Measuring the Effects of Non-Price Promotion on U.S. Poultry Meat Product Exports

by

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The U.S. government has implemented several non-price promotion programs in international markets to increase export demand by providing services or information to current or potential buyers in targeted countries for specific commodities or products. The non-price promotion program can be an effective way to increase competitiveness in world markets. The USDA Foreign Agricultural Service *(FAS)* currently conducts two major non-price export promotion programs for poultry meat products: the Foreign Market Development program (FMD) and the Market Access Program (MAP). Since 1986, thirty countries[1] have been targeted for non-price promotion of U.S. poultry meat products. Figure 1 shows annual per capita imports of U.S. poultry meat products of these target countries. There has been a marked increase during the period of 1986-1996. The observed changes in imports may be due to changes in relative import prices and income; however, other potentially important variables, such as introduction of a promotional program, may also have changed import demand. The promotion expenditures on poultry meat products increased about from $6 million in 1986 to more than $8 million in 1996 for a total of $78 million. U.S. poultry meat product exports for the target markets increased from just under $228 million to about $2.2 billion during the same period.

U.S. poultry meat products have received the bulk of federal export assistance. Thus it is important to establish a method for evaluating these effectiveness of the promotion expenditures.

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[1]They are Hong Kong, Russia, Thailand, Philippine, Japan, China, Singapore, Mexico, Bahrain, Vietnam, New Zealand, Canada, Poland, S. Korea, Saudi Arabia, United Arab Emirates, South Africa, Germany, Greece, United Kingdom, Guatemala, France, Bermuda, Kuwait, Lebanon, Ukraine, Taiwan, Oman, Indonesia, and Malaysia.

The effectiveness of export non-price promotion programs can be evaluated by determining whether the advertising programs shift and/or rotate the demand curve, reflecting changes in underlying income and price elasticities and resulting structural change in demand. In the case of the Almost Ideal Demand System (AIDS) model, advertising and promotion effects have been incorporated into the demand system by positing a set of linear, auxiliary relationships to shift the intercept of the demand curve (e.g., Duffy 1991; Baye et al. 1992), or by incorporating the advertising variable into the price index to rotate the demand curve, or by scaling prices (e.g., Green et al., 1991). However, previous methods have not allowed advertising to effect both price and income directly from the AIDS share equations. The effect of advertising and promotion on the demand for poultry meats is modeled using a gradually switching AIDS model using advertising as a structural change switching variable.

The objectives of the study are (1) to evaluate the non-price promotion effectiveness in selected international markets for U.S. poultry meat products, and (2) to determine how demand elasticities may differ among regions/countries. The paper proceeds as follows. The next section describes the gradually switching dynamic AIDS model. After which, the models to be estimated are presented, the data are described, and finally, the results are reported.

Theoretical model

Advertising can cause the demand curve to shift and/or to rotate, which reflects the changes in the underlying income and price elasticities, and results in a structural change in demand. Structural change can be modeled in many different ways. It is commonly modeled by incorporating some function of time as a regressor and/or allowing the intercept/or slope coefficients to change over the sample period by including binary shifters (or dummy variables).

Dahlgram (1987) and Moschini and Meike (1989) account for structural changes by using gradually switching regression models. Another way of modeling structural changes is to incorportate the advertising effects into the demographic variables. This demographics-translating technique is discussed by Pollack and Wales (1992). In our study, a gradually switching regression technique is used. Instead of using a time function as a regressor, an advertising variable is employed as a continuous shifter, which allows the intercept and slope coefficients of the demand function to change over the sample period. The AIDS model is employed. The major advantage of using AIDS is the simplicity with which parameters can be related to the restrictions of demand and other theoretical advantages. The AIDS approach has been applied in estimating consumer demand but less frequently in estimating import demand, especially, estimating advertising effects in import/export demand.

Gradually Switching Dynamic Advertising AIDS Model

Deaton and Muellbauer's (1980) AIDS cost function can be defined as

$$\text{(1)} \quad \ln C\,(P, A, u) = \alpha_o + \sum_j (\alpha_j + \sum_k \delta_{jk} \ln A_k)\ln p_j + \tfrac{1}{2}\sum_k \sum_j (\gamma_{jk}^* + \theta_{jk}^* \ln A_j) \ln p_j \ln p_k + u \prod p_k^{\beta_k + \pi_k \ln A_k},$$

where α, β, γ,and δ are parameters; p_k represents price of good k; A_i represents advertising expenditures to country i; and u represents unobservable utility. It can be seen that C (u, p, A) is homogeneous of degree one in p, if

$$\text{(2)} \quad \sum_j (\alpha_j + \sum_k \delta_{jk} \ln A_k) = 1; \text{ and } \sum_k (\gamma_{jk}^* + \theta_{jk}^* \ln A_j) = \sum_k (\beta_k + \pi_k \ln A_k) = 0.$$

In order to hold for arbitrary levels of advertising, we must have

$$\text{(3)} \quad \sum_j \alpha_j = 1; \ \sum_k \delta_{jk} = 0; \ \sum_k \beta_k = \sum_k \pi_k = 0; \ and \ \sum_k \gamma_{jk}^* = \sum_k \theta_{jk}^* = 0.$$

The generalized AIDS share equation is

(4) $w_i = \alpha_i + \sum_k \delta_{ik} \, lnA_k + \sum_j \gamma_{ij} \, ln\, p_j + \sum_j \theta_{ij} \, lnA_i \, ln\, p_j + \beta_i ln(y/P) + \pi_i \, lnA_i \, ln(y/P),$

where the parameters, γs, are defined as

(5) $\gamma_{ij} = \frac{1}{2} \, (\gamma_{ij}^* + \gamma_{ji}^*) = \gamma_{ji}\,;$

and P is a price index defined as

(6) $\ln P = \alpha_o + \sum_k (\alpha_k + \sum_i \delta_{ki} \, lnA_i \,)\, ln\, p_k + \frac{1}{2} \sum_k \sum_j (\gamma_{kj}^* + \theta_{kj}^* \, lnA_j) ln\, p_k \, ln\, p_j.$

Equation (4) is the gradually switching dynamic advertising AIDS demand function in budget share form. The adding up restriction on the parameters of the AIDS equation (4) requires

(7) $\sum_i \alpha_i = 1; \; \sum_i \delta_{ij} = 0; \; \sum_i \gamma_{ij} = 0; \sum_i \beta_i = 0; \sum_i \pi_i = 0;$ and $\sum_i \theta_{ij} = 0,$ for all j.

Homogeneity is satisfied if and only if, for all j that

(8) $\sum_i \gamma_{ij} = 0;$

and symmetry[2] is satisfied provided

(9) $\gamma_{ij} = \gamma_{ji}\,.$

Deaton and Meullbauer also suggest substituting the price index in equation (6) by the Stone price index,

(10) $ln\, P^* = \sum_i w_i \, ln\, p_i.$

Let η_i denote the total expenditure (income) elasticities, and e_{ij} the uncompensated price

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[2] Note that advertising effects are not necessarily symmetric; that is $\partial q_i / \partial A_j \neq \partial q_j / \partial A_i$. (see Baye et al. 1992).

elasticities. Then, the elasticity formulae are calculated as follows: (δ_{ij} = 1 when i = j; and δ_{ij} = 0 when $i \neq j$)

(11) $\eta_i = 1 + (\beta_i + \pi_i lnA_i) / w_i$, and

(12) $e_{ij} = [(\gamma_{ij} + \theta_{ij} \, lnA_i) - (\beta_i + \pi_i \, lnA_i)] \, w_j / w_i - \delta_{ij}$.

Data Description and Estimation Procedure

Data needed for estimation are values for poultry meat products exports, advertising expenditures, and price indices for each importing country of poultry meat products. The data used in this study for calculation of expenditure share (w), total export expenditures, quantity of poultry meats, and unit prices were collected from various issues of *FATUS (Foreign Agricultural Trade United States)* for the years 1972-1996. Prices were derived as implicit deflators from expenditure series measured at 1990 prices. The deflator CPI (consumer price index) obtained from various issues of the *IMF Financial Statistics.* U.S. advertising expenditures in each country were provided by the *US poultry & Egg Export Council* for the years 1986-1996. Only the government FMD Program, TEA and MPP/MAP program expenditure data are used. Private organization and contributions company are not included. These expenditures were expressed on a real per capita basis by deflating with the mid-year estimates of the population and CPI of each country (both are from various issues of *IMF Financial Statistics*). The total expenditure series were also transformed to a per capita basis.

In order to reduce the size of the system being estimated, the thirty export countries were aggregated into six groups. Hong Kong, Japan, Mexico, Singapore, South Africa, and ROW (rest of the world) are identified in Table 1. Except for ROW, the other five countries were selected because of their higher promotion expenditures for U.S. poultry meat product exports during the years of 1986-1996.

Estimations are performed with the gradually switching AIDS in its extended form.[3] For empirical purposes, an additive error structure is always assumed for the model in equation (4).[4] In this study, equations (4) and (6) are estimated with the dynamic AIDS model. The elasticities for AIDS are given by equations (11) and (12). Since the budget shares sum to one, it follows that the covariance matrices are singular. In the absence of autocorrelation, Barten (1977) has shown that estimates of the parameters can be obtained from full information maximum likelihood methods by arbitrarily deleting one equation. The estimation results are invariant to the choice of the equation deleted. When autocorrelation is present, standard corrective procedures are used to purge the equations of autocorrelation. To cope with the nonlinearity and the singularity of the models, maximum likelihood methods are used to estimate the dynamic demand systems incorporating the effects of advertising. Following Rickertsen et al. (1995), a linearly declined lag

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[3] For estimating purposes, the series of advertising figures were divided by 3,500 for scaling down to between 0 and 1. It is noted that the advertising series used in our analysis is in A_i form, instead of $\ln A_i$ form as advertising in log form caused some negative expenditure elasticities.

[4] The system of demand equations above ignore the dynamic structural changes, which would allow the consumer to immediately and fully adjust to changes in prices and income. Empirically, one often finds that the application of static models to time series data leads to misspecification (see, for example, Baye et al. (1992)). The simplest way to introduce dynamics is to include the lagged budget share $w_{i,t-1}$ on the right-hand-side of equation (4). However, empirically, four of the six total expenditure elasticity estimates were negative in this case. In addition, a stochastic specification with autocorrelation is assumed for the demand system. When autocorrelated error terms are assumed, then $e_{i,t} = \rho_i e_{i,t-1} + u_{i,t}$, where u is independently and identically distributed normal with mean zero and variance-covariance matrix $\sigma^2 \Sigma$, $u_t \sim N(0, \sigma^2 I)$, and ρ_i is the same for all equations. The estimated autocorrelation coefficient for the model was significantly different from 1 ($\rho = 1$ with an asympotic t = 257.3). This implies an unit root with an infinite variance for the equation disturbance term.

structure of the advertising variable is specified. The lag structure assumes that $A_{it} = 0.4\ A_{it-1} + 0.3\ A_{it-2} + 0.2\ A_{it-3} + 0.1A_{it-4}$. Empirically, a complete U.S. poultry meat export demand system is estimated, using a conditional AIDS model to estimate equations (4) and (6) within a group. The unconditional income elasticities can be obtained by multiplying the conditional income elasticity estimates by the income elasticity of the imported group (Lee et al. 1992).

Results

Parameter estimates based on the restrictions of symmetry and homogeneity are reported in Table 2. Table 2 suggests the following patterns of aggregate consumption behavior. Advertising effects appear in three parts of the system. The values of δ_{ij}s represent the advertising effect on slope (slope shifter). Except for Japan, the estimated own advertising effects are not statistically significantly different from zero at the 5% significance level. All of the own advertising effects are found to be positive as expected except for Hong Kong. However, most of them are statistically insignificant. The results seem to be consistent with the Galbraithian hypothesis. Galbraith hypothesized that advertisers had the power to influence the patterns of demand across broad product groups. The values of θ_{ij}s represent the cross-price advertising effects. The cross-price advertising effects for Japan and Singapore are negative and statistically significant at the 5% level. All cross-price advertising effects are negative suggesting that the import price of U.S. poultry meat products increases as advertising expenditures decrease. The values of π_{ij}s represent the total expenditure effects of advertising. Except for Mexico and South Africa, advertising has a positive effect on total expenditure, which suggests a positive relationship between total expenditure and advertising expenditure in Hong Kong, Japan, Singapore, and ROW.

Table 3 reports the price and total expenditure elasticities of demand from the LA/AIDS model. Except for Mexico, the demand for Hong Kong, Japan, Singapore, South Africa and ROW are price elastic. A check of the eigenvalues of the Slutsky matrix revealed that the neoclassical curvature restrictions are satisfied at all data points. All goods are nomal goods, with Hong Kong, Japan, Singapore, and ROW having expenditure elasticities greater than one.

Conclusion

Our study demonstrates that the annual U.S. poultry meat export data can be modeled using a switching dynamic version of the AIDS model. Advertising can significantly cause the demand curve, not only to shift, but also to rotate which reflects the underlying changes in income and price elasticities. The estimated parameters and elasticities seem plausible for price and expenditure effects, and positively encourage the effect of advertising on U.S. poultry meat product exports in the thirty targeted international markets.

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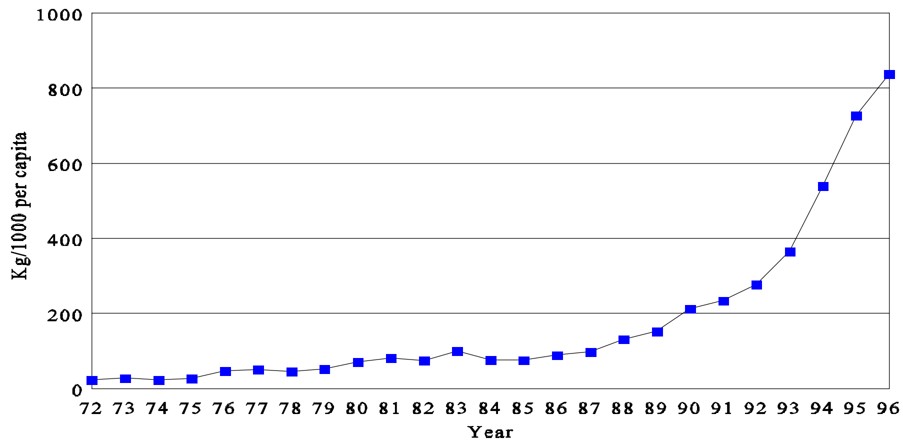

Figure 1: U.S. Poultry Meat Product Exports for 30 Target Market: 1972-1996

Table 1. Yearly and Total Advertising Expenditures and Shares of Total U.S. Poultry Meat Product Export Values, 1986-1996

	1986-1988	1989-1991	1992-1994	1995-1996	Total	Export share
Hong Kong	3526209	5318557	4734923	2375277	15954966	19.2%
Japan	4895121	12739353	8702758	3954220	30291452	17.0%
Singapore	1991773	2298277	2590325	1111165	7991540	3.6%
Mexico	0	508758	4629163	546840	568471	13.5%
South Africa	273252	709369	912848	449340	2344809	0.9%
R.O.W.	1934610	2515496	5547849	5557589	15555726	37.7%
WORLD	12620965	24089992	27117866	13994431	77823254	1

Table 2. Gradually Switching Advertising AIDS Model for U.S. Poultry Meat Product Exports (1972-1996)

	Hong Kong i=1	Japan i=2	Mexico i=3	Singapore i=4	S. Africa i=5	R.O.W. i=6
α_i	1.0636*	0.0347	0.1807	-0.2696	-0.0224	1.0765*
δ_{i1}	-7.8707	-0.2636*	2.8190	0.1633	-0.0888	5.2409
δ_{i2}	2.8351	5.7918*	-6.3584	-0.9677	-0.0613	5.2409
δ_{i3}	3.7937	-3.4093	10.3080	-0.4210	0.6870	-10.9581
δ_{i4}	0.0172	0.1463	-1.0563	0.7848	0.0236	0.0844
δ_{i5}	-1.3032	6.9006*	-37.8080	3.6923*	1.8534	26.6648
δ_{i6}	-0.3164	-0.5077	-255.850	-1.6201	-0.0383	258.3277
γ_{i1}	0.0903	0.0059	-0.1034*	-0.0104*	-0.0104*	-0.0025
γ_{i2}	0.0059	-0.0040	-0.0073*	0.0083	0.0005	-0.0034
γ_{i3}	-0.1034*	-0.0073*	0.1458*	-0.0371	0.0032*	-0.0012
γ_{i4}	0.0200	0.0083	-0.0371	-0.0098	0.0062*	0.0124*
γ_{i5}	-0.0104*	0.0005	0.0032*	0.0062*	0.0003	0.0002
γ_{i6}	-0.0025	-0.0034	-0.0012	0.0124*	0.0002	-0.0055*
θ_{i1}	-1.2897	7.2849*	-116.95	1.7339*	3.2155	106.0100
θ_{i2}	0.4036	-2.3676*	62.5990	-0.1064	0.5633	-61.0920
θ_{i3}	0.1503	-1.5699*	-4.8169	0.2131	-0.9360	6.9594
θ_{i4}	0.9173	-3.6077*	18.0230	-2.1801*	-1.9529	-11.1999
θ_{i5}	0.0294	0.2320	-14.1460	0.0676	-0.2512	14.0686
θ_{i6}	0.9136	-2.4903*	79.0580	-0.9026*	1.5855	-78.1641
β_i	-0.0471	0.0003	-0.0424	0.0892*	0.0021*	-0.0021*
π_i	0.4345	0.2439	-5.9585	0.1901	-0.2698	5.3598

Note: Asterisks (*) are used to denote statistically significant coefficients ($\alpha = 0.05$). To save space, the t-values (or standard errors) are not reported.

Table 3   Price and Total Expenditure Elasticities

	Price						Total Expenditure
Country (i)	ε_{i1}	ε_{i2}	ε_{i3}	ε_{i4}	ε_{i5}	ε_{i6}	η_i
Hong Kong	-1.3968	3.3016	-53.061	0.8079	1.4225	47.865	1.0632
	(0.985)	(4.248)	(68.399)	(0.907)	(1.890)	(62.041)	(0.2988)
Japan	0.5129	-2.8311	41.548	0.3738	0.4058	-41.19	1.1947
	(0.219)	(2.301)	(62.720)	(0.428)	(0.553)	(61.009)	(0.2418)
Mexico	-1.8199	-0.4307	0.7959	-0.5231	-0.125	1.3392	0.7636
	(2.3828)	(0.9506)	(1.9515)	(0.7347)	(0.4379)	(3.5663)	(0.9503)
Singapore	0.6805	-3.5253	17.2677	-3.3708	-1.8882	-10.99	1.8299
	(1.057)	(4.943)	(24.849)	(3.012)	(2.678)	(15.285)	(0.7413)
S Africa	-40.639	3.3459	-75.885	25.2522	-1.3392	88.771	0.6368
	(144.78)	(6.840)	(165.78)	(86.673)	(5.353)	(154.54)	(1.6042)
R.O.W.	-0.9125	-1.5638	13.135	3.8319	0.3444	-16.06	1.2204
	(0.528)	(0.849)	(17.679)	(1.675)	(0.366)	(17.894)	(1.1654)

Note: The values in parentheses are standard errors.