Did Mexican Meat Demand Change under NAFTA?

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Contributed Paper prepared for presentation at the International Association of Agricultural Economists Conference, Beijing, China, August 16-22, 2009

Abstract

A censored non linear QUAIDS model was applied to estimate Mexican meat demand parameters using annual household survey data for six years from 1992 to 2004. Results suggest that in Mexico and throughout the analyzed period, beef and pork meat were luxury items while chicken was a normal good. Small but insignificant changes in meat demand parameters were found after NAFTA implementation suggesting that changes on consumer behavior due to macroeconomic variables might take longer periods to be quantifiable.

Keywords

QUAIDS model, Mexico meat demand, NAFTA

Introduction

Since its implementation in 1994, NAFTA has been regarded as the most important change-driver of the Mexican economy. After NAFTA, Mexico became the largest export market of U.S. meat products accounting for $1.5 billion of which $712 million correspond to beef and veal, $246 to pork, and $540 to poultry (USDA-FATUS, 2008). In this period Mexico also became the world's eighth largest producer and the seventh largest importer of meat (FAO, 2006). According to the Mexican Agriculture Secretary (SAGARPA; 2006) per capita meat consumption in Mexico increased 73% from 1990 to 2004 (from 32.9 to 56.9 kg). This increase could be attributed to the fact that, through NAFTA, Mexicans have been exposed to new varieties, qualities, and types of meat products at lower prices. However, when this per capita consumption is compared to the equivalent of Canada and the United States (94 and 118 kg, respectively), Mexican per capita meat consumption is still low, suggesting a possible increase in consumption of all types of meat in Mexico, as per capita income raises and consumer preferences become more in line with its NAFTA partners. This potential growth could provide the Mexican and foreigner meat suppliers the opportunity to expand their markets in that country.

The most recent research on Mexican meat demand systems have reported quite diverse results. Golan et al., (2001) used 1992 (pre-NAFTA) survey data and found that the own-price elasticities of beef, pork, and poultry were -1.10, -0.56, and -0.63, respectively.

Dong et al., (2004) with data from the Mexican household survey of 1998; analyzed information from households located in towns with more than 15,000 inhabitants. They also excluded households reporting only food consumption away from home. Dong et al.,(2004) estimated own-price elasticities for beef, pork and poultry meat to be -0.63, -0.13, and -0.83, respectively. When comparing these results to those of Golan et al. (2001) the authors suggested that the differences were probably due to the methodology employed in their estimation of the demand system, as well as, to the peso devaluation of 1994.

According to the results described above, it is seems plausible that the parameters of the Mexican meat demand, which are critical to any projection of future meat consumption in Mexico, have been changing since and through the implementation of NAFTA.

The objectives of this study are: 1) to provide updated meat demand parameters that would be useful to policy makers and meat suppliers in Mexico and 2) to evaluate if NAFTA has had an impact on the demand parameters.

To accomplish these objectives, a Mexican meat demand system consisting of aggregated beef, pork and chicken meat, was estimated. These particular types of meat were chosen because they are the most consumed in Mexico. In order to estimate the demand system, first, it was necessary to deal with the censoring problem, thus, a modification of the two step censored methodology suggested by Shonkwiler and Yen (1999) was employed. A multi probit model was used to calculate the probability that a household would purchase meat in general and specific types of meat in lieu of the unit probit model suggested by the authors. The Nonlinear Quadratic Almost Ideal Demand System (NQAIDS) developed by Banks et al., (1997) was adopted to estimate the parameters of the meat demand in Mexico from 1992 to 2004.

The remainder of the paper is organized as follows. Theoretical issues related to the estimation procedures, as well as the estimation methods used are discussed in the next section. Section III provides a description of the data set. Results of the demand system analysis are provided in section IV. Finally, the last section summarizes the conclusions and potential policy implications.

Theory Background

Weak separability is important in demand system's analyses because it is considered a necessary and sufficient condition for two-stage budgeting (Deaton and Muellbauer, 1980). Following Deaton and Muellbauer (1980) food is assumed to be weakly separable from non-food and within food, meat is also assumed to be weakly separable from non-meat food; consequently the consumer's utility maximization decision can be decomposed into several stages: in a first stage, total expenditure is allocated among food and non-food items. In a second stage, food expenditure is then allocated among meat and other food items. Following the latter idea, then in a third stage, meat expenditure is allocated among types of meat. Consumer decision's can be additionally decomposed into types of cuts for every type of meat; however, types of cuts within each group are considered to be close substitutes and consequently this research deals only with the aggregation over generic beef, pork, and chicken meat because, traditionally, they have been considered the most popular meat purchased in Mexico. Figure 1 shows the utility tree of a representative Mexican household and emphasizes the scope of this research.

To better understand the Mexican meat market, it is important to identify the response of consumption of different meat type to price and income changes, as well as, their response to demographic variables. To estimate the Mexican meat demand system, we began with the classical utility maximization framework and according with Kao, et al. (2001):

let $U(x;\alpha)$ be a utility function with m commodities x1, …, xm;

where:

α represents unobserved preferences explained by demographic variables of the consumers.

Then the utility maximization model of the consumer was:

(1) $\max_{x}\{U(x;\alpha): v'x = 1, x \geq 0\}$

where:

v = p/M is a m-dimensional vector of goods prices normalized by income M. Note that U is strictly increasing and strictly quasi-concave so as to guarantee a unique solution for the demand vector, x*.

Furthermore, assuming that U is continuously differentiable, the demand, x*, can be characterized by the Kuhn-Tucker conditions:

Let x* = ($0,...,0, x^*_{l+1},..., x^*_m$) be a demand vector

where:

the first l goods, with $l \geq 0$, are not consumed and all remaining goods (indexed l+1 through m) are consumed.

Then the demand estimation for different types of meat (x*) were:

(2) $\frac{\partial U(x^*;\alpha)}{\partial x_i} - \lambda v \leq 0$ for i=1,…,l

(3) $\frac{\partial U(x^*;\alpha)}{\partial x_i} - \lambda v = 0$ for i=l+1,…,m.

where:

λ is the Lagrange multiplier corresponding to the budget constraints.

The Demand System

To estimate the parameters of the Mexican meat demand system considered in Figure 1 and equation (1), the Nonlinear Quadratic Almost Ideal Demand System (NQUAIDS) developed by Banks et al. (1997) was used. Some authors, such as Blundell et al., (1993) and

Lyssiotouet al., (2002) emphasize that the Non-linear QUAIDS model has the flexibility of including nonlinearities and interactions with household-specific characteristics in the utility function, which can be important for household survey data, and also have better forecasting performance.

In the Non-linear QUAIDS specification, the dependent variable is the average budget share (w_i) of each type of meat:

(4) $w_i = p_i q_i / X$

where:

w_i is the average budget share of the ith meat type purchased; p_i is the price of the ith type of meat purchased; q_i is the amount of the ith type of meat purchased; and $X = \sum p_1 q_i$ is the total meat expenditure

The demand model then, is given by:

(5) $$w_i = \alpha_i + \sum_j \gamma_{ij} \ln P_j + \beta_i (\ln y - \ln P) + \frac{\lambda_i}{\prod_j p_j^{\beta_i}} (\ln y - \ln P)^2 + \sum_{ik} \kappa_{ik} R_k + \varepsilon_i$$

where:

P is the corresponding price index, w_i is the budget share of the ith meat, and the α's, β's, γ's, λ's and κ's are parameters estimated. R's are dummy variables corresponding to different demographic variables; and ε_i is the error term, furthermore, the price index (lnP) in equation (5) is defined as:

(6) $$\ln P = \alpha_0 + \sum_j \alpha_j \ln p_j + \frac{1}{2} \sum_j \sum_i \gamma_{ij} \ln p_i \ln p_j$$

Symmetry and homogeneity constraints can still be imposed in (5), however, adding up is guaranteed only in the absence of censoring, issue that will be discussed in the next section.

The use of equation (5) in estimating the budget share equation in (4) implies that the model is truly non-linear. We did not replace (5) by any linear approximation because according to Buse (1994), Green and Alston (1990), and Thompson (2004) such linear approximations cause additional difficulties.

In order to avoid singularity of the variance-covariance matrix of error terms the chicken meat equation was omitted from the demand system; parameters for this type of meat were calculated from the theoretical restrictions imposed to the model.

Censored Issues

Heien and Wessells (1991), Byrne et al. (1996), Shonkwiler and Yen (1999) Dong et al. (2004), and Pofahl et al. (2005) agree that household-level data sets avoid the issue of aggregation over consumers, and often provide large samples, however, these data sets present major estimation problems, mainly due to the fact that households do not consume all the commodities available to them at any given time, thus, creating the necessity to obtain an empirical model that assure non-negativity of the predicted quantities purchased and is agreeable with constraints implied by economic theory.

In general there are two types of censoring, whether a household does not purchase the commodity or only purchases a specific type. To deal with the issue of whether a household purchases meat or not, an inverse mills ratio was created before the estimation and afterwards a sample of households that purchased at least one type of meat was chosen. Households that did not purchased any type of meat were omitted. In order to avoid the sample selection issue, households that only ate out were not excluded from the sample.

Regarding the second type of censoring, several methodologies have been developed to solve the problem of samples with commodity purchase censoring, however, in this study we used a modification of the methodology proposed by Shonkwiler and Yen (1999) where the estimation of the demand system is realized by means of a two-step procedure with limited dependent variables.

Some authors, among them, Chen and Chen (2002), Tauchmann (2005), and Yen and Lin (2006), consider the Shonkwiler and Yen approach inefficient due to the unit probit estimation in the first step. Thus, in order to improve efficiency and to account for the error correlation among the different meat consumption equations, we conducted a multi-probit estimation using latent variables with a selection mechanism instead of the unit probit estimation in the first step to determine the probability that a given household will consume any type of meat. The decision to purchase a given type of meat was modeled as a binary-choice problem depending on household size, income and dummy variables for the geographical region were the household was located.

The estimated parameters from the multi probit model were then used to calculate the cumulative density functions (CDF) $\Phi_i(.)$ and the probability density functions (PDF) $\phi_i(.)$, which, in turn, were used to estimate the unit value and the second step of the demand vector proposed by Shonkwiler and Yen (1999).

As suggested by Deaton and Muellbauer (1988), and Dong et al. (1998), the unit value is an indicator of the household preferences. To consistently estimate the parameters of the budget share equation in (5), the following unit value equation was estimated:

(7) $P_{it} = \Phi(Z_{it}'\hat{\alpha}_i) f(X_{it}, \beta_i) + \eta_{ii}\phi(Z_{it}'\hat{\alpha}_i) + \xi_{it}$,

Where:

Pit is the unit value for each of the three types of meat, X includes income, urbanization, marriage status, age, and other household characteristics as well as quantity of meat consumed.

The parameter estimates from this procedure were then used to calculate the expected value of the different prices, especially for those households that do not consume any of the meats under consideration (i.e. the censored observations).

In the second step suggested by Shonkwiler and Yen (1999), equation (5) was modified as follows:

$$(8)\quad w_i = \Phi(.)\{\alpha_i + \sum_j \gamma_{ij} \ln P_j + \beta_i(\ln y - \ln P) + \frac{\lambda_i}{\prod_j p_j^{\beta_i}}(\ln y - \ln P)^2 + \sum_k \kappa_{ik} R_k\} + \pi_i \phi(.) + \varepsilon_i$$

Therefore, instead of using the traditional NQUAIDS specification of the budget share equation in (5), we use equation (8) to estimate the parameters needed to calculate the demand elasticities.

Note that the traditional symmetry and homogeneity constraints can still be imposed in equation (8) above. However, enforcing the adding-up constraint requires some adjustment as follows:

$$(9)\sum_{i=1}^{n} \Phi_i(.)\alpha_i = 1;$$

$$(10)\sum_{i=1}^{n} \Phi_i(.)\gamma_{ij} = 0;$$

$$(11)\ \sum_{i=1}^{n} \Phi_i(.)\beta_i = 0;$$

(12) $\sum_{i=1}^{n} \Phi_i(.)\lambda_i = 0$;

(13) $\sum_{i=1}^{n} \Phi_i(.)\kappa_{ik} = 0$.

Elasticity Calculation

Without censoring, the uncompensated own-price and cross-price elasticities associated with the Non-linear QUAIDS model in (8) can be calculated using the approach in Pofahl et al. (2005). However, using equation (3) the procedure for calculating price elasticities has to be modified as follows:

(14) $$\eta_{ij} = \frac{\partial \ln Q_i}{\partial \ln P_j} = \delta_{ij} + \frac{\partial \ln w_i}{\partial \ln P_j} = \delta_{ij} + \frac{1}{w_i}\frac{\partial w_i}{\partial \ln P_j}$$

where:

$$\frac{\partial w_i}{\partial \ln P_j} = \Phi(.)\{\gamma_{ij} - \beta_i \frac{\partial \ln P}{\partial \ln P_j} + \frac{\lambda_i(\ln y - \ln P)}{(\prod_j P_j^{\beta_i})}[2\frac{\partial \ln P}{\partial \ln P_j} - (\ln y - \ln P)\beta_i]\}$$

$$\frac{\partial \ln P}{\partial \ln P_j} = \alpha_j + 0.5\gamma_{jj} \ln P_j + \sum_{i \neq j} \gamma_{ij} \ln P_i$$

$$\delta_{ij} = \begin{cases} 1 & if\ i = j \\ 0 & otherwise \end{cases}$$

Expenditure elasticities then are computed as:

(15) $$\varepsilon_i = 1 + \frac{\partial \ln w_i}{\partial \ln y} = 1 + \frac{1}{w_i}\{\Phi(.)(\beta_i + \frac{2\lambda_i}{\prod_j P_j^{\beta_i}}(\ln y - \ln P))\}$$

Based on Slutsky's equation, the compensated price elasticities are derived as follows:

(16) $e_{ij}^{*} = \eta_{ij} + e_i w_j$

The standard error can be solved using the Delta method.

Data

Official Mexican Survey data for the years 1992, 1994, 1996, 1998, 2002, and 2004 was obtained from the Encuesta Nacional de Ingresos y Gastos de los Hogares (ENIGH). This survey is carried on for one week every two years and records data on food purchases and its monetary value for the three months prior to the survey week in households throughout Mexico. Socioeconomic characteristics of households are also recorded and include, among others, demographic data of household members, state, size of the town where the household was located, and frequency and place of food purchases.

The sample of households surveyed each two-year period varied and was considered to be independent every time, thus, the sample size used for the estimation also varied. For this research, only urban households located in towns larger than 15,000 inhabitants were considered. The data analyzed were the Mexican urban household purchases of beef, pork, and chicken meat. Aggregation over these generic types of meat was done because they are considered the three main categories of meat traditionally consumed in Mexico.

Table 1 shows the number of households analyzed and the percentage of Mexican urban households that purchase each type of meat in any given year. Around 80% of the Mexican urban households purchased at least one of the three types of meat analyzed and around 60% of the Mexican urban households in the sample purchased both beef and chicken but only 20% of them purchased pork.

Average price, expenditure, and budget shares for beef, pork and chicken meat, as well as, total meat expenditure are presented in Table 2. For any given year, beef, pork, and chicken meat budget shares were around 50, 10, and 40%, respectively.

Estimation Results

Multiple probit estimates for beef, pork, and chicken meat purchased in the Mexican urban households are presented in Table 3. Household size was the only variable significant ($p < 0.01$) for all equations across the years analyzed. As the number of members living in the household increased, purchases for all types of meat also increased. Income was significant ($p < 0.01$) for purchases of beef meat in 1992-1926 and 2002-2004; in 1998 income did not ($p > 0.01$) affected the probability of purchasing beef meat. In the case of probability of purchasing pork meat, income was significant ($p < 0.01$) in 1996 and 2004. Income affected ($p < 0.01$) the probability of chicken meat purchases only in 1996. In all cases, as income increased the probability of purchasing meat also increased. Regarding regional dummies, there was not a clear tendency on the effect of the geographical region where the household was located on the probability of purchasing a specific type of meat.

Parameter estimates for the Non-linear QUAIDS model are presented in Table 4. Most of the parameters estimated are statistically significant ($p < 0.05$); at the same time, most parameters associated to the quadratic term are significant ($p < 0.05$) in every year which supports the idea that, at least statistically, Non-linear QUAIDS is a good specification for the Mexican meat demand.

Expenditure, compensated own-price and cross-price elasticities are presented in Table 5. All along the analyzed period, expenditure elasticities suggest that beef and pork meat were luxury items (in the elastic range) while chicken was a normal good. The uncompensated own-price elasticities for 1992 are a little higher than those found by Golan, et al. (2001) for the same year (their elasticities of beef, pork, and poultry were -1.10, -0.56, -0.63 respectively), this may be likely due to the different methodology and data set used since Golan, et al. (2001) employed a sample with households buying at least one of the five types of meat they considered (beef, pork, chicken, processed meat and fish). Other factors explaining the difference may include the fact that they did not account for the sample selection issues when they dropped the households without meat consumption. Our elasticities are also higher than those reported by Dong, Gould and Kaiser in 1998 (the elasticities of beef, pork, and poultry were -0.63, -0.13, and -0.83 respectively in their paper). The reason for those differences might be related to the fact that we have considered a more aggregated meat demand system than theirs and that we only accounted for three meat categories in our estimation. At the same time, all our expenditure elasticities of beef, pork and poultry are a little higher for the years after NAFTA than those before NAFTA implementation. The uncompensated price elasticities of chicken are slightly higher after NAFTA as well.

Final remarks

Our study estimates Mexican meat demand parameters using six different annual surveys over a period of twelve years. We used an improved methodology over previous studies to take account for the endogenous relationship between unit values and qualities of meat. The elasticities found differ in some cases from the annual estimations of Golan et al. (2001 using 1992 data) and those of Dong et al. (2004) using 1998 data which were quite different from each other.

For all types of meat analyzed, 1996 and 1998 presented certain degree of variability. Data and results from 1996 and 1998 certainly reflect the state of the Mexican economy at that time. At this point in time, Mexico was still recovering from a devaluation of 100% of the peso in 1994.

Of all three types of meat analyzed, beef presented the most variability, in terms of elasticity, throughout the time period analyzed; however, elasticities at the end and beginning of the analyzed period were similar. Our results did not suggest that NAFTA cause significant consumer behavior changes during the first ten years. The results further suggest that any conclusion related to the effects of macroeconomic condition changes should be made carefully.

Our elasticities should provide basis for a more confident estimation of the price and income effects when forecasting the future trends of the Mexican meat market because they were estimated using the same methodology for the entire period of time analyzed. This becomes especially important because Mexico has turned into the second largest market for US meat and also because the recent ending of NAFTA liberalization process may impact domestic Mexican prices for chicken.

The high levels of expenditure elasticity found in this study for beef and pork meat in Mexico (luxury range) allows to project a fast expanding market for US exports given the expected growth of Mexican income (faster than the US income growth for the next ten years according to FAPRI).

The fact that meat demand parameters in Mexico seem to change very slowly with time under NAFTA implementation suggest that similar situation could be expected in the numerous developing countries with whom the US has signed or is negotiating Free Trade Agreements including liberalization of meat markets. (Central America, Dominican Republic, Chile, Peru, Colombia, Panama, etc.). That is, initial expansion of meat consumption due mostly to lower tariffs and prices, then to higher income levels and only in the long term due to changes in demand parameters or consumer behavior.

Finally, as mentioned earlier, a note of caution may be appropriate in regard to this study. The estimations presented here are based on a relatively small historical data set. The findings will be enhanced as more data becomes accessible. Although we did not find significant changes in the Mexico meat consumption parameters.

In summary, results from the Mexican meat demand systems estimated with the same methodology throughout 1992 to 2004, indicated that Mexican meat elasticities changed slightly when analyzed before and after NAFTA which reinforces the idea that elasticity differences among meat types found in previous studies are indeed due to changes in the methodology approach, as well as, overall macroeconomic conditions.

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Figure 1. Utility Tree of the Mexican Meat Consumption and scope of this research.

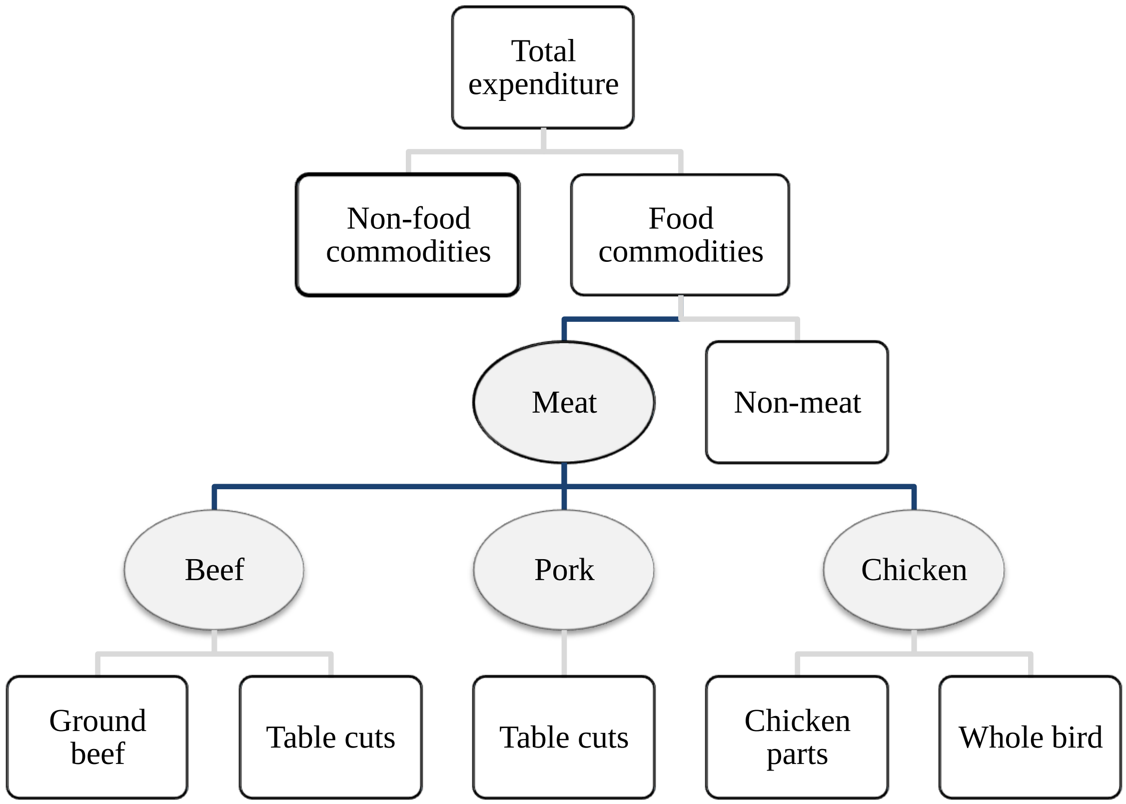

Table1. percentage of Mexican urban households that purchased beef, pork, chicken or at least one of these types of meat in the same time period

	Year					
	1992	1994	1996	1998	2002	2004
Mexican urban households	5,520	6,606	6,652	5,173	12,388	17,297
	Mexican urban households that purchased meat, %					
Beef	68	69	66	66	62	58
Pork	27	26	24	24	24	20
Chicken	60	59	55	57	57	55
At least one type of meat	84	84	81	81	81	77

Table 2. Average price, total meat expenditure, and budget share of beef, pork, and chicken meats in a sample of Mexican Urban Households for 1992 to 2004

	Year					
	1992	1994	1996	1998	2002	2004
	Average price, pesos kg^{-1}†					
Beef	15.44	13.43	12.08	11.37	9.86	11.31
Pork	14.19	12.31	11.56	10.56	8.67	9.87
Chicken	8.25	7.87	7.30	7.04	5.66	6.26
	Total meat expenditure†					
Beef	213.63	193.35	146.16	141.71	112.43	113.39
Pork	58.38	47.80	39.77	34.33	31.01	28.75
Chicken	116.24	104.04	83.97	81.11	72.90	76.91
	Average budget share, %					
Beef	0.53	0.55	0.54	0.50	0.50	0.50
Pork	0.13	0.13	0.13	0.12	0.13	0.12
Chicken	0.34	0.33	0.34	0.34	0.37	0.38

† real pesos of 1992

Table 3. Estimated probability of consumption of beef, pork, and chicken meats in a sample of Mexican Urban Households for 1992 to 2004

	Year								
	1992			1994			1996		
	Beef	Pork	Chicken	Beef	Pork	Chicken	Beef	Pork	Chicken
Intercept	0.15*	-0.92*	-0.37*	0.19*	-0.99*	-0.39*	0.03	-1.01*	-0.42*
Household size	0.07*	0.06*	0.08*	0.09*	0.09*	0.09*	0.07*	0.06*	0.08*
Income (10^{-2})	0.40*	0.00	0.02	0.57*	0.07	-0.04	2.36*	0.43*	0.38*
North West	-0.07	-0.51*	-0.10	-0.22*	-0.38*	-0.15*	-0.10*	-0.42*	-0.06
North East	-0.11*	-0.54*	-0.33*	-0.21*	-0.54*	-0.37*	-0.02	-0.47*	-0.32*
Center	0.02	0.20*	0.62*	-0.08*	0.00	0.63*	-0.01	0.11*	0.61*
South South East	-0.09*	0.41*	0.52*	-0.25*	0.30*	0.69*	-0.09*	0.39*	0.67*
	1998			2002			2004		
Intercept	0.08*	-1.06*	-0.35*	0.04	-1.11*	-0.32*	-0.11*	-1.24*	-0.46*
Household size	0.10*	0.08*	0.09*	0.07*	0.09*	0.08*	0.10*	0.10*	0.11*
Income (10^{-2})	0.26	-0.36	0.06	2.15*	0.29	0.09	0.35*	0.31*	-0.05
North West	-0.14*	-0.32*	-0.10*	-0.14*	-0.39*	-0.22*	-0.18*	-0.36*	-0.13*
North East	-0.18*	-0.44*	-0.29*	-0.09*	-0.49*	-0.35*	-0.02	-0.39*	-0.31*
Center	-0.01	0.14*	0.50*	-0.15*	0.12*	0.58*	-0.06*	0.07*	0.53*
South South East	-0.26*	0.47*	0.50*	-0.25*	0.35*	0.48*	-0.19*	0.32*	0.54*

* significant at 0.01.

Table 4. NQUAIDS Mexican beef and pork demand Parameter Estimated for 1992 to 2004

	Year					
	1992	1994	1996	1998	2002	2004
Beef	Estimates					
$\Phi(.)*$Beef Intercept †	2.99*	2.06*	5.47*	2.05*	3.19*	6.55*
$\Phi(.)*$ln(Beef price) †	-1.83*	-1.97*	-2.55*	-2.11*	-3.19*	-4.91*
$\Phi(.)*$ln(Pork price) †	-0.52*	1.13*	-0.01	1.00*	1.78*	3.02*
$\Phi(.)*$(lnY-lnP) †	0.30*	0.24*	0.13*	0.31*	0.33*	0.11*
$\Phi(.)*(\text{lnY-lnP})^2$	0.24*	-0.04*	0.18*	-0.06*	0.25*	-0.05*
$\Phi(.)*$IMR†	-0.89*	-0.58*	-0.52*	-0.44*	-0.47*	-0.52*
$\Phi(.)*$Household size	0.05*	0.03*	-0.11*	-0.01	-0.03*	-0.21*
$\phi(.)$ †	-0.08*	-0.50*	-3.73*	-0.58*	-1.29*	-3.72*
Pork						
$\Phi(.)*$Pork Intercept	0.35*	0.35*	1.02*	0.82*	0.83*	0.31*
$\Phi(.)*$ln(Pork price)	-1.54*	-2.13*	-2.37*	-2.66*	-4.34*	-4.03*
$\Phi(.)*$(lnY-lnP)	0.24*	-0.01	0.18*	-0.07	0.25*	0.20*
$\Phi(.)*(\text{lnY-lnP})^2$	-0.05*	0.02*	-0.05*	0.03*	-0.03*	-0.01*
$\Phi(.)*$IMR	-0.20*	0.002	-0.001	0.07*	-0.14*	-0.09*
$\Phi(.)*$Household size	0.04*	-0.002	0.005	-0.01	0.01*	0.02*
$\phi(.)$	0.89*	0.28*	0.39*	0.16*	0.26*	0.21*
Survey's sample size	4654	5569	5408	4178	10083	13340
Likelihood	9079	10986	10636	8188	19888	26478

* significant at 5%.

† $\Phi(.)$: Cumulative density function based whether a household purchases a specific type of meat; Beef price: "Simulated" beef unit value; Pork price: "Simulated" pork unit value; Y: Total meat expenditure; IMR: Inverse mill ratio calculated based on whether a household purchases meat; $\phi(.)$: Probability density function based on whether a household purchases a specific type of meat.

Table 5. Estimated, Uncompensated and Compensated Own-price and Cross-price and Expenditure Elasticities of Three Types of Meat in Mexico, for 1992 to 2004

	Year								
	1992			1994			1996		
Type of meat	Beef	Pork	Chicken	Beef	Pork	Chicken	Beef	Pork	Chicken
	Uncompensated cross price elasticities								
Beef	-1.07	-0.05	0.09	-1.08	-0.05	0.11	-1.22	-0.05	0.13
Pork	-0.04	-0.68	-0.27	-0.04	-0.60	-0.36	-0.41	-0.78	-1.04
Chicken	0.11	-0.26	-0.82	0.10	-0.38	-0.77	0.07	-0.74	-0.86
	Compensated cross price elasticities								
Beef	-0.52	0.50	0.64	-0.52	0.51	0.67	-0.60	0.57	0.75
Pork	0.09	-0.55	-0.14	0.09	-0.47	-0.24	-0.29	-0.66	-0.92
Chicken	0.43	0.06	-0.49	0.41	-0.06	-0.45	0.33	-0.48	-0.60
	Expenditure elasticities								
	1.03	0.97	0.96	1.03	0.99	0.96	1.16	0.92	0.78
	1998			2000			2004		
	Uncompensated cross price elasticities								
Beef	-1.35	-0.73	1.02	-1.16	-0.14	0.23	-1.29	-0.04	-0.08
Pork	-0.71	-0.82	0.52	-0.12	-0.61	-0.27	0.10	-0.70	-0.39
Chicken	1.48	0.97	-0.85	0.25	-0.28	-0.99	-0.20	-0.64	-0.92
	Compensated cross price elasticities								
Beef	-0.65	-0.03	1.71	-0.53	0.49	0.87	-0.59	0.65	0.61
Pork	-0.58	-0.69	0.65	0.02	-0.47	-0.13	0.22	-0.58	-0.27
Chicken	1.67	1.16	-0.66	0.50	-0.03	-0.75	0.07	-0.38	-0.65
	Expenditure elasticities								
	1.30	1.04	0.55	1.25	1.07	0.67	1.39	1.05	0.70