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NAFTA AT 21: STRUCTURAL CHANGE IN MEXICAN'S DEMAND FOR U.S. MEAT AND MEAT PRODUCTS

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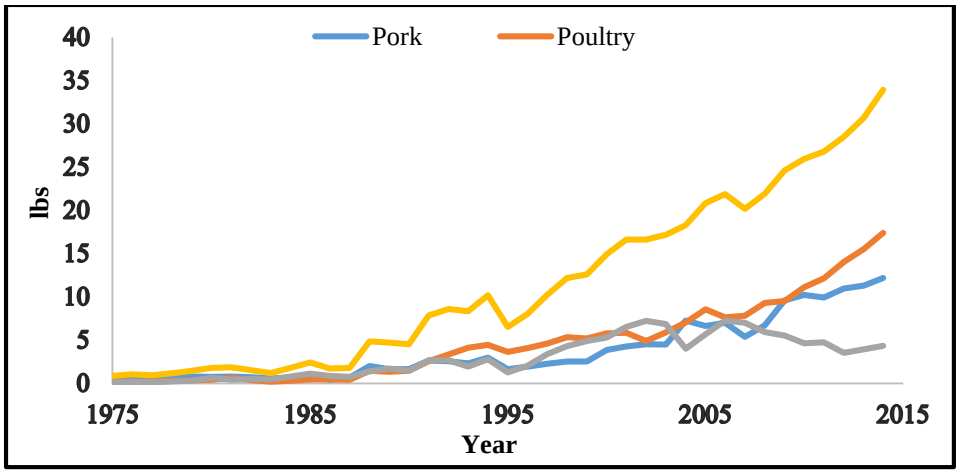
Abstract

The purpose of this paper is to examine the influence of the North American Free Trade Agreement (NAFTA) on the change in consumer preference for U.S. meat and meat products in Mexico and to provide empirical estimates of the extent of sensitivity of meat price change to change in quantity demand. The analyses used an Inverse Almost Ideal Demand System (IAIDS) model to address the study objectives due to its appropriateness in modeling the level of utility for commodities with fixed or exogenously determined short run supply. The study findings show that Mexico's participation in NAFTA could have indirectly effected a structural change in demand for imported meat from the U.S. but the direction of change is heterogeneous among the different meat groups. Also, while Mexican demand for U.S. meat is inflexible, price response to changes in the quantity of imported U.S. poultry is much sensitive compared to pork and beef.
Keywords: *NAFTA, Structural Change, Meat Demand, Mexico, Flexibility*
JEL Codes: *F140 F150 Q11 Q170*

1. Introduction and Background

In the last two decades, the Mexican meat (beef, poultry, and pork) market has reflected a sustained growth in domestic household consumption. Per capita household meat consumption levels went up from 103lbs in 1993 to 137.41lbs in 2014, an increase of about 33 percent. However, per capita consumption of meat imported from the United States expanded by more than 300 percent between 1993 and 2014. Meat imports from the United States form a significant portion of the total domestic meat consumption in Mexico and accounts for about 13 percent of Mexico's beef consumption, 25 percent of poultry consumption, and 34 percent of pork consumption.

Figure 1 shows the annual consumption of U.S. beef, pork and poultry in Mexico from 1974 through 2014. The structure of consumption has changed. Chicken consumption level has increased substantially and much faster than pork and beef with an increase in per capita consumption by 13lbs since 1993. Pork consumption level also went up faster than beef. Mexicans consumed 9.8 more pounds per capita of imported U.S. pork in 2014 than in 1993 but consumed only 2.4 more pounds per capita of imported U.S beef in 2014 than in 1993. With regards to share contribution of the different meat groups in total U.S. meat consumed, the share of beef in total imported U.S. meat consumed declined from 27 percent in 1993 to 13 percent in 2014, while pork and poultry expanded to 36 percent and 51 percent in 2014 from 29 percent and 44 percent in 1993 respectively.



Source: *USDA/FAS database and IMF World Economic Outlook database*

Figure 1. Per Capita Consumption of U.S. Meat

A number of factors other than the theoretical price and income changes have been proven empirically to explain the shift in the consumption of meat and other animal products. For the case of the changing Mexican demand towards U.S. meat and meat products, a combination of rising incomes, higher import flow from the U.S. due to tariff elimination, emerging middle-class population, and changes in relative prices are important determinants shaping Mexican consumers demand. Many trade analysts argue that, much of the changes in these factors could be directly or indirectly linked to Mexico's participation in the North American Free Trade Agreement (NAFTA) in 1994 (see Lustig, Bosworth, & Lawrence, 1992; Burfisher, Robinson, & Thierfelder, 2001; De Janvry, A. 1996; Kose, M. M. A., et. al, 2004; Villarreal, M. A. & Fergusson, I. F., 2015; Zahniser, S., et. al, 2015). Thus, there is a possibility that the NAFTA deal has been instrumental in the changing taste and preference for U.S. meat and meat products in Mexico.

From the foregoing, the question that this paper seeks to address is: how has Mexican's consumption of U.S. meat and meat products changed as a result of NAFTA? It begins with examining whether Mexico's participation in the NAFTA deal has indirectly effected a structural change in the demand for U.S. meat and meat products. A long run effect of the free trade agreement could be a change in the characteristics – quality and price – of meat and meat products on the Mexican market which could influence consumers' choice decision towards U.S. meat and meat products. Second, it calculates the extent of substitutability among the three meat types to give insight into the changing consumption pattern towards imported meat from the United States. Consumption decisions or choices among the three meat groups imported from the U.S. by Mexico has important implications for the U.S. meat industry since Mexico is the largest volume market for U.S. pork, poultry, and beef[1]. Yet no previous literature has analyzed the possibility of structural change in Mexicans' demand for imported meat from the U.S. This paper seeks to contribute to the ongoing debate about the direct and indirect effect of the NAFTA on the Mexican economy.

The remainder of the paper is organized as follows. The next section provides a brief overview of NAFTA with a focus on agricultural trade between U.S. and Mexico. The ensuing

[1] The Mexican market represent 20%, 31% and 23% of all U.S. beef, pork and poultry volume exports respectively.

section describes the method used to address the study objectives followed by a succinct discussion of the data and data source. A discussion of the results and conclusion are contained in the last two sections respectively.

2. Overview of NAFTA

The North American Free Trade Agreement entered its 21st year in 2015 as the first, largest, unique, and comprehensive reciprocal free trade agreement among two highly developed economies – U.S. and Canada – and a developing country – Mexico. The agreement was hailed as comprehensive because it covered not just trade in goods and services but also investments, labor markets, and environmental policies. Yet it was considered an asymmetric economic integration (Echeverri-Carroll, 1995; McGgaughey, 1992) due to the wide disparity between the U.S. and Canadian economies on one hand and the Mexican economy on the other hand. Mexico, at the time of initial negotiation, was coming out of protectionism and gradually opening up its markets to global trade to cushion its ailing economy – increasing national debt, falling oil process, rising interest rates and high volatility of its currency were contributing to the deepening economic crisis and social instability in the country. As such, the Mexican government negotiated several trade policies that would help stabilized the economy. Some of the trade policies undertaken included the unilateral reduction in the average weighted imports tariffs and joining the General Agreement on Tariffs and Trade (GATT) in 1986. Later on, Mexico entered into two separate bilateral trade agreement with the U.S. and Canada under the umbrella of the NAFTA in 1994 which ended in 2008. The participation in the NAFTA was a realization of the Mexican government's policy initiative to opening up the country to investment and trade with its neighboring countries. The NAFTA planned to eliminate all tariff and quota barriers to agricultural and other trade and investment flow among the three North American countries. Elimination of tariffs for some sensitive commodities for each country was, however, effected progressively over a 14-year timeline until 2008.

Tariff and quota elimination for agricultural commodities were implemented using a six-period phase-out schedule or transition periods: January 1994, January 1998, January 2002, January 2003, October 2007 and January 2008. For example U.S. fresh strawberries, sorghum, certain citrus fruits, and oranges exported to Mexico became duty-free immediately in 1994. Likewise, duty-free access was granted to a same set of commodities from Mexico in the United States in addition to corn, barley, soy meal, apples, pears, peaches, beef, pork, and poultry immediately the NAFTA was effected (Hufbauer, 2005). Tariffs on certain commodities were gradually eliminated at each schedule period until all tariff rate quotas fully phased out in 2008. The choice of tariff elimination period for all commodities to some degree was influenced by the level of sensitivity and importance of crop(s) to each country's economy, prevailing national agricultural policies and standards set under the general agreement on tariffs and trade.

One of the major expectations of the three countries for such multilateral cooperation was to create a single regionally integrated market which will drastically reduce the cost of imports and inflation to spur trade and investment among the NAFTA partners. Twenty-one years after implementation, it is evident from the increasingly broad array of agricultural commodities traded and the rate at which commodity price effect(s) are transmitted across the three countries, that the agricultural market is nearing integration (Zahniser, S, et. al, 2015). Agricultural trade between U.S. and Mexico has more than quintupled during the NAFTA period. At the time of implementation, agricultural trade balance between the U.S. and Mexico was $1.7 billion, Mexico deficit, but current data shows only $92 million Mexico deficit in 2014, representing 95 percent in deficit reduction over the NAFTA period. Thus, evidently, trade liberalization spurred agricultural trade between U.S. and Mexico and contributed substantially to the decline in Mexico's agricultural trade deficit with the U.S.

The level of agricultural trade, however, varied by commodity. For instance, in 2014, meat and meat product made up more than one-fifth of U.S. agricultural exports to Mexico, up from 14 percent in 1994. Growth in meat exports represented about 22 percent of total agricultural export growth. This sustained growth performance in meat imports from the U.S. underscores the response of Mexican consumers to changing economic conditions – incomes are rising, as such, the middle-class population is expanding and consumer tastes and preference towards protein-rich diets have heightened. Thus, the removal of trade restrictions could have, in part, spurred economic expansion in Mexico, which has, in turn, stimulated an increase in demand for U.S. meat and meat product.

3. Methodology

There is very few application of the differential approach[2] to consumer demand in import demand studies in a developing country context. These models are rooted in economic theory but their use as appropriate estimation techniques depends on the type of commodity under investigation and requires data, especially price data, with the relevant variation to identify key parameters. However, most often than not price data for agricultural commodities are rare in developing countries and if available does not have the desired variability characteristics. In the specific case of U.S. meat and meat products to Mexico, the short run supply is assumed to be fixed and exogenously determined. This is because not only is meat a perishable commodity with relatively shorter storage life but also import supply of meat from the United States are exogenously determined by the level of trade restriction in place at a particular time period. In such situations, price other than quantity must adjust for the market to clear. The use of a quantity dependent differential model such as the inverse almost ideal demand system (IAIDS) model as opposes to price dependent differential model is more appropriate in modeling the level of utility or demand for such commodity.

The IAIDS model as developed by Eales and Unnevehr (1994) has been widely used to empirically estimate quantity dependent demand systems. The model preserves most of the desirable properties of the traditional AIDS model. However, consumer preferences are represented by the distance function as opposed to the cost function. The distance function characterizes the amount by which all quantities consumed must be changed proportionally to attain a target utility level (Eales & Unnevehr, 1994). It is defined mathematically by

$$log\ D(u,q) = (1-u)log\{a(q)\} + ulog\{b(q)\} \tag{1}$$

where D denotes the distance function, u is the utility and q is a quantity vector, $a(q)$ and $b(q)$ are positive homogenous functions representing quantity of subsistence $(u = 0)$ and quantity of bliss $(u = 1)$ respectively. The specific functional forms for $log\ a(q)$ and $log\ b(q)$ are given by

$$loga(q) = \alpha_0 + \sum_k \alpha_k logq_k + \frac{1}{2}\sum_k \sum_j \gamma_{kj}\ logq_k logq_j \tag{2}$$

$$logb(q) = loga(q) + \beta_0 \prod_k {p_k}^{\beta_k} \tag{3}$$

Substituting (2) and (3) into (1) gives the IAIDS distance function as

[2] Examples include the Rotterdam model (Theil, 1965; and Barten 1966), the Translog model (Christensen, Jorgenson, and Lau, 1975), and the Almost Ideal Demand System (Deaton & Muellbauer, 1980a)

$$log\ D(u,q) = \alpha_0 + \sum_k \alpha_k logp_k + \sum_k \sum_j \gamma_{kj}\ logq_k logq_j + \beta_0 \prod_k {p_k}^{\beta_k} \quad (4)$$

The compensated inverse demand equations are then derived by differentiating (4) with respect to quantities consumed: $\partial D(u,q)/\partial q_i = p_i$. To get the budget share, w_i, both sides are multiplied by $q_i/D(u,q)$ to get

$$\frac{\partial logD(u,q)}{\partial logq_i} = \frac{p_i q_i}{D(u,q)} = w_i \quad (5)$$

The IAIDs model in budget shares is therefore given as

$$w_i = \alpha_i + \beta_i logQ + \sum_j \gamma_{ij}\ logq_j \quad (6)$$

where α_i , β_i , γ_{ij} are parameters, w_i is the share of total expenditure allocated to the ith good, q_i is the quantity of good i, Q is the quantity scale index defined by:

$$logQ = \alpha_o + \sum_k \alpha_k logq_k + \frac{1}{2}\sum_k \sum_j \gamma_{kj}\ logq_k logq_j \quad (7)$$

and $\gamma_{ij} = \frac{1}{2}\left(\gamma_{ij}^* + \gamma_{ji}^*\right)$

$logQ$ is nonlinear in parameters, hence estimating equation (7) requires nonlinear estimation methods. To avoid estimating such complex nonlinear systems, Q is usually approximated to some known index Q^* by using a Stone's quantity index: $log\ Q^* = \sum w_k\ logq_k$. This index is similar to the Stone price index used by Deaton and Muellbauer (1980) to estimate linear approximation AIDS (LA/AIDS) model. The following conditions should be satisfied or imposed during estimation for the IAIDS model to be theoretically meaningful: $\sum_{i=1}^{q} \alpha_i = 1$, $\sum_{i=1}^{q} \gamma_{ij} = 0$, $\sum_{i=1}^{q} \beta_i = 0$ (adding up); $\sum_j^q \gamma_{ij} = 0$ (homogeneity); and $\gamma_{ij} = \gamma_{ji}$ (symmetry) $\forall\ i\ and\ j$.

The share equation is expanded to include a dummy variable for NAFTA participation to control for possible structural changes in demand due to NAFTA. The NAFTA dummy is introduced as shift on the intercept term as $\alpha_i = \alpha_{i0} + \mu_{ij} d_t$, where d_t is the dummy variable for NAFTA: $d_t = 1$ if $t \geq 1994$ and $d_t = 0$ if $t \leq 1994$. If the coefficient on the NAFTA dummy variable is positive and statistically significant in the meat share equation then there is evidence that the implementation of NAFTA significantly effected an indirect structural change in Mexican's demand for U.S. meat and meat products.

The inverse demand system estimation measures sensitivities between price and quantity in terms of flexibilities (Houck, 1965). According to Eales and Unnevehr (1994), flexibilities can be interpreted in a similar fashion as elasticities. For example price flexibilities measures the percentage change in normalized prices resulting from a 1 percent change in the consumption of a good while scale flexibilities show the percentage change in the normalized price of that good in response to a proportionate change in the consumption of all goods. Scale flexibilities greater than -1 are luxury goods and less than -1 are necessity goods (Eales and Unnevehr 1994). The uncompensated demand flexibilities are derived from equation (7) and estimated using the formula below:

$$f_{ij} = -\delta_{ij} + \frac{1}{w_i}\left[\gamma_{ij} + \beta_i\left(w_j - \beta_j logQ\right)\right] \quad (8)$$

where the Kronecker delta δ_{ij}, is equal to one if $i = j$ and zero otherwise. The formula used to calculate the scale flexibility is given as:

$$f_i = -1 + \frac{\beta_i}{w_i} \quad (9)$$

The compensate price flexibility for good i with respect to the quantity of good j is derived as:

$$f_{ij}^{*} = f_{ij} - w_j f_i \quad (10)$$

4. Data

The model is estimated using monthly time series data from January 1974 to December 2014 inclusive on three nondurable meat groups namely pork and pork products, beef and beef products, and chicken and chicken products. Monthly import data (quantity and value) for each meat group were derived from the Foreign Agricultural 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 pounds computed by dividing import quantity by Mexico's population. It is assumed that all imported quantities are totally consumed. Data on the average annual population obtained from the World Bank database was used as a proxy for average monthly population. The demand system is estimated using the Seemingly Unrelated Regression (SUR) estimator with restrictions on the parameters. The parameters for $q - 1$ equations were estimated and the last equation was recovered from the imposed restrictions. After imposing the theoretical restrictions there were 492 observations and 12 parameters to be estimated.

5. Results and Discussion

The parameter coefficients for the linear IAIDS model for all three meat groups and the NAFTA dummy after imposing homogeneity and symmetry restrictions are reported in table 1. The R-square for each share equation and the expenditure share of each meat group are reported in the last two columns of table 1. The estimated model fit well with the data as shown by the high explanatory power of 0.79, 0.88 and 0.94 for the pork, poultry and beef share equations respectively. With the exception of the NAFTA parameter for the poultry share equation, most model parameters are significant at the 99% confidence level and exhibit their *a prior* or theoretical signs. The estimated coefficients formed the basis of deriving the compensated and uncompensated quantity and scale flexibilities with no straightforward economic interpretation with the exception of the NAFTA dummy which has direct implication for the existence or nonexistence of structural effect in the demand for U.S. meat and meat products in Mexico.

The structural change in preference was examined under the framework of "changing tastes and preferences" and the potential effect was explicitly modelled by introducing a state variable in the demand system to capture the evolving or systematic preference for U.S. meat due to NAFTA's elimination of trade barriers which allow the free flow of commodities from the U.S. to Mexico (Moschini & Moro, 1995). The estimated coefficients on the NAFTA dummy imply that the preferences underlying the demand for U.S. meat and meat products in Mexico have changed over time with NAFTA in place. However, the indirect effect of NAFTA varied across the different meat groups. While the beef and pork share equations showed positive and statistically significant indirect NAFTA effect, the poultry share equation exhibited a negative and statistically significant indirect effect of NAFTA. Thus, the participation of Mexico in the NAFTA agreement was found to significantly impact the demand for all the three meat groups from the U.S. Evidently, the demand parameters and preference for U.S. meat and meat products in Mexico have, therefore, undergone a structural change due to the NAFTA agreement.

Table 1. Parameter Estimates of Inverse Almost Ideal Demand System

	Intercept	**Pork**	**Poultry**	**Beef**	**Scale**	**NAFTA**	R^2
Pork	0.301*** (0.003)	0.206*** (0.003)	-0.104*** (0.003)	-0.101*** (0.002)	-0.020*** (0.005)	0.009** (0.004)	0.94
Poultry	0.346*** (0.003)	-0.104*** (0.003)	0.189*** (0.004)	-0.085*** (0.002)	-0.092*** (0.007)	-0.071*** (0.005)	0.79
Beef	0.352*** (0.003)	-0.101*** (0.002)	-0.085*** (0.002)	0.186*** (0.003)	0.113*** (0.007)	0.062*** (0.006)	0.88

The participation in NAFTA decreased the poultry budget share for U.S. meat consumption expenditure by 7.1% and increased the pork and beef budget shares by 6.2% and 0.9% respectively. The results also suggest that the average budget share for the three meat groups in a Mexican consumer's meat expenditure for U.S. meat and meat products shows a relatively higher average budget share for beef (40%), followed by pork (33%) and then poultry (27%). This is not surprising given the declining trend in beef imports during the NAFTA period forcing average unit price for beef to increase to a relatively higher level. Pork and poultry imports increased tremendously during the NAFTA period and this may have significantly driven average unit prices for pork and poultry down. However, overall import quantities of meat from the U.S. more than quintuple after NAFTA causing an increase in the relative consumption of U.S. meat and meat products in Mexico. This reinforces the increased in average unit price for U.S. beef and pork during the NAFTA period when imports or supply grew at a relatively slower rate.

Next, the flexibility or substitutability measures were evaluated at the mean of the expenditure shares using equations 8-9 and estimates for the uncompensated own and cross quantity flexibilities, as well as the scale flexibilities, are presented in table 2. The estimated own quantity flexibilities are shown in the diagonal entries of the table and the off-diagonal elements represent the cross price flexibilities. The own quantity flexibilities for all meat groups had expected negative signs, which indicates that for each meat group when the quantity goes up, the price will go down. The own-quantity flexibilities are less than 1 in absolute terms, indicating that demand for U.S. meat is inflexible. However, the Mexican meat market is relatively more sensitive to increased beef quantities from the U.S. compared to pork and poultry. A 1% increase in the consumption of beef supplied or imported from the U.S. is associated with a 0.437% decline in the average normalized unit price of U.S. beef in Mexico.

Table 2. Uncompensated Demand and Scale Flexibilities

		Price Flexibilities		
	Scale Flexibility	Pork	Poultry	Beef
Pork Price	-1.061	-0.405	-0.331	-0.156
Poultry Price	-1.349	-0.516	-0.392	-0.049
Beef Price	-0.718	-0.325	-0.441	-0.437

Results reported in table 2 also suggests that pork and poultry consumption are a little less flexible than beef consumption. The magnitude of their own quantity substitutability is similar, as such, an increase (decrease) in pork and poultry consumption by one percent was found to decrease (increase) average normalized unit price by 0.41% and 0.39% respectively. The compensated quantity flexibilities show a rather high inflexibility of demand for U.S. meat and meat products. The findings for the own quantity flexibility is more evident from the level of import quantity of the different meat groups, where import volumes for pork and poultry are expanding albeit a gradual decline in beef import quantities and per capita consumption

level. Any increase in beef quantity is likely to dampen prices faster than pork and poultry quantity change and this might not look attractive to beef importers in Mexico and exporters in U.S. alike. The less sensitivity of pork and especially poultry to own quantity change is a probable cause to the increasing relative supply of both products experienced in Mexico.

Table 3. Compensated Demand Flexibilities

	Pork	Poultry	Beef
Pork	-0.05	-0.044	0.10
Poultry	-0.07	-0.027	0.098
Beef	0.268	0.145	-0.149

The results for the cross quantity flexibilities indicate that the meat groups are all quantity-substitutes but with relatively low magnitude. Thus, they are weak quantity-substitutes. The cross effect of pork quantity change on poultry price is relatively higher. A 1% increase in the quantity of pork results in a 0.52% decrease in the normalized price of poultry. Pork price is in turn more sensitive to changes in poultry supply (0.33%) than beef supply (0.16). The price response of beef to cross quantity changes ceteris paribus is more prevalent for poultry (0.44) than pork (0.32). However, the response of Mexican consumers' to U.S. beef quantity increases result to a relatively small reduction in the price (0.049) of U.S. poultry meat. These results have implications for the effect of meat supply on prices and can influence production and exports decisions among U.S. meat producers.

Table 4. Estimated Average Budget Share

Variable	Mean	Std. Dev	Min	Max
Pork	0.33	0.130	0.143	0.827
Poultry	0.27	0.085	0.046	0.721
Beef	0.40	0.138	0.021	0.711

The information conveyed by the scale flexibility is the relationship between proportional change in a normalized price (marginal value) and the scale expansion in the consumption bundle. It measures the effect on marginal value from an increase in consumer welfare (Park & Thurman, 199). As expected, an increase in the scale of consumption by 1% (i.e. all U.S. meat quantities increase by 1%), is associated with a decline in the normalized meat price of 0.72% for beef, 1.3% for pork and 1.0% for pork. The scale flexibility for pork is close to -1, meaning the preference for pork is homothetic, i.e. the consumption of pork is independent of the level of total expenditure and the marginal rate of substitution of pork for the other meat groups is constant. The scale flexibility of poultry also means that the price of imported poultry from the U.S. is more sensitive to the change in aggregate U.S. meat consumption, making beef price the least sensitive to increases in aggregate meat consumption.

6. Conclusion

The consumption of U.S. meat and meat products in Mexico has expanded greatly after the NAFTA implementation, most especially for poultry and pork. The elimination of import restrictions for most U.S. agricultural commodities in Mexico has been argued to contribute to growth in agricultural trade flows beside other factors as rising incomes, emerging middle class, and changing tastes and preferences. Twenty-one years after NAFTA, it is only appropriate to examine if the changes in Mexican demand for U.S. meat and meat products is as a result of Mexico's participation in the NAFTA and also understand the extent of

substitutability of the three meat groups over the study period. The results have both policy and production implications for U.S. meat producers.

The LA/IAIDS model was utilized to address the two stated objectives: examining the impact of NAFTA on structural change in preference for U.S. meat and meat products in Mexico and estimating the extent of substitutability among the three meat groups. Three meat share equation systems were constructed and analyzed with the iterated SUR estimator. The data and results show that the structure of consumption for U.S. meat and meat products in Mexico has indeed changed. The change could be largely attributed to the NAFTA implementation, which was shown to be statistically significant for all the meat share equations. The direction of influence, however, varied across the three meat groups. Both beef and pork budget shares had a positive effect from NAFTA against a negative effect on poultry budget share. Specifically, the budget share of poultry in total expenditure for U.S. meat declined by 7.1% as a result of NAFTA whiles beef and pork budget shares expanded by 6.2% and 0.9% respectively. Growing poultry consumption or imports drove down the average unit price faster than pork. The average unit price of beef has been rising given the declining trend in imports during the NAFTA period.

The substitutability or flexibility measures reflect a more sensitive beef price to own quantity change compared with pork and poultry. However, the beef price is less sensitive to overall consumption change whiles Mexican consumers' price response to poultry is much sensitive to pork quantity changes. The results suggest that there exist a weak substitution relationship among the three meat group. Thus the effect on price change from a change in the supply of any meat type only has a marginal effect on its own price and the price of the other meat groups. In the long run, effective artificial price controls for U.S. meat and meat products in Mexico can be undertaken with an understanding of the extent of meat substitutability as examined in this paper.

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