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Impact of NAFTA on the Preference for Meat Consumption in USA: An Inverse Demand System Approach

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ABSTRACT: This study examines the impacts of NAFTA on meat demand and develops an inverse demand system model for meat to analyze price and scale flexibility. The inverse demand system model for meat products suggests that, After NAFTA, there is a decline in average on the preference for beef consumption. The availability of low quality beef and the concern over infectious disease through the imported beef might be the reasons for this decline on the preference for beef consumption. Results show that all meats are substitutes to each other and proportionate increase in all meats reduce the price for meats.

Keywords: Inverse demand system model; NAFTA; Price and Scale Flexibility
JEL Classification: Q11; Q17; D12; F13

1. Introduction

The study of U.S total expenditure on meat production is particular important to meat industry in the United States and to the economy in general since around 27 percent of food expenditure is spent on meat products (Haley,2001). The final provisions of the North American Free Trade Agreement (NAFTA) were fully implemented on January 1, 2008. Launched on January 1, 1994, NAFTA is one of the most successful trade agreements in history and has contributed to significant increases in agricultural trade and investment between the United States, Canada and Mexico and has benefited farmers, ranchers and consumers throughout North America. From 1992-2007, the value of U.S. agricultural exports worldwide climbed 65 percent. Over that same period, U.S. farm and food exports to two NAFTA partners grew by 156 percent.

The U.S is also one of the world leading importers and producers of beef and pork products. The General Agreement on Tariffs and Trade (GATT), North American Free Trade Agreement and Uruguay Rural Agreement on agriculture are opening up the U.S meat market. Only very minor tariffs now affect meat imports into the United States. The face of international trade is altering quickly, especially with globalization as one of the key catalysts for change. It can be argued that free trade leads to better allocation of resources and increased competitive forces, which reduce production cost and ultimately consumer prices and increase quality of product. Canada-US Free Trade Agreement (CUSTA) in 1989 eliminated tariffs on both live cattle and beef within a few years of its implementation. NAFTA refined the policies outlined in CUSTA and extended them to Mexico. In Canada and the U.S, the cattle and beef industries have a significant impact on the economy and play major role in agriculture of both countries. Canada and Mexico continue to be the United States' primary trading partners in cattle. Beef imports from Canada prior to the implementation of the US-Canada free trade agreement in 1989 were subject to quantitative restrictions under the U.S meat import act of 1979. Since 1990, beef import from Canada has grown steadily upward. The value of U.S. poultry exports to Mexico and Canada has increased nearly 40 percent since 1994 with gains of more than 11 percent annually. The recent growth in demand from Mexican consumers has already led to annual imports that exceed NAFTA quotas.

The elimination of tariffs on beef exports to Mexico, negotiated under the NAFTA, has resulted in strong growth in the market for United States beef. Trade is just one factor affecting the beef and cattle market. Other important factors affecting U.S cattle and beef prices are the changes in domestic supply, changes in disposable income, changes in market conditions for competing meats and changes in consumer tastes and preferences. U.S meat prices are determined at the retail level and work their way back along the supply chain to the wholesale and producer levels. Short – term fluctuations in margins along the supply chain may exist due to the changing supply and demand conditions.

Trade can benefit consumers in several ways. Trade gives consumers access to a wider variety of products. An indirect benefit to consumers occurs when domestic producers strive to compete with imported products by seeking ways to improve their products or lower their costs of production through increased efficiency. Food safety is an important example of a broad consumer issue with an agricultural trade component. U.S. consumers are concerned about the adequacy of existing U.S. food safety regulations and the effectiveness of government enforcement. They have expressed similar concerns about the safety of imported food products

This study tries to develop an inverse demand system model for meat to analyze price and scale flexibility and the impacts of NAFTA on meat demand. This study considers monthly demands for aggregate meat. In short run, quantities are more properly viewed as exogenous rather than prices. The quantities are predetermined by domestic production and imports at the market level and prices must adjust so that available quantities are consumed. This implies that quantity based measures may be more appropriate at the aggregate level. Given these facts, inverse demand system analysis is most suitable to achieve the objectives of this study.

2. Methodology

Since inverse demand systems provide the theoretical basis for empirical applications related to analysis of quantity effects for price adjustable products, the studies of inverse demand systems have been focused on by many economists. Inverse demand systems have been developed according to two different approaches. The first one utilizes the Rotterdam methodology, which is a direct approximation of the conceptual inverse demand relationships without imposing restrictions that is implied by utility maximization. (Barten and Bettendorf, 1989; Matsuda, 2005). Even though the Rotterdam method is difficult to incorporate into the demand systems without having an idea about the structure of preferences, the Rotterdam method can obtain the inverse demand systems which explain well the quantity effect on prices in terms of the substitution effect and scale effect.

An alternative method to the Rotterdam method is based on a dual representation of preferences, which, in turn, is based on a specified functional form of the direct utility or distance function. (Kim, 1997; Wong and McLaren, 2005). The distance function is a convenient vehicle for generating inverse demand systems incorporating structural features required for most welfare analysis applications. Furthermore, since concavity and montonicity are preserved under addition and the nesting of increasing concave functions, a straightforward way of generating wider classes of regular distance functions is readily available (Wong and McLaren, 2005).

To derive an inverse demand system, preferences are represented by distance function. It characterizes the amount by which all quantities consumed must be changed proportionally to attain a particular level of utility. That is, it gives the proportional "distance" along a ray from the origin by which quantities must be reduced or inflated to reach a particular indifference surface. Given utility function U{q}, the distance function D{u,q} is a scalar giving the amount by which all quantities in the current consumption bundle, q, must be divided to reach the indifference surface defined by u. Thus, distance function D is implicitly defined by U{q/D(u,q)}= u. The distance function possesses properties similar to the cost function: It is linearly homogenous, concave, and non-decreasing in quantities. Differentiation of the logarithmic distance function with respect to the quantity of particular good yields the compensated inverse demand function for that good.

Moschini and Vissa (1992) and Eales and Unnevehr (1993) followed this approach and developed an inverse, almost ideal, demand system. Good i's expenditure share, w_i, is

$$\mathbf{w}_i = \alpha_i + \sum_{j=1}^{n} \gamma_{ij} \ln q_j + \beta_i \ln Q \quad (1)$$

Where q_i is the quantity of good i. and lnQ is defined by

$$lnQ = \alpha_0 + \sum_{k=1}^{n} \alpha_k \ln q_k + 0.5 \sum_{k=1}^{n} \sum_{j=1}^{n} \gamma_{kj} \ln q_k \ln q_j \qquad (2)$$

The demand restriction $\sum_i \alpha_i = 1$ $\sum_i \gamma_{ij} = \sum_i \beta_i = 0$ (adding up); $\sum_j \gamma_{ij} = 0$ (homogeneity); and $\gamma_{ij} = \gamma_{ji}$ (symmetry) are imposed on the system.

Price elasticities are typically calculated in ordinary demand systems. Price flexibilities, defined as the percentage changes in normalized prices (prices divided by total expenditure) caused by a 1 percent change in the consumption of that good, may be calculated in inverse demand systems. Furthermore, the scale flexibility is the analogous to the expenditure elasticity. The scale flexibility of good i show the percentage change in the normalized price of that good in response to a proportionate increase in the consumption of all goods.

The uncompensated price flexibility, f_{ij}, and scale flexibility, f_i, are calculated as

$$f_{ij} = -\delta_{ij} + \frac{\gamma_{ij}}{w_i} + \frac{\beta_i}{w_i}\left(\alpha_j + \sum_k \gamma_{kj} \ln q_k\right) \qquad (3)$$

and

$$f_i = -1 + \frac{\beta_i}{w_i} \qquad (4)$$

Where $\delta_{ij} = 1$ for $i = j$ and $\delta_{ij} = 0$ otherwise.

Deaton and Muellbauer (1980: 320) suggested that other variables could be included in the almost ideal model by allowing the constant terms in equation (1), (2) and (3) to vary with them. Following this approach, A dummy variable for NAFTA, degree of openness for meat trade with foreign countries which was measured by the ratio between sum of export and import of meat product and domestic production of meat and interaction of openness and NAFTA are introduced into the system such that

$$\alpha_i = \alpha_{i0} + \theta_{ij}\,\text{Nafta} + \lambda_{ih}\,\text{openness} + \mu_{ik}\,\text{NAFTA*openness}. \qquad (5)$$

Dependent variable is expenditure share of each commodity. Then, sum of expenditure share on the system should be 1. This restriction was imposed on the system. Adding up requires that $\sum_i \alpha_{i0} = 1$ and $\sum_i \theta_{ij} = 0\ \forall j$, $\sum_i \lambda_{ih} = 0\ \forall h$, and $\sum_i \mu_{ik} = 0\ \forall k.$ Where θ_{ij} is the coefficient of NAFTA dummy variable.

3. Econometric Framework

Three groups of meat are included in the system: beef, pork and chicken. Monthly prices and quantities from January 1980 and December 2003 were obtained from Economic Research Services, USDA and Bureau of Labor Statistics, Department of Labor. It is necessary to consider the stochastic properties of relevant econometric models in selecting a desirable model, in which the estimated, unknown parameters should be unbiased, consistent, and efficient. The econometric model specification should be formed to reflect the features of stochastic procedure and the data used in the study. This includes contemporaneous correlation of disturbance terms in the equations of the system, singularity related to the adding up condition in the budget share equations, the autoregressive process in the time series data in the inverse demand systems.

There is correlation between the disturbances in individual budget share equations of the system because of the substitutability/complementarity of the meat products used in the study. If the disturbances are correlated with each other, system of estimation procedure yields coefficient estimators, at least asymptotically, more efficient than single equation least square estimators. Therefore, this study will basically use Zellner's seemingly unrelated regression model. However, in using a SUR model, many other stochastic issues should be solved to get a consistent and efficient estimation. The demand theory restriction of the adding up, homogeneity and symmetry conditions are imposed. Related to the adding up condition in budget share equations, singularity is a critical problem because the covariance matrix of the disturbance terms is singular. This restriction can be imposed by dropping one of the equations and other equations were estimated by SUR. Estimates of the dropped equation were recovered from the estimates of other equations. One of the distinguishing features of the inverse demand systems is that quantity is predetermined.

4. Results and Discussions

In short run, quantities are more properly viewed as exogenous rather than prices. I assumed that the quantities are predetermined by domestic production, exports and imports at the market level and prices must adjust so that available quantities are consumed. This implies that quantity based measures may be more appropriate at the aggregate level. Given these facts, inverse demand system analysis is most suitable to achieve the objective of this study. Thus, the inverse model is appropriate. Test statistics and parameter estimates from the inverse model using SUR estimates are therefore reported.

The mean shares of total expenditures, w, and the Durbin-Watson values, DW, are reported in table 1. DW values are in inconclusive region for each equation. Because the difference value of these variables was used to estimate this model there is no severe autocorrelation. The estimated parameters are reported in table 2. The uncompensated price, scale flexibilities are presented in table 3.

Table 1. Mean shares and Durbin-Watson values

Equation	w	Dw
Beef	0.423698	2.356
Pork	0.286777	2.234
Poultry	0.289525	2.25

Table 2. Estimated parameters with t values in parentheses

	α_{i0}	θ_i			γ_{ij}			β_i
					With respect to quantity of			
	Intercept	open	NAFTA	NAFTA*open	beef	pork	chicken	lnQ
Beef	0.0382*	0.0140*	-0.01119*	-0.00286*	0.2365**	-0.1487**	-0.0879**	0.0457**
	(2.27)	(2.29)	(-2.26)	(-2.13)	(13.81)	(-14.04)	(-5.28)	(4.05)
Pork	-0.0217	-0.0081	0.00655	0.00156	-0.14866**	0.2526**	-0.10398**	0.0799**
	(-1.39)	(-1.41)	(1.42)	(1.25)	(-14.04)	(20.67)	(-7.71)	(7.53)
Chicken	0.9935*	-0.0059	0.00464	0.00129	-0.08789**	-0.1039**	0.19187**	-0.1256**
	(2.43)	(-0.70)	(0.69)	(0.70)	(-5.15)	(-7.52)	(8.26)	(-8.05)

* - 5% significant
**- 1% significant

NAFTA dummy is statistically significant and negative in the beef equation. It suggests that, due to the NAFTA agreement, there is a change in the preference for beef consumption. After NAFTA, beef export and import has increased among NAFTA partners. High quality of US beef is exported to Canada and Mexico. Canada export live cattle and beef to America. Mexico export mainly live cattle. America is net importer of beef. Because High quality of US beef exported and low quality of beef imported. The low quality of beef available in the US market has increased. Consumers in U.S may concern over disease that may be encountered in imported beef. Therefore, there may be a slight decline in the preference for beef consumption in U.S. NAFTA dummy in the chicken and pork equation is positive but not significant. After the NAFTA, the net export of chicken and pork has increased to Mexico and Canada. The domestic chick and pork production and quality of these meats have increased. In this model, the intercept represents exogenous trend in consumption. It suggests that there is a huge increase in the consumption of chicken and a slight increase in the consumption of beef over the years.

Table 3. Uncompensated price and scale flexibilities calculated at mean values

	Uncompensated price flexibility with respect to quantity of			Scale flexibility
	beef	pork	Chicken	
Beef	-0.48736** (29.58)	-0.38176** (14.90)	-0.23863** (5.51)	-0.89226** (32.68)
Pork	-0.63654** (16.00)	-0.199** (4.70)	-0.63005** (8.70)	-0.72112** (19.00)
Chicken	-0.11972** (6.25)	-0.48358** (9.35)	-0.21167** (5.98)	-1.4339** (26.62)

** - Significant at 1% level, (t value in parentheses)

The price flexibilities show the percentage changes in the normalized prices associated with a 1 percent change in the supplied quantity of meat. All the own compensated and uncompensated price flexibilities are negative. This shows that an increase in the supply of each meat reduces its normalized price. The own uncompensated price flexibilities of beef, pork and chicken are –0.487, -0.199 and -0.221 respectively. These values imply that a 10 percent increase in the supplied quantities is associated with 4.87, 1.99 and 2.27 percent decline the price of beef, pork and poultry respectively. The own price flexibility of beef and chicken is nearly same as the value Kesavan and Buhr (1995), and Surajudeen (1993) found on their study on Inverse demand system approach to Meat products in United States. They considered only beef, pork, chicken and other food in their system approach. If a study includes more commodities in the demand system this value become large.

The cross price flexibility of all meats is negative and significant. It indicates that these meats are substitutes each other. Scale flexibility of all meats is negative and significant. The scale flexibility of meat shows the percentage change in the normalized price of that meat in response to a proportionate increase in the supply of all meats. As the quantities increase, the scale flexibilities show that the normalized price also decreases as expected. The scale flexibility is higher for chicken. This means that the price of chicken is more sensitive to the changes in aggregate food consumption.

5. Conclusion

This inverse demand system model for meat products suggests that, After NAFTA, there is a decline in average on the preference for beef consumption. The availability of low quality beef and the concern over infectious disease through the imported beef might be the reasons for this decline on the preference for beef consumption. Results show that all meats are substitutes to each other and proportionate increase in all meats reduce the price for meats.

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