The Potential For High-Value Agricultural Products Under The North American Free Trade Agreement: The Case of Beef in Mexico and Canada

Okwudili O. Onianwa*

Abstract

The prospects for U.S. beef products in the advent of a North American Free Trade Agreement were examined using a system-wide approach to import allocation. Results indicate that increases in the standard of living in Mexico and Canada would stimulate increased importation of processed and unprocessed beef products. Bulk beef product in both countries had expenditure elasticities greater than one, while semi-processed and highly processed beef products had expenditure elasticities of less than one.

Key words: bulk, high-value, highly processed, import share, NAFTA, semi-processed

Introduction

The recently ratified North American Free Trade Agreement (NAFTA) is expected to boost total United States agricultural sales given continued income and population growth, particularly in Mexico. Since the mid 1980's, U.S. agricultural exports to Mexico have grown significantly from $1.4 billion to approximately $4 billion in 1992 (Coats, Jr.). This increase is largely attributed to the unilateral liberalization in Mexico, the comparative advantages of the two countries, and the relatively strong performance of the Mexican economy. Between 1990 and 1993, income growth in Mexico averaged 3.6 percent annually. Improved economic activity resulting from the NAFTA agreement will further enhance income, and hence stimulate increased demand for agricultural products. It is estimated that this agreement would increase annual U.S. agricultural exports by $2 billion (Madigan).

Several studies have noted that the benefits from this trade agreement are commodity specific. Certain specialty crops, fruits, vegetables, and horticultural products will face high competition under NAFTA due to their high labor requirement (Kennedy, et al. and Disney). Beef trade, on the other hand, is generally projected to be favorable. Lee et al. have shown that increases in real per capita income in middle-income developing countries are negatively related to the import shares of processed wheat products but positively related to the import shares of bulk wheat. Conversely, the import shares of U.S. processed beef products were found to be positively related to increases in income.

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*The author is assistant professor of Agricultural Economics at Alabama A&M University. This research was completed at the University of Arkansas at Pine Bluff where the author was assistant professor of Agricultural Economics. The author wishes to acknowledge Oral Capps, Jr., Richard Levins, Brian Buhr, Magid Dagher, Richard Alderfer and Carole Engle for their useful comments and suggestions. Appreciation is also expressed to other anonymous referees.

J. Agr. and Applied Econ. 27 (2), December, 1995: 377-385

United States export trade in beef with Mexico is very significant. In 1990, beef and veal export stood at $80.8 million, beef variety meats, $31.6 million, tallow, $57.3 million, and, hides and skins $83.4 million. Live cattle export yielded a total of $55.4 million, of which $11.0 million comprised beef breeding stock, $35.2 million, dairy breeding stock, and $9.2 million cattle for slaughter (USDA, 1992). Consequently, information on future performance of high-value products (HVPs) under the NAFTA will provide valuable insights into the probable future directions of these products.

The objective of this study is to assess the potential for exporting processed and unprocessed beef products under NAFTA. Results of this work will provide pertinent information necessary to take greater advantage of this trade agreement. The methodology employed is discussed, followed by description of the data used, results of the analysis, and discussion of the implications.

Methodology

To evaluate the export potential of beef products, a two-stage budgeting process is employed following Armington. This process involves the assumption of a weak separable utility function for the importing nations subject to a budget constraint. First, it is assumed that the importing nations (Mexico and Canada) allocate total import expenditures on U.S. products among competing goods. In the second stage, the given expenditure for a specific product is allocated among different classes of that product differentiated by the value-added activities or the unit value. In this sense, commodities are differentiated by their unit values or their level of enhancement into unprocessed, semi-processed, and highly processed products. Thus, fresh or frozen beef is treated differently from live cattle and prepared or preserved meat products.

By assuming block independent preferences (Theil et al.), a system-wide approach to import allocation to estimate demand for HVPs from the U.S. was used. This approach permits the estimation of the demand equations for all beef classes simultaneously, thus accounting for interdependencies among the various classes. Conditional demand functions from the second stage are used to estimate the parameters. For empirical estimation, the absolute version of the Rotterdam model was adopted to fit the data. Specifically the demand for HVPs is given as:

$$(w_{it}^{*}.D_{q_{it}}) = \phi_i.DQ_g + \sum_{j=1} \pi_{ij}.Dp_{ijt} + e_{it}^{*} \quad (1)$$

where:

g = import markets

ij = class of products (unprocessed, semi-processed and highly processed product)

t = time (years)

q_{it} = Quantity of HVPs imported from the U.S. in time t

Dq_{it} = $\log(q_{it}/q_{it-1})$

w_{it} = value share of HVP imported from the U.S. in time t

w_{it}^{*} = $(w_{it-1} + w_{it})/2$ = two year value share average of HVPs imported from the U.S.

DQ_g = $\Sigma_i(w_{it}^{*}.Dq_{it})$

$\Sigma_i w_{it}$ = w_g^{*}= Total group value of HVP imported in country g in time period t and t_{-1}

P_{ijt} = real import price of beef (unprocessed, semi-processed or highly processed) products in time t

DP_{ijt} = $\log(P_{ijt}/P_{ijt-1})$

π_{ij}^* = the conditional slutsky price coefficient between *i*th and *j*th class in a particular group $P_{ij}^*=(P_iP_j/m)(\partial q_i/\partial p_j)$

ϕ_i = (ϕ_i/m_g) = the conditional marginal budget share of country *g*'s HVPs import

$e_{i,t}$ = random error terms assumed normally distributed with zero mean.

Note that the conditional marginal budget share gives what proportion of a *$1.00* increase in income would be spent on commodity *i*. The duality concept implies the following restrictions:

$$\sum_i \phi_i = 1 \qquad (2)$$

$$\sum_j \pi_{ij} = 0 \qquad (3)$$

$$\pi_{ij}^* = \pi_{ji}^* \qquad (4)$$

The above specifications are the adding up, linear homogeneity and the symmetry conditions, respectively. The homogeneity and symmetry conditions were tested using the likelihood ratio test (Alston et al.). The derived values in both cases were below the critical values at 5 percent significant level of the chi-square distribution, thus satisfying the hypotheses of homogeneity and symmetry. From this specification, three measures of elasticities are possible: the Cournot, the Slutsky, and the Frisch. The Slutsky elasticities were derived to account for both the substitution and income effects.

Data Description

To facilitate this study, data for beef products were constructed using data from the *Foreign Agricultural Service* of the USDA. Beef products were classified into bulk, semi-processed, and highly processed products. Annual data for 1978 to 1988 were used in the analysis. The difference in classification precluded the use of data prior to 1978. Bulk products in this study refer to live cattle exported for slaughter, while semi-processed products consist of all chilled, fresh and frozen beef. Prepared and preserved beef and veal products are consumer-oriented highly processed beef products.

Semi-processed and highly processed beef products are measured in metric tons, while unprocessed bulk beef consists of live cattle exported for slaughter. Again, data limitation prevented the conversion of bulk products to metric ton or to per pound basis. The weight of an animal (cattle) depends on the breed, the stage of growth and other factors. These important information were not available, therefore, it is not rational to assume a common average weight for all types of live cattle exported.

Real import unit values were computed as the ratio of total export value of good *i* to total national export of good *i* deflated by the consumer price index (*CPI*) (1986=100) as:

$$RP_i = (Total\ Export\ Value/Total\ National\ Export) / CPI \qquad (5)$$

Data for the *CPI* were taken from the *World Agricultural Trend and Indicators* published by the USDA supplemented with data from the *International Financial Statistics published by the IMF*. For simplicity, other factors such as trade barriers and other policy variables were not considered. All prices are in US dollars.

A summary of the descriptive statistics of the data used in this analysis are presented in tables 1 and 2. At the means, the average value shares of beef products for the period under consideration were 61, 24, and 15 percent for bulk, semi-processed, and highly processed beef in Mexico while the average value shares for beef products in Canada were 26, 59, and 15 percent, respectively. Similarly, on average, real import unit values were

Table 1. Descriptive Statistics of Variables Used in the Analysis of U.S. Beef Export To Mexico (1978-1988)

	Bulk	Semi-Processed	High-Processed
Average budget share	0.61260	0.24235	0.14506
Standard deviation	0.21326	0.11532	0.11272
Maximum	0.89800	0.49959	0.32797
Minimum	0.17244	0.07105	0.02260
Average real import price	0.47661	2.69320	2.49540

Table 2. Descriptive Statistics of Variables Used in the Analysis of U.S. Beef Export To Canada (1978-1989)

	Bulk	Semi-Processed	High-Processed
Average budget share	0.25806	0.59017	0.15177
Standard deviation	0.17072	0.15433	0.05816
Maximum	0.57886	0.81015	0.24508
Minimum	0.07280	0.32499	0.07224
Average real import price	0.45177	3.92220	3.42130

$477.00, $2,693, and $2,495 for bulk, semi-processed and highly processed beef products in Mexico, respectively. In Canada, the average real import unit values were $452, $3,922, and $3,421 for bulk, semi-processed, and highly processed beef products, respectively.

Estimation Results

Maximum likelihood estimates for beef import demand in Mexico and Canada are presented in tables 3 and 4. These estimates were constrained by homogeneity and symmetry restrictions. To mitigate the problem of singularity of the variance-covariance matrix of the disturbance terms, one equation was omitted. The parameters of the omitted equation were derived through the homogeneity conditions. The omitted equation corresponds to highly processed beef products. In the case of Mexico (table 3), the t ratios indicate that with the exception of two, all the coefficients are significant at the five percent level. The diagonal elements are all negative. The conditional marginal budget shares for bulk, semi-processed and highly processed beef were 0.74, 0.22, and 0.04, respectively.

Therefore, when U.S. beef expenditure share in Mexico increases by *$1.00*, live cattle expenditures increase by $0.74, fresh and frozen beef expenditures increase by $0.22, while prepared

Table 3. Parameter Estimates For Conditional Beef Export Demand to Mexico

	Conditional Marginal Share	Conditional Slutsky Coefficient			
Beef Products	θ_i	P_b	P_s	P_h	R^*
Bulk Cattle	0.74 (11.4)	-0.33 (-1.57)	0.18 (1.40)	0.15 (1.46)	0.92
Semi-Processed	0.22 (5.20)		-0.07 (-0.62)	-0.10 (-1.30)	0.77
High-Processed	0.04			-0.05 (0.40)	

* Square of correlation between observed and predicted values.
Value of log-likelihood function 17.03.
Number in parentheses are t-ratios.

Table 4. Parameter Estimates For Conditional Beef Export Demand in Canada

	Conditional Marginal Share	Conditional Slutsky Coefficient			
Beef Products	θ_i	P_b	P_s	P_h	R^*
Bulk Cattle	0.29 (2.47)	-0.08 (-2.24)	0.08 (2.45)	0.002 (0.18)	0.67
Semi-Processed	0.59 (6.00)		-0.08 (-2.53)	0.050 (0.40)	0.76
High-Processed	0.12			-0.05 (-2.83)	

* Square of correlation between observed and predicted value.
Value of log-likelihood function 21.2.
Number in parentheses are t-ratios.

and preserved meat products expenditures increase by $0.04. This suggests that among the beef products, the total expenditure on prepared and preserved meat products is least.

Similarly, in table 4 for Canada, the t ratios indicate that all the coefficients are significant at the five percent level except two. The diagonal elements are all negative as expected. The conditional marginal budget shares for the three beef classes were 0.29, 0.59, and 0.12 for bulk, semi-processed and highly processed beef, respectively. This suggests that, when U.S. beef expenditure share in Canada increases by $1.00, live cattle expenditures increase by $0.29, fresh and frozen beef products by $0.59, while the preserved and prepared beef products expenditure increases by $0.12.

Tables 5 and 6 present the compensated mean price elasticity estimates for beef export shares to Mexico and Canada. The elasticity estimates are in accordance with prior expectations.

In Mexico, the conditional expenditure elasticities were 1.20, 0.90, and 0.28 for bulk, semi-processed and highly processed beef products, respectively. The income elasticity estimates of 0.90 and 0.28 for semi-processed and highly processed

Table 5. Mean Elasticity Estimates For Beef Products in Mexico

Products	Conditional expenditure elasticity	Bulk	Semi Processed	Highly Processed
Bulk	1.20	-0.54	0.29	0.24
	(14.1)	(-1.60)	(1.45)	(1.50)
Semi Processed	0.90	0.74	-0.29	-0.41
	(4.81)	(1.42)	(-0.62)	(-1.20)
Highly processed	0.28	1.03	-0.69	-0.34
		(1.50)	(-1.20)	(-0.37)

* Numbers in parentheses are t-ratio.

Table 6 Mean Elasticity Estimates For Beef Products in Canada

Products	Conditional expenditure elasticity	Bulk	Semi Processed	Highly Processed
Bulk	1.12	-0.30	0.29	0.007
	(2.75)	(2.0)	(2.45)	(0.13)
Semi Processed	0.99	0.13	-0.14	.090
	(5.99)	(2.44)	(-2.52)	(4.01)
Highly processed	0.79	0.01	0.34	-0.35
		(0.14)	(4.04)	(-2.84)

* Numbers in parentheses are t-ratios.

beef products suggest that among the beef products, semi-processed and highly processed beef products are necessities with elasticities less than 1. Conversely, bulk beef (live cattle) had an elasticity greater than 1 which defines it as a luxury product.

Following Blanciforti and Green; and Capps, Jr. et al., the individual income elasticities could be derived by multiplying the expenditure elasticities with the group's income elasticity. Rosson,III et al derived the income elasticity for beef in Mexico as 0.95. Therefore, the income elasticity for beef products were derived as 1.14, 0.90, and 0.27 for bulk, semi-processed and highly processed beef products, respectively. These indicate that a 10 percent increase in real income in Mexico will lead to an 11 percent increase in bulk products, a 9 percent increase in semi-processed products and a 3 percent increase in highly processed beef products. All own elasticities are negative as expected. Bulk beef products are positively associated with semi-processed beef products suggesting they are substitutes. This indicates that an increase in the price of bulk beef will result in an increase in the demand for semi-processed beef products. Similarly, highly processed beef products are positively related to bulk beef products. Conversely, semi-processed beef and highly processed beef products are negatively related, suggesting they are complements.

The compensated price elasticities for beef products in Canada are presented in table 6. Again a limited substitutability exists between bulk and

semi-processed beef products, and, between bulk and highly processed beef products, respectively. The expenditure elasticities for bulk, semi-processed and highly processed beef products were 1.12, 0.99, and 0.79, respectively. Using quarterly data, Young estimated the income elasticity for beef in Canada as 0.91. Therefore, the income elasticities for the various beef classes were derived as 1.02, 0.90, and 0.72, respectively. This suggests that a 10 percent increase in real income in Canada leads to a 10 percent increase in bulk beef, a 9 percent increase in semi-processed beef, and a 7 percent increase in highly processed beef products.

Summary and Conclusions

This study analyzed the import shares of U.S. value-added beef products in Mexico and Canada. Eleven-year annual data was analyzed using a system wide approach to import allocation. The results indicated that increases in the standard of living in both countries, particularly in Mexico would stimulate increased importation of beef products.

All own elasticities had the appropriate signs; -0.54, -0.29, and -0.34 for bulk, semi-processed and highly processed beef products in Mexico, and, -0.30, -0.14, and -0.35 for bulk, semi-processed, and highly processed beef products in Canada, respectively. In both countries, bulk beef products were found to be positively associated with semi-processed beef products and highly processed beef products, respectively. In Mexico, semi-processed beef and highly processed beef products had a negative relationship suggesting they are complements. Contrary to the findings of Lee et al, the results suggest that, in Mexico, the import share of live cattle was positively associated with income growth. This may be due to the differences in the methodology used. While Lee et al. employed a single equation approach, this study adopted a system-wide approach as noted earlier. Furthermore, the income elasticities for the present study were derived from the total expenditure elasticities, while the income elasticities in the case of Lee et al. were developed on a per capita basis.

In both Mexico and Canada, the import share of bulk beef were higher, followed by the import shares of semi-processed beef products and highly processed beef products, respectively. However, the import shares of semi-processed and highly processed beef products were higher in Canada than Mexico, for each percent increase in income.

In summary, beef products in general have strong prospects in the advent of a NAFTA. Although, the expenditure elasticities for bulk beef in both countries were higher, both semi-processed and highly processed beef products showed a significant positive response for each percent increase in income. The results are consistent with the general forecast on beef trade in Mexico and Canada, and support increase promotion of U.S. beef products in both countries.

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