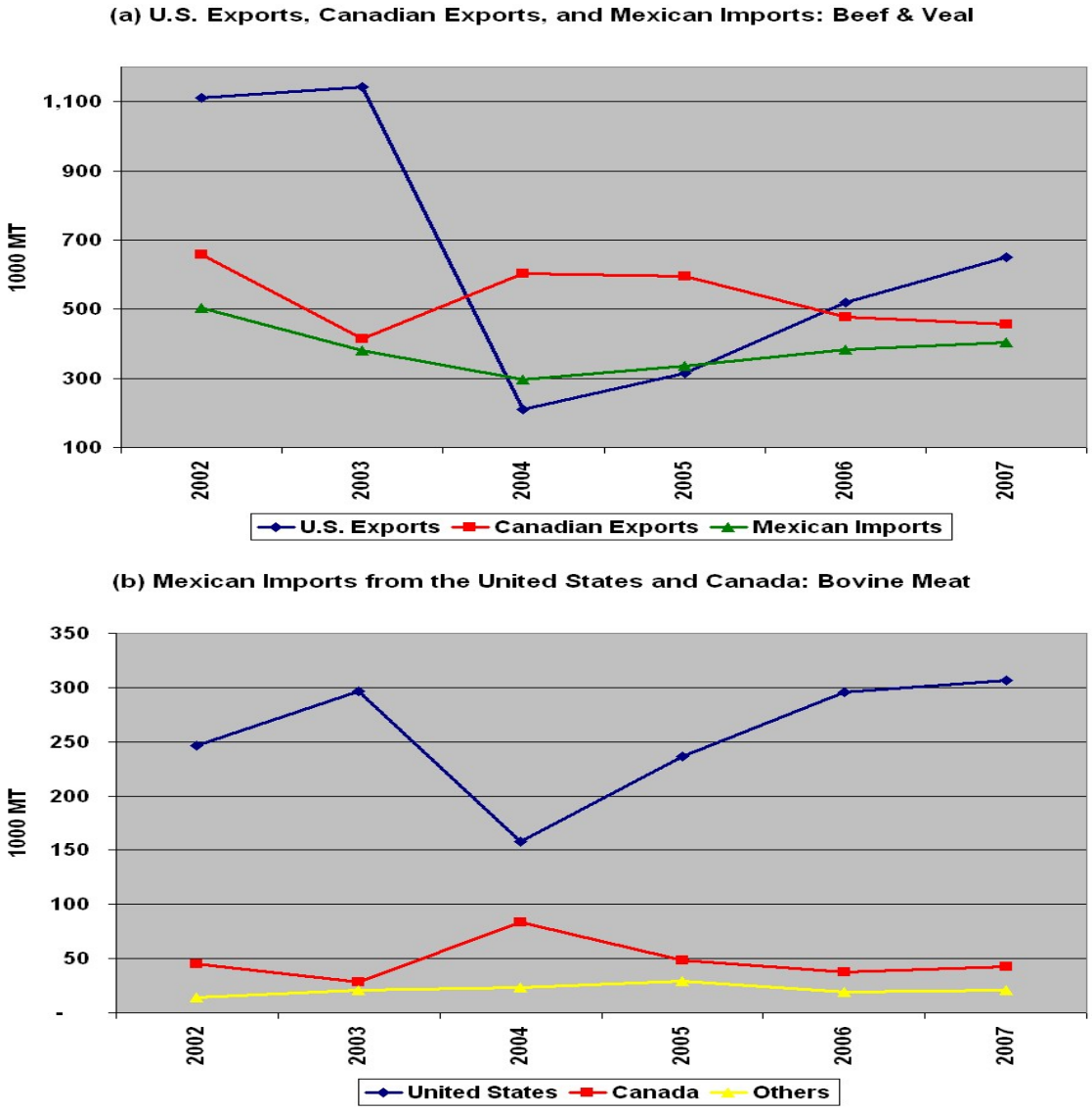

Figure 1. Bovine Meat Trade

Note: Series in Panel (b) were computed from chapter 2 (meat and edible meat offal) of the Harmonized System. Bovine meat is the sum of bovine meat carcasses and halfcarcasses, other bovine meat cuts with bone-in, boneless bovine meat and bovine remains. At the 8-digit level of disaggregation, bovine meat carcasses and halfcarcasses include commodities 02011001 and 02021001. Other bovine meat cuts with bone-in include 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 (January to December) except for 2002, which was reported from April to December.

Source: Panel (a) from USDA-ERS-PSD Online Database. Panel (b) from Mexican Ministry of Economy, SIAVI Database. Charts computed by authors.

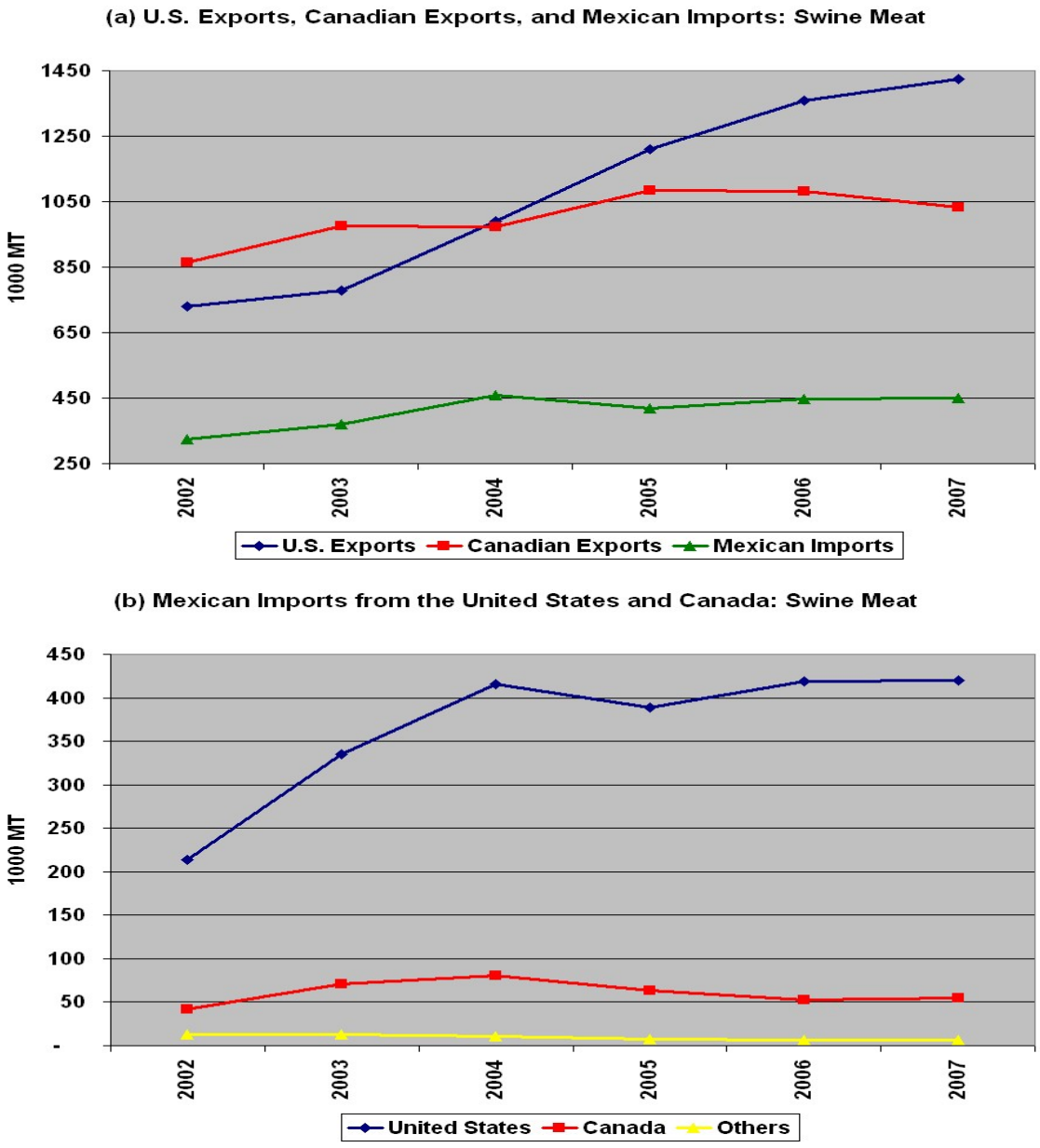

Figure 2. Swine Meat Trade

Note: Series in Panel (b) were computed from chapter 2 (meat and edible meat offal) of the Harmonized System. Swine meat is the sum of swine carcasses and halfcarcasses; swine hams, shoulders and cuts thereof, with bone-in; boneless swine meat; and swine remains. At the 8-digit level of disaggregation, swine meat carcasses and halfcarcasses 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 (January to December) except for 2002, which was reported from April to December.

Source: Panel (a) from USDA-ERS-PSD Online Database. Panel (b) from Mexican Ministry of Economy, SIAVI Database. Charts computed by authors.

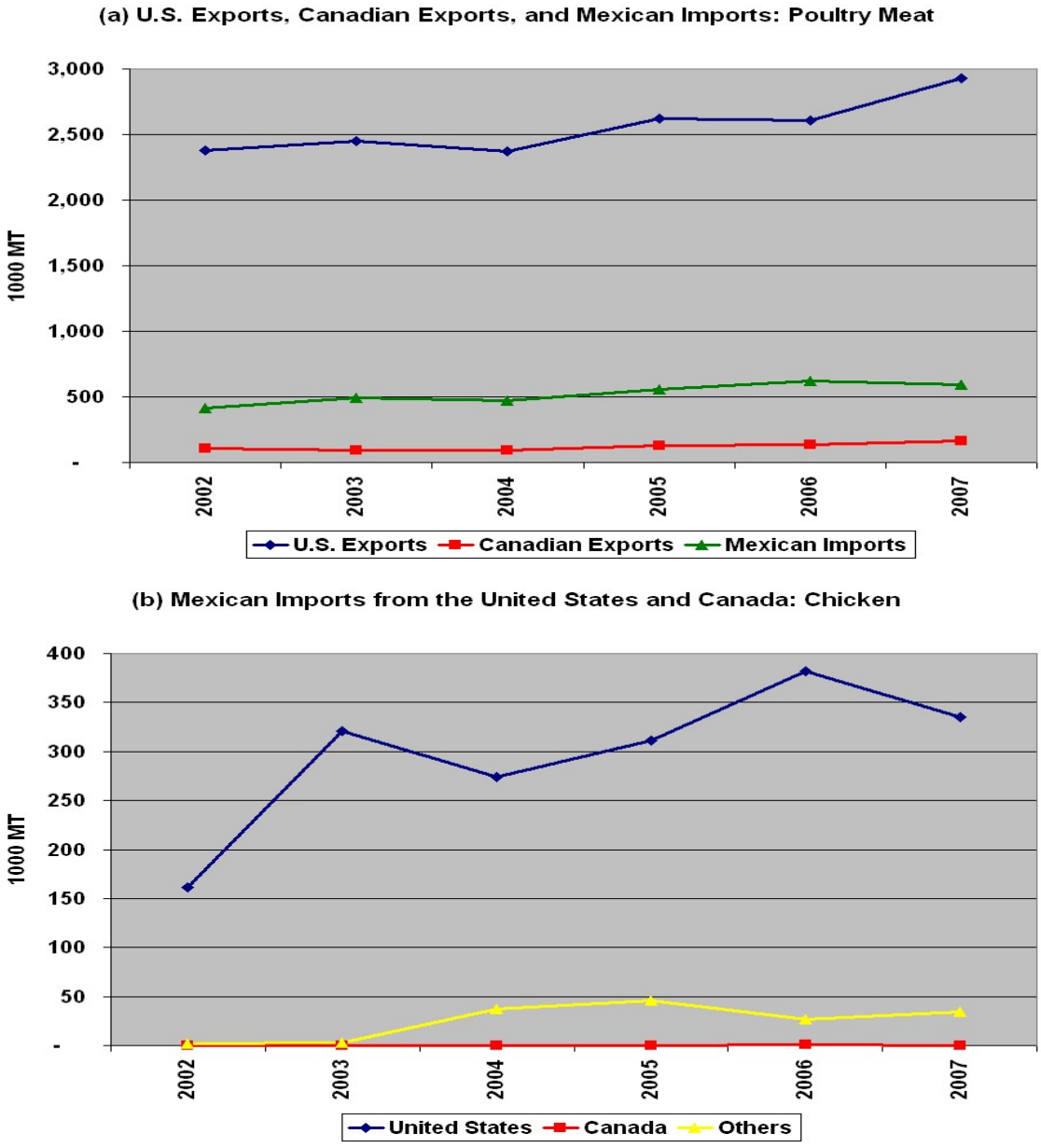

Figure 3. Chicken Trade

Note: Series in Panel (b) were computed from chapter 2 (meat and edible meat offal) of the Harmonized System. Chicken is the sum of whole chicken, boneless chicken, chicken legs and thighs, and other chicken cuts and offal. At the 8-digit level of disaggregation, whole chicken includes 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 (January to December) except for 2002, which was reported from April to December.

Source: Panel (a) from USDA-ERS-PSD Online Database. Panel (b) from Mexican Ministry of Economy, SIAVI Database. Charts computed by authors.

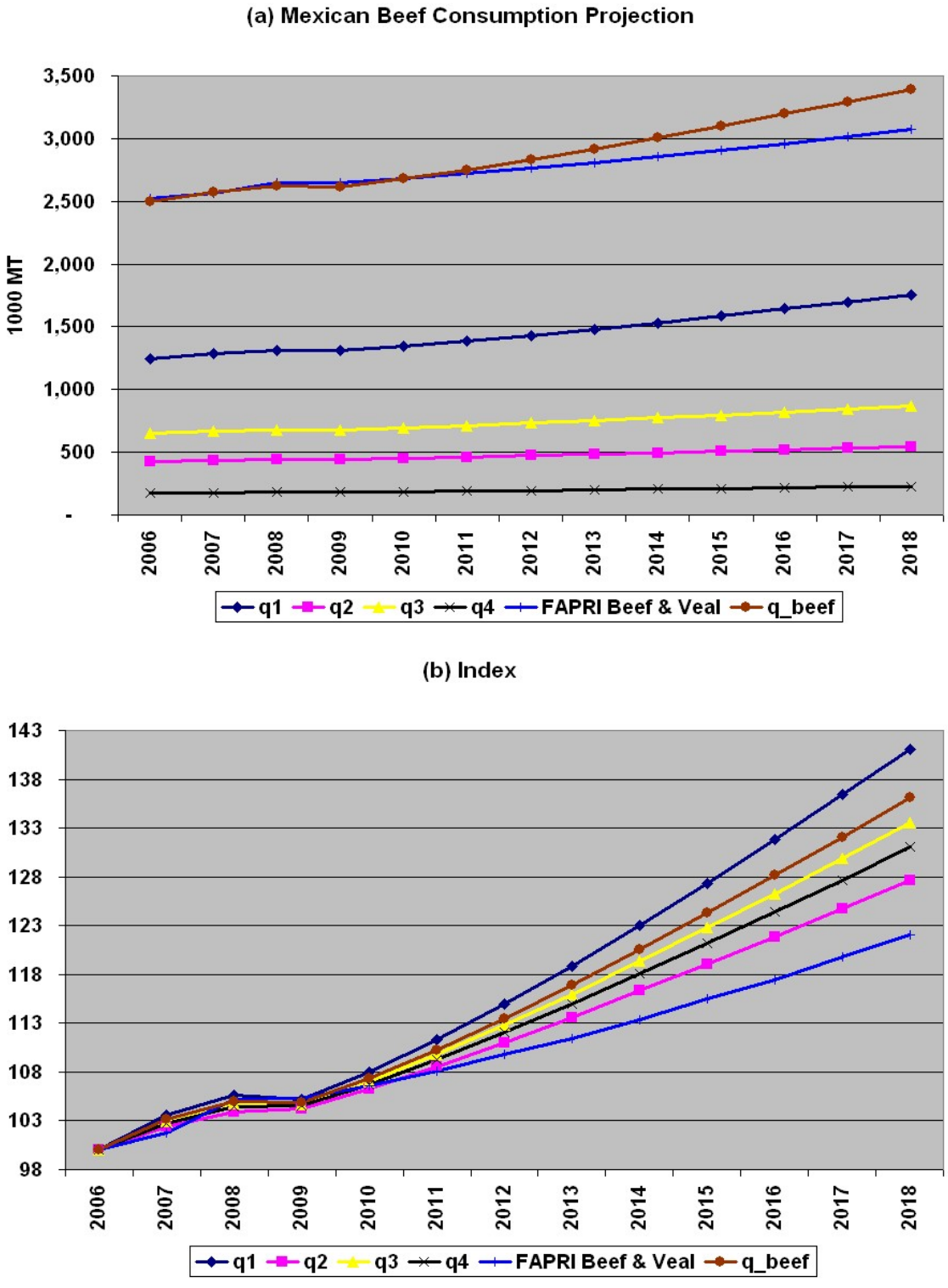

Figure 4. Mexican Beef Consumption Projection

Note: FAPRI beef and veal consumption is the projection reported in FAPRI (2009b, p. 342) and FAPRI (2009a).

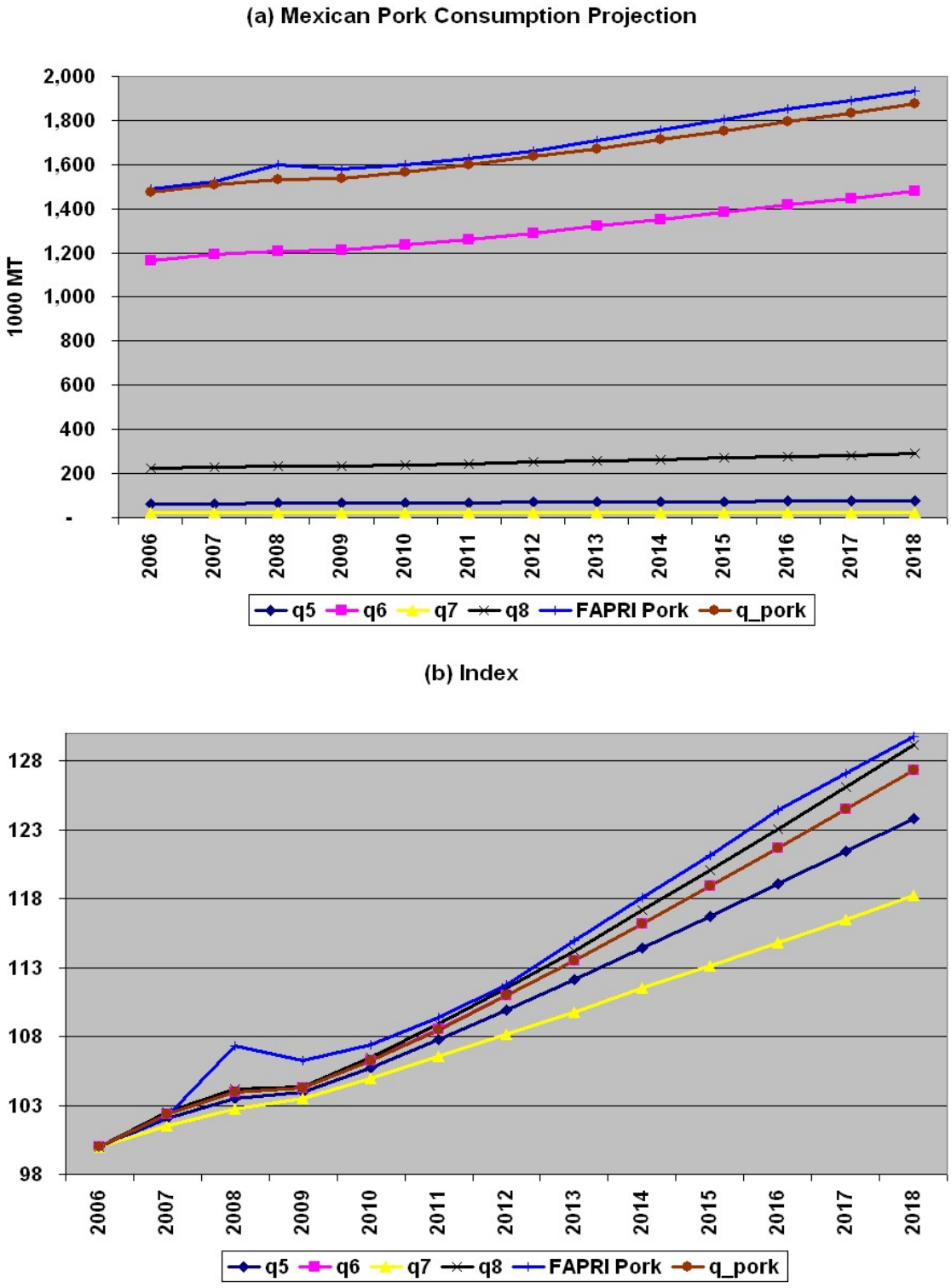

Figure 5. Mexican Pork Consumption Projection

Note: FAPRI pork consumption is the projection reported in FAPRI (2009b, p. 342) and FAPRI (2009a).

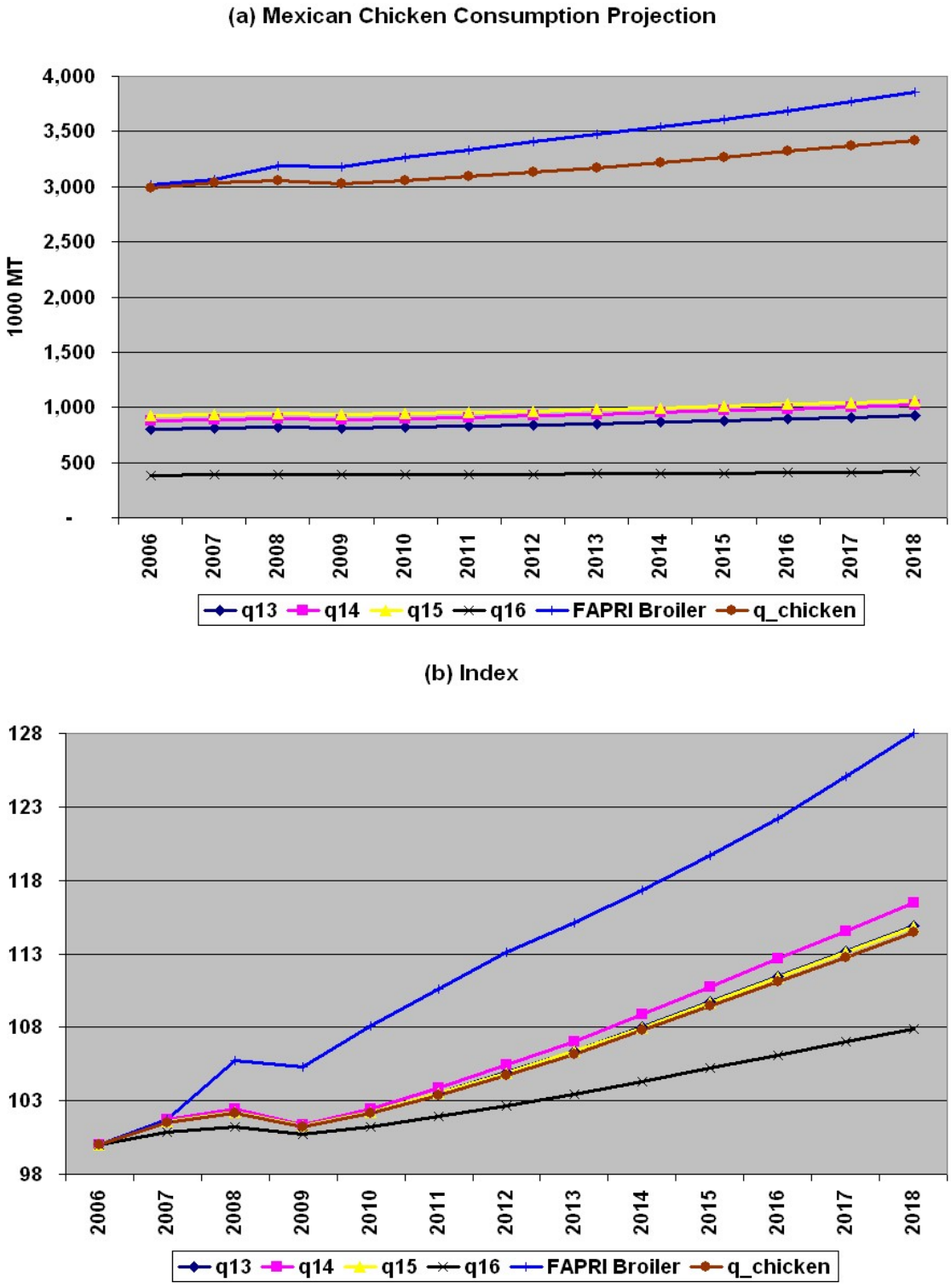

Figure 6. Mexican Beef Consumption Projection

Note: FAPRI broiler consumption is the projection reported in FAPRI (2009b, p. 342) and FAPRI (2009a).

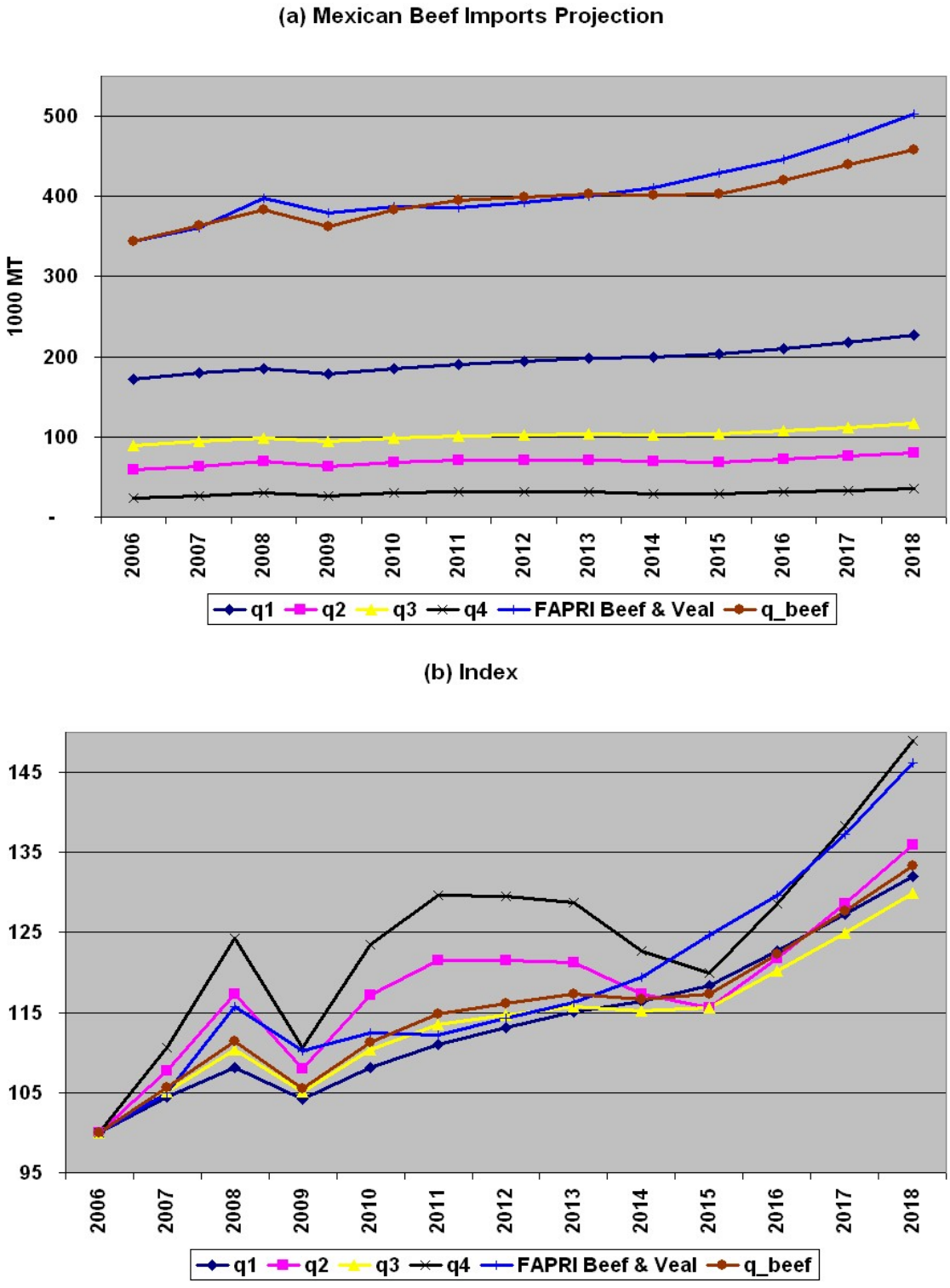

Figure 7. Mexican Beef Imports Projection

Note: FAPRI beef and veal imports is the projection reported in FAPRI (2009b, p. 325) and FAPRI (2009a).

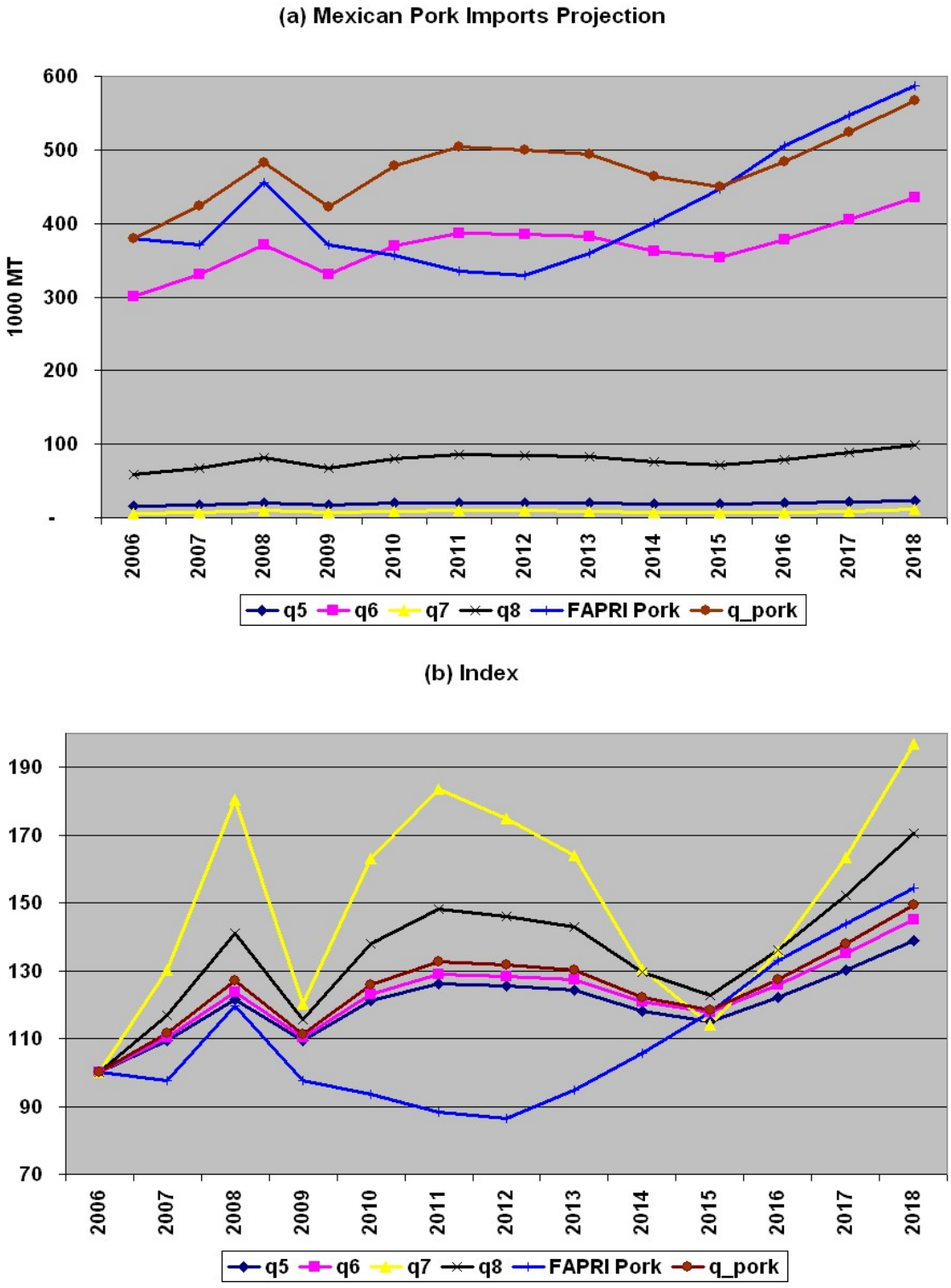

Figure 8. Mexican Pork Imports Projection

Note: FAPRI pork imports is the projection reported in FAPRI (2009b, p. 327) and FAPRI (2009a).

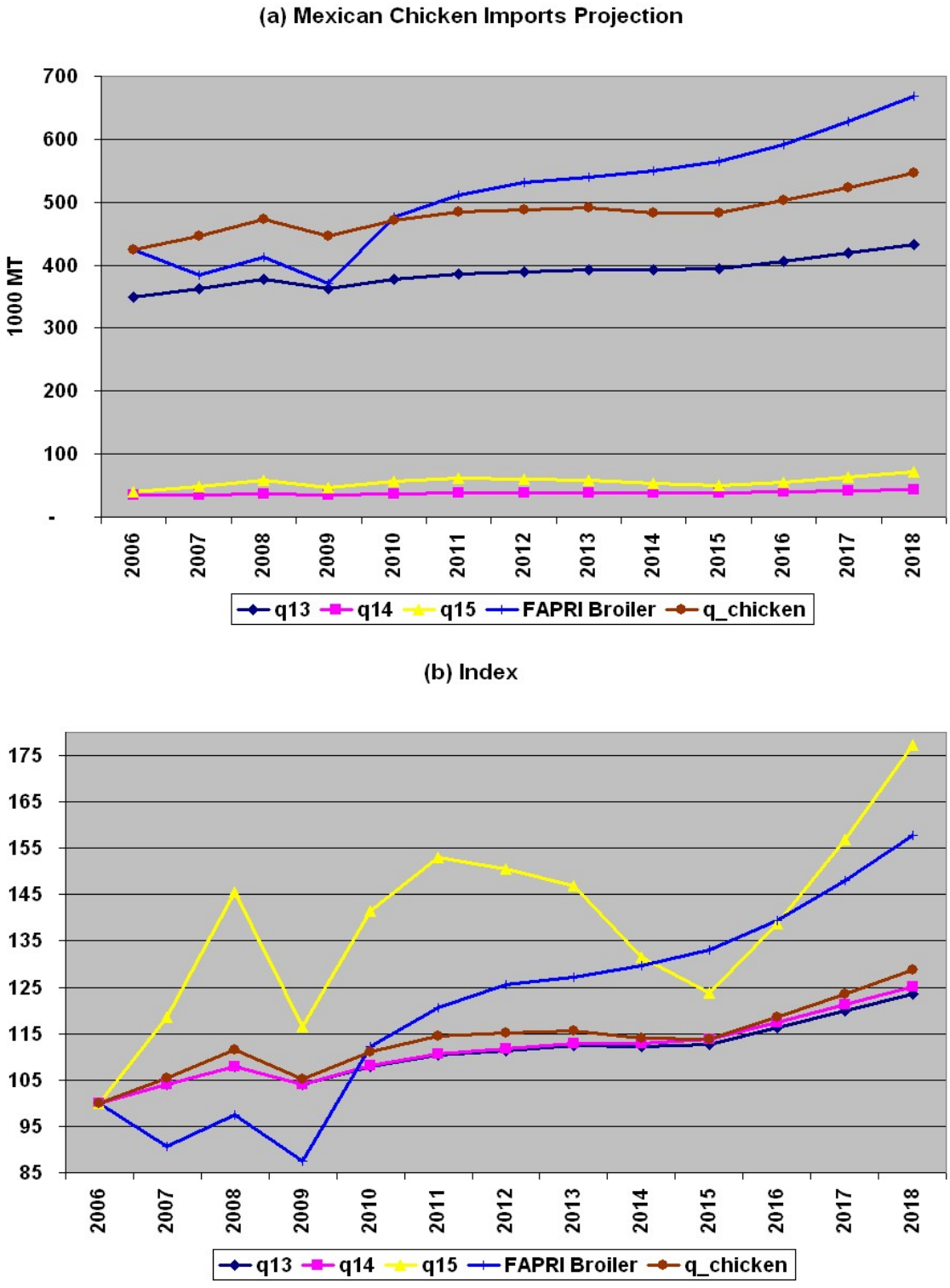

Figure 9. Mexican Chicken Imports Projection

Note: FAPRI broiler imports is the projection reported in FAPRI (2009b, p. 329) and FAPRI (2009a).

Tables

Table 1. Number of Non-Missing and Missing Observations and Average Prices

p_i	Number Non-Missing	Number Missing	Before p_i Imputed		After p_i Imputed	
			Mean (Pesos/Kg)	Std. Error of Mean	Mean (Pesos/Kg)	Std. Error of Mean
Beef						
p_1	6,348	10,561	61.3642	0.2572	60.8785	0.1059
p_2	2,938	13,971	55.6279	0.4059	56.2014	0.0780
p_3	2,795	14,114	52.0036	0.6439	51.4183	0.1199
p_4	734	16,175	36.8413	1.0864	35.8138	0.1046
Pork						
p_5	892	16,017	50.3311	0.6043	50.3466	0.0417
p_6	1,506	15,403	47.0965	0.5020	46.9521	0.0519
p_7	366	16,543	48.6391	0.9688	47.9718	0.0515
p_8	2,168	14,741	46.8656	0.5416	46.7112	0.0816
Processed Beef & Pork						
p_9	3,175	13,734	50.7869	0.9072	51.2935	0.1824
p_{10}	4,156	12,753	50.5261	0.4528	48.7871	0.1385
p_{11}	2,384	14,525	31.2680	0.5327	31.4529	0.0849
p_{12}	2,626	14,283	72.5129	1.1257	73.8783	0.2174
Chicken						
p_{13}	5,057	11,852	35.2406	0.2458	34.6859	0.0969
p_{14}	5,716	11,193	28.5982	0.2876	28.1278	0.0953
p_{15}	760	16,149	22.4321	0.8949	24.8824	0.0924
Processed Chicken						
p_{16}	2,593	14,316	46.7430	0.5581	46.0728	0.1000
Seafood						
p_{17}	3,970	12,939	48.7240	0.5964	47.9096	0.1596
p_{18}	713	16,196	81.5472	2.2547	87.1642	0.1806

Note: Average exchange rate in 2006 is US $1 = 10.90 Pesos (Banco de México 2008).

Note: p_i, $i = 1,2,\ldots,18$, 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 Products 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 Products, 17 = Fish, 18 = Shellfish.

Source: ENIGH 2006 Database, computed by authors.

Table 2. Per Capita Consumption of Meat Cuts Per Week

q_i	Number of Non-Zero Obs.	Number of Zero Obs.	Excluding Zero Obs.		Including Zero Obs.	
			Mean (Kg/Capita)	Std. Error of Mean	Mean (Kg/Capita)	Std. Error of Mean
Beef						
q_1	6,348	10,561	0.2689	0.0040	0.1078	0.0022
q_2	2,938	13,971	0.2089	0.0052	0.0369	0.0012
q_3	2,795	14,114	0.3170	0.0093	0.0562	0.0020
q_4	734	16,175	0.3249	0.0168	0.0151	0.0011
Pork						
q_5	892	16,017	0.2231	0.0095	0.0109	0.0007
q_6	1,506	15,403	0.2699	0.0083	0.0205	0.0519
q_7	366	16,543	0.1755	0.0090	0.0038	0.0003
q_8	2,168	14,741	0.2839	0.0240	0.0388	0.0035
Processed Beef & Pork						
q_9	3,175	13,734	0.1265	0.0038	0.0239	0.0009
q_{10}	4,156	12,753	0.1340	0.0031	0.0352	0.0017
q_{11}	2,384	14,525	0.1787	0.0050	0.0264	0.0010
q_{12}	2,626	14,283	0.1363	0.0048	0.0221	0.0010
Chicken						
q_{13}	5,057	11,852	0.4100	0.0065	0.1458	0.0032
q_{14}	5,716	11,193	0.4480	0.0073	0.1403	0.0032
q_{15}	760	16,149	0.4719	0.0563	0.0251	0.0035
Processed Chicken						
q_{16}	2,593	14,316	0.1969	0.0056	0.0293	0.0011
Seafood						
q_{17}	3,970	12,939	0.2762	0.0075	0.0676	0.0023
q_{18}	713	16,196	0.2783	0.0169	0.0113	0.0009

Note: q_i, $i = 1, 2, \ldots, 18$, 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 Products 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 Products, 17 = Fish, 18 = Shellfish.

Source: ENIGH 2006 Database, computed by authors.

Table 3. Results from DuMouchel and Duncan's (1983) Test

Equation	F	p-value
q_1	1.7907	0.0090
q_2	2.0893	0.0011
q_3	1.7377	0.0126
q_4	1.9422	0.0032
q_5	1.3806	0.0976
q_6	4.3003	<0.0001
q_7	3.0603	<0.0001
q_8	1.7962	0.0086
q_9	1.7718	0.0101
q_{10}	4.4449	<0.0001
q_{11}	1.6708	0.0191
q_{12}	8.3251	<0.0001
q_{13}	2.4402	0.0001
q_{14}	9.2035	<0.0001
q_{15}	7.3924	<0.0001
q_{16}	1.9762	0.0026
q_{17}	1.1127	0.3166
q_{18}	3.7224	<0.0001
Critical Values		
$F^*_{25;16,884}(0.01) = 1.77$		
$F^*_{25;16,884}(0.05) = 1.52$		

Table 4. Marshallian Price Elasticities

Table entries estimate e_{ij}.

i\j	1	2	3	4	5	6	7
1	-1.0270*	0.1874†	-0.4383*	-0.1690	0.1565	-0.3042†	-0.1590
2	0.3941*	-3.4594*	-0.1164	-0.1068	0.4419	0.3923	0.3808
3	-1.2609*	0.2100	-1.7451*	0.2404	1.2346*	-0.5032	-3.3987*
4	-1.8100*	0.4889	-0.3440	-4.8186*	-1.3840	0.8117†	-1.5508
5	0.7866	-0.7295†	0.0720	-0.2287	-4.4711*	-1.1063	-1.6662†
6	-1.2086*	-0.5236	0.0135	0.4876†	-0.7959	-4.8375†	0.9168
7	-2.4904*	-0.5660	0.2482†	0.1254	-1.9010	-0.8229	-15.9428‡
8	-0.1314	0.4929	0.3194	0.3868†	1.4251‡	1.6971*	-1.9708†
9	0.1705	-0.0911	0.1114	-0.0318	0.9794‡	-0.3901	0.0174
10	0.2400†	-0.7629*	0.4232*	-0.2591	0.1586	0.1704	-1.3375*
11	-0.3879*	-0.1636	0.1905*	-0.5674‡	1.0437*	-0.8304‡	0.4634†
12	0.1538	-0.7593†	0.0713	-1.2194*	-2.2317*	0.0021	0.5628
13	-0.2773‡	0.0030	0.0300	-0.4099*	0.2920	0.3180†	0.6752*
14	0.3895†	-0.3419†	-0.2401	-0.1481‡	-0.0380	0.0698	-0.2241
15	0.0033	0.2217	0.0484	0.3276	0.7168	0.4577	-1.7283
16	-0.0592	0.2251	0.0547	0.1362	2.1079*	0.2196	-1.7323*
17	-0.0347	-0.1137	0.0638	-0.1373	0.9090*	-0.6018†	-1.6105‡
18	-1.0742‡	0.5885†	-0.6597*	0.1389	0.8832	0.3021	0.2106

Note: $i = 1, 2, \ldots, 18$, 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 Products 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 Products, 17 = Fish, 18 = Shellfish.
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.

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Table 4. ***continued***

Table entries estimate e_{ij}.

i\j	8	9	10	11	12	13	14
1	0.0375	0.0174	-0.0030	-0.0186	-0.0346	-0.2778*	-0.0361
2	0.1548	-0.0236	0.0619	-0.0916	-0.0081	0.0032	0.2245
3	-1.0235*	0.1885	0.0609	0.2369	-0.1490	-0.3109*	0.0158
4	-0.2194	0.6108	-0.2380	0.5040	-0.7262‡	-0.6557‡	-0.4232†
5	0.7246†	-0.4432†	-0.5834‡	0.0896	-0.1335	-0.1423	-0.5410†
6	0.3153	-0.1748	-0.3171	0.0492	0.5835*	0.1087	-0.4584†
7	-0.2945	0.1764	-0.0677	0.6991‡	-1.4896*	-0.2333	-0.5569†
8	-8.3019*	0.6219	0.0730	0.5472	-0.4080	-0.2200	-0.3565†
9	-0.1277	-1.2275*	-0.6150	-0.0932	-0.3774*	-0.1623	-0.2235†
10	0.1069	0.0478†	-0.7832*	0.2719‡	0.2156	0.0995	0.1305‡
11	0.6703*	0.0787‡	-0.0091	-1.8406†	-0.1287‡	-0.0014	-0.1101
12	-0.3655	0.1009	-0.6053*	0.0806	-3.1156*	0.5946*	-0.0236
13	-0.0566	0.0603	0.1820*	-0.0051	0.1125	-1.2841*	-0.1555*
14	0.0332	-0.0866	-0.2281†	-0.1014	0.0320	0.0290	-1.2640*
15	0.1402	-2.0678	-2.6776	1.0031	0.2440	-0.1783	-0.2035
16	0.6956†	0.0533	0.1333	0.2558†	0.0448	0.2076†	0.0365
17	0.1549	-0.0718	0.2375†	0.1125	0.0456	-0.0525	0.1371
18	-0.5493	0.0255	0.2046	0.4451†	0.0774	-0.1591	-0.0278

Note: $i = 1, 2, \ldots, 18$, 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 Products 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 Products, 17 = Fish, 18 = Shellfish.
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.

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Table 4. ***continued***

Table entries estimate e_{ij}.

i\j	15	16	17	18
1	0.0325	-0.1666†	-0.0394	-0.6354*
2	0.1064‡	-0.1294	-0.0950	-0.9724*
3	0.2704	0.1163	-0.1758	-0.6919*
4	0.4998	-0.2088	-1.3958*	1.1782
5	0.2138†	0.8314*	0.0147	-0.9145†
6	0.0094	0.1924	0.1516	0.3673
7	-0.3212	-0.6395	-0.4851†	-0.6696
8	0.0529	-0.8650†	-0.2177	0.4907
9	-0.3070*	-0.3966†	-0.0510	0.0536
10	-0.4764*	0.2149	0.0845‡	0.4884
11	-0.2771	0.3034	0.2344*	0.6494
12	-0.6132*	0.2790‡	0.0330	0.3075
13	-0.0368	0.1865‡	0.0551†	0.0615
14	0.1768†	-0.0120	-0.7013*	-0.0068
15	-9.1730*	1.1161†	-0.4770	-0.0833
16	0.1239	-1.2713*	0.0404	0.1742
17	0.2298‡	0.1382	-0.9825*	0.6658*
18	0.1831	1.1353‡	-0.0001	-7.5997*

Note: $i = 1, 2, \ldots, 18$, 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 Products 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 Products, 17 = Fish, 18 = Shellfish.
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. Expenditure Elasticities

	i	$\hat{e}_i$
1	Beefsteak	0.9733*
2	Ground Beef	0.5228*
3	Other Beef	0.7260*
4	Beef Offal	0.6413*
5	Pork Steak	0.3904*
6	Pork Leg & Shoulder	0.5141*
7	Ground Pork	0.1846
8	Other Pork	0.5776*
9	Chorizo	0.6190*
10	Ham, Bacon & Similar Products	0.4547*
11	Beef & Pork Sausages	0.2728*
12	Other Processed Beef & Pork	0.3570*
13	Chicken Legs, Thighs & Breasts	0.6142*
14	Whole Chicken	0.6761*
15	Chicken Offal	0.6112*
16	Chicken Ham & Similar Products	0.3354*
17	Fish	0.6970*
18	Shellfish	0.4361*

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 6. Income Elasticities

	i	$\hat{\eta}_i$
1	Beefsteak	0.6563
2	Ground Beef	0.3525
3	Other Beef	0.4895
4	Beef Offal	0.4324
5	Pork Steak	0.2632
6	Pork Leg & Shoulder	0.3467
7	Ground Pork	0.1245
8	Other Pork	0.3895
9	Chorizo	0.4173
10	Ham, Bacon & Similar Products	0.3066
11	Beef & Pork Sausages	0.1840
12	Other Processed Beef & Pork	0.2407
13	Chicken Legs, Thighs & Breasts	0.4141
14	Whole Chicken	0.4559
15	Chicken Offal	0.4121
16	Chicken Ham & Similar Products	0.2262
17	Fish	0.4700
18	Shellfish	0.2941