NAFTA at 20: Structural Change in Mexican's Demand for U.S. Meat Products

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Background:

The North American Free Trade Agreement (NAFTA) entered its 20th year as a unique and the first reciprocal free trade agreement among asymmetrically developed nations – Mexico, a developing country and both Canada and the United States being developed countries (Echeverri-Carroll, 1995; McGaughey and Jr, 1992). This trilateral trade agreement called for the elimination of all barriers on trade and investment flow among Mexico, Canada and the United States over a 15-year timeline. The potential effectiveness of this asymmetrical trade agreement generated much controversy, with critics highlighting Mexican small farmers as the biggest losers. However, twenty years after it went into effect, U.S. imports from as well as exports to Mexico have increased dramatically. A number of factors (economic expansion and liberalization of the Mexican economy in the mid 1980's, and rising household income levels) other than NAFTA, with NAFTA as a major driving force has substantially influenced US-Mexican trade and this has change the consumption pattern among Mexican households in the last two decades or so. According to FAO data, meat imports and consumption increased considerably in Mexico in the last couple of years.

In the last two decades the Mexican meat market has reflected a sustained growth in domestic household demand. Per capita household meat (beef, poultry and pork) consumption levels went up from 78.93 lbs in 1990 to 137.3 lbs in 2012 according to World Bank data. Chicken consumption level went up much faster than pork and pork went up slightly faster than beef resulting in an increase in per capita chicken consumption by 3kg and per capita pork consumption by 2.4 kg since 2006 (USMEF, 2013). However, beef consumption dropped by nearly 2kg within the same period. This situation is typical of a developing country where food consumption is generally responsive to economic and income growth causing movement away from the

consumption of predominantly grain or carbohydrate based food products to a more protein-rich and diversified or balanced diet.

Studies have shown that a shift in the consumption of meat and animal products can be caused by factors other than price and income change. For the case of Mexico, factors cited for this rise in consumption is a combination of rising incomes, urbanization, higher import flows to complement domestic production in meeting rising demand, and changes in tastes and preferences. High import flows has been facilitated by the gradual elimination of trade barriers (total elimination of trade restrictions for beef and other meat products took place in 2008), increasing the affordability and accessibility to U.S. beef, poultry and pork. Population growth rate in Mexico has contracted in the last decades and price levels for meat and meat products experienced high price explosiveness (beef price increased by 52.74% between 2009 and 2013). With these situations, an argument for an increase in demand for meat and meat product could be made. This study draws on these dynamics to examine any structural changes in Mexican demand for U.S. meat and meat product due to the North American Free Trade Agreement that eliminated all trade restrictions by the end of 2008.

Intense debate ensued over the impact the trilateral agreement would have on the Mexican economy and on the livelihood of its populace. Nonetheless, twenty years after NAFTA came into effect, the literature is silent on how the high agricultural exports inflow to Mexico – Mexico was the third, second and first largest volume market for U.S. beef, pork and broiler chicken in 2013 – from the US have influenced the dietary pattern of the growing Mexican middle-class population. This paper contributes to the literature in that regard by providing evidence for the impacts of NAFTA on Mexican's demand for U.S. meat products. Following Eales and Unnevehr (1994),

quantities are treated as exogenously predetermined due to the biological lags associated with meat production and prices adjust to clear the market.

Methodology:

The almost ideal demand system (AIDS) model developed by Deaton and Muellbauer (1980) is suitable and widely used to empirically estimate static demand systems, with many desirable properties (e.g. Eales and Unnevehr, 1988; etc). The model provides a theoretical basis that preserves the generality of both the Translog and Rotterdam models – capable of applying the second-order Taylor expansion to unknown functions and has similar statistical testing of constraints respectively. The AIDs model in budget shares is given as

$$w_i = \alpha_i + \beta_i \ln\left(\frac{X}{P}\right) + \sum_{j=1}^{q} \gamma_{ij} lnp_j \quad i = 1,2, \dots \dots \dots, q, \qquad (1)$$

where α_i , β_i , γ_{ij}^* are parameters, w_i is the share of total expenditure allocated to the ith good, p_i is the price of good i, X is the total expenditure given by:

$$X = \sum_{i=1}^{q} p_i x_i \ , \qquad (2)$$

P is the Deaton and Muellbauer's exact price index defined by:

$$lnP = \alpha_o + \sum_{k=1}^{q} \alpha_k \, lnp_k + \frac{1}{2} \sum_{k=1}^{q} \sum_{l=1}^{q} \gamma_{kl} lnp_k lnp_l \qquad (3)$$

and $\gamma_{ik} = \frac{1}{2}(\gamma_{ik}^* + \gamma_{ki}^*) = \gamma_{ki}$

By Shepard's lemma, the restrictions on the demand functions are deduced from the cost function and the resulting conditions imposed during the estimation of the constrained model are given as:

[Adding up] $\sum_{i=1}^{q} \alpha_i = 1$, $\sum_{i=1}^{q} \gamma_{ij} = 0$, $\sum_{i=1}^{q} \beta_i = 0$,

[Homogeneity] $\sum_j^q \gamma_{ij} = 0,$

[Symmetry] $\gamma_{ij} = \gamma_{ji}\ ,$ $\forall\ i\ and\ j.$

The adding up restriction is automatically satisfied. The Marshallian or uncompensated demand elasticities were derived from equation (1) and estimated using the formula below:

$$e_{ij}^{*} = -\delta_{ij} + \frac{1}{w_i}\left[\gamma_{ij} - \beta_i\left(\alpha_j + \sum_k^q \gamma_{kj}\, lnp_k\right)\right] \qquad (4)$$

The formula used to calculate the expenditure elasicities is given as:

$$\eta_i = 1 + \frac{\beta_i}{w_i} \qquad (5)$$

The Slutsky equation was then used to derive the formula for the Hicksian or compensate price elasticity for good i with respect to the price of good j as:

$$e_{ij} = -\delta_{ij} + \frac{\gamma_{ij}}{w_i} + w_j - \frac{\beta_i}{w_i}\left(\alpha_j + \sum_{k=1}^{q} \gamma_{kj}\, lnp_k - w_j\right) \qquad (6)$$

where the Kronecker delta δ_{ij}, is equal to one if $i = j$ and zero otherwise.

To identify any structural changes due to the North American Free Trade Agreement and to account for the gradual reduction in tariffs, a trend effect and a dummy variable for NAFTA are included into the intercept term α_i as

$$\alpha_i = \alpha_{i0} + \upsilon_{ih} t + \mu_{ij} d_t \qquad (7)$$

where d_t is a dummy variable for NAFTA

$$d_t = \begin{cases} 1, & if\ t \leq 2008 \\ 0, & if\ t > 2008 \end{cases}$$

The NAFTA variable is included in the model to determine changes that occurred in Mexican meat demand with the total elimination of tariff and non-tariff barriers to U.S meat exports to Mexico in 2008. The trend term is expected to capture the effect of the degree of market openness and any

trend-induced factors that influenced meat consumption. Given the added variables, the adding up restriction requires that $\sum_{i=1}^{q} \alpha_{i0} = 1$ and $\sum_{i=1}^{q} \mu_{ij} = 0 \ \forall j$, and $\sum_{i=1}^{q} v_{ih} = 0 \ \forall h$.

Data:

The model is estimated using monthly data from January 1994 to February 2013 inclusive on three nondurable meat groups namely pork and pork products, beef and beef products, and chicken and chicken products. Monthly quantities and values for each meat group were obtained from the Economic Research Services, USDA. Monthly prices were the unit prices for each commodity derived from the ratio of value over quantity. Quantity data represent the per capita consumption of beef, pork and chicken in grams computed by dividing export quantity by population. Data on the average annual population were obtained from the World Bank database and were used as a proxy for average monthly population. The parameters for $q - 1$ equations were estimated using the iterative nonlinear seemingly unrelated regression (SUR) with restrictions on the parameters. The parameters in the last equation are recovered from the imposed restrictions.

Results:

Table 1 shows the average budget for the three different kinds of meat in a consumer's meat expenditure. Consumer's demand for beef is larger than poultry, which is slightly higher than pork. Two demand factors could be attributed to this situation: relatively higher supply of pork and poultry meat to beef resulting to relatively higher average beef prices. The estimated parameters of the AIDS equation for the demand of U.S. meat in Mexico are presented in Table 2. With the exception of the trend and dummy variables, the estimated parameters do not have

straightforward economic interpretation but forms the basis of deriving the price and expenditure elasticities.

The NAFTA dummy and trend effect variables are statistically significant with negative and positive effects respectively. Given the declining trend in U.S. beef exports to Mexico (see Figure 1) after total elimination of tariffs in 2008, the negative coefficient of the dummy in the beef equation suggests a decline in the preference for U.S. beef. Figure 1 shows a gradual shift from the import and consumption of U.S. beef to U.S. poultry and pork since 2008. This trend contradicts the negative coefficient estimates of the dummy variables in the pork and poultry equations. There exist a gradual shift in the structural demand for all three meat commodities but the direction of the shift in poultry and pork do not meet *a prior* expectation.

Table 2 report estimates of average Marshallian price and expenditure elasticities for the study period. The own-price elasticities are all found to meet expectation with negative signs except poultry with a positive sign. The own-price elasticities were mostly inelastic. The value of elasticity is however lowest for poultry in absolute terms followed by pork mostly due to the small expenditure share. Beef is the most responsive to price changes with the highest own-price elasticities. This is not surprising since beef is the most expensive followed by pork, and then poultry. This in part explains the steady decline in the consumption of U.S. beef which could have been compounded with the discovery of BSE in U.S. beef. The uncompensated cross price elasticities of all meats are negative. It's an indication that these meats are complements for each other violating economic theory. Nonetheless, Mexican dishes often requires multiple types of meat, a possible explanation to the unusual elasticity signs.

The expenditure elasticities generally had the expected signs. The beef and beef products is expenditure elastic whiles pork and poultry are income inelastic. U.S. beef can be identified as

a normal and a luxury good in Mexico and pork and poultry are normal and necessities. Following the decrease in beef consumption after the total elimination of tariffs, one would expect relatively higher expenditure elasticities for pork and poultry. The dip in consumption may be as a result of the fall in supply and not a shift in consumer preferences. The estimates of average Hicksian or compensated demand elasticities are given in Table 4. With the exception of pork as a net substitute for poultry, all cross price and own price coefficients have similar signs as the uncompensated elasticity estimates. The values of the compensated elasticities are generally lower than the uncompensated elasticity after accounting for expenditure and budget shares.

Conclusion:

The estimates of this study adds to the lingering debate on the effectiveness of NAFTA on the Mexican economy. With the very limited studies on the meat consumption pattern in Mexico after NAFTA implementation, the paper contributes to the literature by providing evidence of structural changes in demand and elasticity estimates. The AIDS model suggests that after NAFTA there is a decline on average, in the preference for U.S. beef in Mexico. The decline in exports and higher beef prices caused a shift in consumption from beef to poultry and pork. The results for pork and poultry consumption are however inclusive. The elasticity estimates also show that all three types of meat – beef, pork, and poultry – have inelastic demand. The cross price elasticities shows that meat types are complement for each other. Also, all meat can be considered as normal to luxury goods, as expected *a priori.* Poultry have a relatively low expenditure elasticity and can therefore be considered a necessity as a protein source in Mexican diets.

References:

Barten, A. P. Consumer Allocation Models: Choice of Functional Form. Empirical Economics, 18 (1993): 129-158.

Deaton A & Muelbauer J: An Almost Ideal Demand System. The American Economic Review 70(3):312–326. (1980).

Eales Js & Unnevehr Lj: Demand for beef and chicken products: Seperability and structural change. American Journal of Agricultural Economics 70(3):521-532. (1988).

Eales Js & Unnevehr Lj: The inverse almost ideal demand system. European Economic Review 38:101–115. (1994).

Echeverri-Carroll, Elsiel, ed. Nafta and Trade Liberalization in the Americas. Publication place: University of Texas at Austin Bureau of, 1995.

McGaughey, William, and Jr. A U.S.-Mexico-Canada Free-Trade Agreement: Do We Just Say No? Minneapolis: Thistlerose Pubns, 1992.

U.S. Meat Export Federation: http://www.usmef.org/usmef-mexico-conducts-beef-pricing-seminars/ (2013).

Appendix:

Table 1: Estimated average budget share

Variable	Mean
Pork	0.2673561
Poultry	0.2744877
Beef	0.4581563

Table 2: Parameter estimates of almost ideal demand system

Parameter	Coefficients	Std Err
γ 11	0.23617***	0.0289
γ 12	-0.03535*	0.0185
γ 13	-0.09392**	0.0311
γ 22	0.27590***	0.0196
γ 23	-0.1335***	0.0255
γ 33	0.22744	0.0188
β 1	-0.03833*	0.0228
β 2	-0.1532***	0.0197
β 3	0.19159	0.0279
α 1	0.37784***	0.0310
α 2	0.57466***	0.0272
α 3	0.04749	0.0223
μ 1	0.00045**	0.000168
μ 2	0.00032**	0.000153
ν 1	-0.084***	0.0127
ν 2	-0.1073***	0.00985

Table 3: Marshallian or Uncompensated Demand and Expenditure Elasticities

	Pork	Poultry	Beef
Pork	-0.23384	-0.21201	-0.40266
Poultry		0.08319	-0.41403
Beef			-0.88632
Expenditure	0.848512	0.42379	1.43361

Table 4: Hicksian or Compensated Demand Elasticities

	Pork	Poultry	Beef
Pork	-0.0070	0.0208	-0.13910
Poultry		0.1995	-0.21987
Beef			0.13984

Table 5: Estimated Parameters for Trend and Structural Changes in Trend

	Pork	Poultry	Beef
Trend	0.000675*** (0.000167)	0.000619*** (.000152)	0.000623*** (0.000159)
Dummy	-0.08853** (0.0131)	-0.10382*** (0.0119)	-0.07354*** (0.0124)

Figure1: U.S. Meat Imports to Mexico