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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. 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 is not 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.

INTRODUCTION

The Mexican meat market is very important for U.S. and Canadian meat exporters.

- It is large.
  - 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.
  - 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.
- It is rapidly expanding.
  - From 1997 to 2006, swine meat, poultry meat, and beef imports grew 449%, 108%, and 80% respectively.
- It has a large preference for animals remains.
  - From 2002 to 2007, imports of remains of bovine animals (average 72,076 MT) are greater than imports of bovine meat carcasses and half-carcasses (average 1,025 MT) and other cuts of bovine meat with bone-in (average 7,418 MT), but smaller than boneless bovine meat (244,799 MT).
  - Similarly, imports of other chicken cuts and offal (average 50,115 MT) are greater than imports of whole chicken (average 10,326 MT), but smaller than boneless chicken (average 148,391 MT) and chicken legs and thighs (average 107,601 MT).

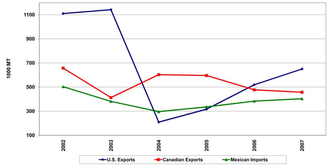


Figure 1. U.S. Exports, Canadian Exports, and Mexican Imports of Beef and Veal
Source: United States Department of Agriculture (USDA) – Economic Research Service (ERS), *Production, Supply and Distribution* (PSD), Online Database (accessed June 12, 2009).

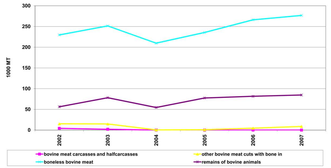


Figure 2. Mexican Imports of Bovine Meat
Source: Mexican Ministry of Economy, *Sistema de Información Arancelaria Via Internet* (SIAVI), Online Database (accessed October 9, 2008). Computed by authors.

- Its per capita meat consumption still remains low compared to the equivalent in the United States and Canada.
  - From 1997 to 2006, Mexico averaged a per capita meat consumption of 61 kg while the Unites States and Canada averaged 122 and 98 kg respectively.
- Unlike previous studies, this study considers table cuts of meats, the entire target population, adult equivalence scales, a price imputation approach, a consistent censored demand system, and estimation techniques from stratified sampling.
  - Erdil (2006), Dong, Gould, and Kaiser (2004), Golan, Perloff, and Shen (2001), Dong and Gould (2000), and Garcia Vega and Garcia (2000) only considered meat aggregates such as beef, pork, and chicken.
  - Dong, Gould, and Kaiser (2004) restricted their analysis to households that live in cities or towns with a population of 15,000 or more.
  - Dong, Gould, and Kaiser (2004), Dong and Gould (2000), and Golan, Perloff, and Shen (2001) used a simple count or proportion of household members.
  - Golan, Perloff, and Shen (2001) and Dong, Shonkwiler, and Capps (1998) substituted the missing price with the corresponding simple average of non-missing prices within each Mexican state and strata.
  - Dong, Gould, and Kaiser (2004), Golan, Perloff and Shen (2001), Dong and Gould (2000), and Garcia Vega and Garcia (2000) treated the sample data (ENIGH) as simple random sample when ENIGH is a stratified sample.

OBJECTIVES

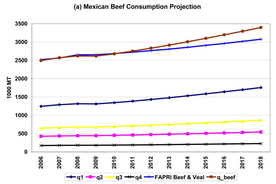
The general objective of this study is to provide an in-depth analysis of Mexican meat consumption while using a theoretically sound research approach that updates Mexican meat demand elasticities.

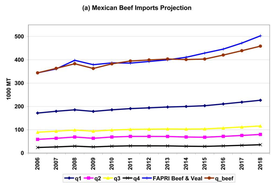
- The study is in-depth.
  - It considers table cuts of meats and it not only presents elasticity estimates but it also identify trends in consumption and imports.
- The study is theoretically sound.
  - It uses the entire target population, incorporates adult equivalence scales to compute the number of adult equivalents, uses a price imputation approach to account for censored prices, uses a consistent censored demand system estimated in two steps to account for censored quantities, and incorporates estimation techniques from stratified sampling because the data sample is a stratified sample.

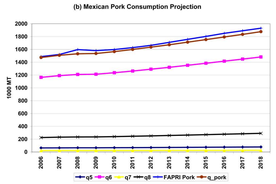
The specific objectives of the study are:

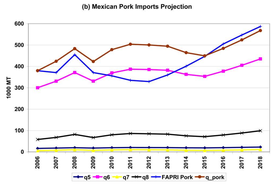
- Identify current and future trends and growth rates in the consumption and imports of specific table cuts of meat;
- Determine trends in the current and future structure of Mexican meat consumption;
- Forecast Mexican consumption of table cuts of meat through changes in real per household income;
- Forecast Mexican imports of table cuts of meat through changes in real per household income and real exchange rate.

PROJECTIONS









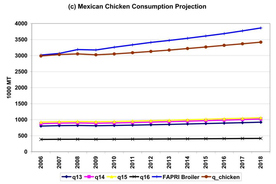


Figure 3. Mexican Meat Consumption Projection

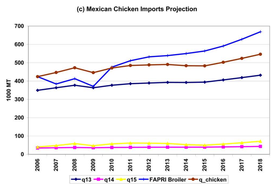


Figure 4. Mexican Meat Imports Projection

Note: q1 = beefsteak, q2 = ground beef, q3 = other beef, q4 = beef offal, q5 = pork steak, q6 = pork leg & shoulder, q7 = ground pork, q8 = other pork, q13 = chicken legs, thighs & breasts, q14 = whole chicken, q15 = chicken offal, q16 = chicken ham & similar products, $q_{beef} = \sum_{i=1}^{4} q_i$, $q_{pork} = \sum_{i=5}^{8} q_i$, $q_{chicken} = \sum_{i=13}^{16} q_i$. FAPRI beef and veal, FAPRI pork, and FAPRI broiler are the projections reported in *FARPI 2009 U.S. and World Agricultural Outlook.*

Data

To obtain elasticity estimates, this study used data on Mexican Household Incomes and Expenditures for 2006 (*Encuesta Nacional de Ingresos y Gastos de los Hogares* or ENIGH).

- ENIGH is published by a Mexican Governmental Institution,
  - Instituto Nacional de Estadística Geografía e Informática (INEGI).
- ENIGH data is collected from households during *one week*.
- ENIGH is a *stratified sample*.
  - It's necessary to incorporate stratification variables (weight and strata) into analysis.
  - Weighted least squares estimation is consistent.
  - Standard errors of parameter estimates obtained from weighted least squares estimation are incorrect and should be ignored.

To perform the forecasts and simulation analysis, additional data was obtained.

- 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 Financial Statistics (IFS).*
- 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 2007-2018 was obtained from
  - *FAPRI 2009 U.S. and World Agricultural Outlook.*

Model

The tth equation of the tth household, in the censored system, can be written as (see Shonkwiler and Yen 1999)

(1) $q_i(t) = \Phi[z_i'(t)\boldsymbol{\alpha}_i]\mathbf{x}_i'(t)\boldsymbol{\beta}_i + \delta_i\phi[z_i'(t)\boldsymbol{\alpha}_i] + \xi_i(t), \quad i = 1, \ldots, 18.$

Equation (1) is estimated in two steps:

- First, obtain maximum-likelihood probit estimates $\hat{\boldsymbol{\alpha}}_i$ of $\boldsymbol{\alpha}_i$ for $i = 1, \ldots, 18$ using the binary dependent variable $d_i(t) = 1$ if $q_i(t) > 0$ and $d_i(t) = 0$ otherwise.

(2) $P[d_i(t)=1 \mid \mathbf{z}_i(t)] = \Phi[z_i'(t)\boldsymbol{\alpha}_i], \quad i = 1, \ldots, 18.$

  - Multiply the contribution of each observation to the likelihood function by the value of the weight variable.
- Second, calculate $\Phi[z_i'(t)\hat{\boldsymbol{\alpha}}_i]$ and $\phi[z_i'(t)\hat{\boldsymbol{\alpha}}_i]$ and estimate $\boldsymbol{\beta}_1, \ldots, \boldsymbol{\beta}_{18}, \delta_1, \ldots, \delta_{18}$ in the system,

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

by seemingly unrelated regression (SUR) procedure.

  - Weight all observations by the weight variable prior to estimation.

To estimate uncompensated price elasticities and meat expenditure elasticities, estimate the unconditional means by $\hat{q}_i(\bar{t})$, compute $\frac{\partial \hat{q}_i(\bar{t})}{\partial x_{ij}}$, and then calculate the elasticities.

DISCUSSION

- Figure 3, Panel (a), shows that beefsteak is expected to continue to be the most consumed beef cut in Mexico, followed by other beef, ground beef and beef offal. Furthermore, 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%). 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).
- Figure 3, Panel (b), shows that pork leg & shoulder is expected to continue to be the most consumed pork cut in Mexico, but the second fastest growing pork cut. 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, Panel (c) of Figure 3, the Mexican consumption of chicken offal, whole chicken, and chicken legs, thighs & breasts are expected to be about the same, and to grow at about the same rate, 2006-2018 growth rate of 15%. 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.
- Figure 4 reports projections of Mexican beef, pork, and chicken imports. Similar to Mexican consumption of table cuts of meats, Mexican imports of table cuts of meats grow at different rates.
- For example, Panel (c) of Figure 4, shows that the most imported Mexican chicken cut is chicken legs, thighs & breasts, but the fastest growing chicken cut is chicken offal. 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%.

RESULTS

Table 1. Marshallian Price Elasticities

Table entries estimate 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	-0.1069	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, …, 18 = beefsteak, ground beef, …, shellfish (see Table 2 or Table 3). 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 2. Expenditure Elasticities

	i	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 *

Table 3. Income Elasticities

	i	η_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

Note: Number of bootstrap resamples = 1,000. Bootstrap significance levels of 0.05 are indicated by asterisks (*).

- Table 1 depicts estimates of the Marshallian own-price and cross-price elasticities. 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).
  - Ground beef is a substitute for beefsteak and vice versa (e_{0102} and e_{0201}).
  - Whole chicken is a complement for chicken legs, thighs, and breasts (e_{1314}).
- Table 2 and Table 3 present the expenditure and income elasticities. All expenditure and income elasticities have the expected positive sign, which means that consumption on all meat cuts is expected to increase as the economy grows.
- Elasticity estimates are used to perform the forecasts and simulation analysis.

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CONCLUSION

- This study presented an updated analysis of current and forecasted Mexican meat consumption and imports at the table cut level of disaggregation. Our results indicate that Mexican consumption of table cuts of meats grow at different rates within and across meat categories. For example, Mexican consumption of beefsteak is the fastest growing but consumption of pork steak is not. However, Mexican consumption of ground beef and ground pork are the slowest growing within their meat categories. In addition, Mexico seems to be following the U.S. preferences for beef cuts, but it is not following the U.S. preferences for chicken cuts.
- Our results also indicate that it may be more appropriate and useful to perform an analysis of Mexican meat consumption at the table cut level of disaggregation. For instance, projections of meat consumption and imports could be more precise if meat cuts, instead of aggregated meat categories, are considered.
- Finally, 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.

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