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Assessing the Effectiveness of MPP Meat Advertising and Promotion in the Japanese Market

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- Facilitate the development of new theory and research methodology.

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Preface

This research was sponsored by a grant from the National Institute for Commodity Promotion Research and Evaluation (NICPRE). NICPRE has sponsored approximately eight to ten projects such as this one each year since its inception. The overall purpose of projects sponsored by NICPRE is to increase understanding of issues in the area of commodity promotion economics. NICPRE will continue to publish findings from these projects as NICPRE Research Bulletins.

Harry M. Kaiser
Director

Introduction

The government of the United States allocates millions of dollars annually to fund advertising and promotion programs in overseas markets. The main objective of such programs is to increase the demand for U.S. products in targeted areas. One such current program is the Market Promotion Program (MPP) which is sponsored by the Foreign Agriculture Service (FAS).

Japan is a market into which many U.S. producers have attempted to introduce their products. This is due to the belief that Japan is a market with potentially large demand for high quality U.S. products. Meat producers in the U.S. understand this potential and have applied to the FAS for MPP funds to assist them in their advertising and promotional efforts. Through the use of these advertising and promotion monies, U.S. producers are aiming to increase both the value and market share of their products relative to the value and market shares of competing suppliers.

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Assessing the effectiveness of advertising and promotion dollars is an important undertaking for both the FAS and the producer groups that fund such programs. In particular, the results of such an assessment are key to the development of future programs and/or amendments to current programs. The focus of this study is to provide an assessment of the effectiveness of promotion and advertising efforts in enhancing U.S. meat demand in the Japanese market.

Although Japan has been an area of consumer demand research for some time, there has been little explicit research done on the effectiveness of advertising and promotion of U.S. meat products in Japan. There are many alternative models, however, that have been used to analyze the demand for meats in this market. These have been developed by numerous authors and summarized by Smallwood, Haidacher, and Blaylock (1989). In their study, Smallwood, Haidacher, and Blaylock categorize the research that has been done into two distinct groups, those that focus on income and price responses, and those that focus on income and socioeconomic determinants. The research in this paper adds to the literature in the first group by constructing an econometric model of the effects of MPP and Targeted Export Assistance (TEA) advertising and promotion expenditures on the demand for U.S. meats in Japan.

The research in this study utilizes an inverse AIDS demand model that disaggregates beef, pork, and poultry commodities into groups based upon origin, including U.S., non-U.S., and domestic (Japanese) sources. In this model, unlike other AIDS models that have been estimated heretofore, a Dirichlet-distributed error process is incorporated into the stochastic specification of the system of demand equations in order to accommodate adding up and unit simplex restrictions on the expenditure share system. Three alternative ways of representing advertising and promotion effort were examined in the econometric model. The variety of forms was chosen to provide

information on whether advertising and promotion efforts exhibit carryover effects, and if so, to what degree they are effective in the current year versus subsequent years.

The Conceptual Framework

AIDS and IAIDS Models

Due to the nature of the study, which required differentiating various meats by competing origins of supply, a demand model was needed that could represent the simultaneous interrelationships between a relatively large number of meat commodities parsimoniously and yet be flexible enough to incorporate advertising and promotion effects on these commodities. The demand model used in this study is the inverse AIDS model. The original AIDS model was devised by Deaton and Muellbauer as a second-order flexible demand system capable of incorporating all exact neoclassical restrictions and being estimable via nonlinear least squares techniques. This AIDS model is based on a PIGLOG cost structure of the form,

(1) $\ln c(u,p) = (1-u) \ln a(p) + u \ln b(p)$

with u being utility and p being prices of the commodities in the model. The specific functional forms for ln a(p) and ln b(p) are given by,

(2) $\ln a(p) = \alpha_0 + \sum_k \alpha_k \ln p_k + \frac{1}{2} \sum_k \sum_j \gamma^*_{kj} \ln p_k \ln p_j$

(3) $\ln b(p) = \ln a(p) + \beta_0 \prod_k p_k^{\beta_k}$.

The budget shares of each good can be determined by applying Shepard's lemma as,

(4) $$\frac{\partial \ln c(u,p)}{\partial \ln p_i} = \frac{p_i q_i(u,p)}{x} = w_i(u,p)$$

where x=c(u,p) is expenditure, $q_i(\mu,p)$ is the utility compensated demand for commodity i, and w_i is the budget share for good i. Inverting the cost function to obtain the indirect utility function in terms of p and x the AIDS demand functions in share form are obtained as

(5) $$w_i = \alpha_i + \sum_j \gamma_{ij} \ln p_j + \beta_i \ln \left(\frac{x}{P} \right) \quad , i=1,...,m,$$

where $\gamma_{ij} = \frac{1}{2} (\gamma^*_{ij} + \gamma^*_{ji})$ and P is a price index given by

(6) $$\ln P = \alpha_0 + \sum_k \alpha_k \ln p_k + \frac{1}{2} \sum_k \sum_j \gamma_{kj} \ln p_k \ln p_j .$$

The following restrictions are imposed so that the system conforms to the neoclassical restrictions of adding up, homogeneity of degree zero, and symmetry:

(7) $$\sum_{i=1}^{n} \alpha_i = 1 \ , \ \sum_{i=1}^{n} \gamma_{ij} = 0 \ , \ \sum_{i=1}^{n} \beta_i = 0$$
$$\sum_j \gamma_{ij} = 0$$
$$\gamma_{ij} = \gamma_{ji}$$

The inverse AIDS model (IAIDS) is an analogue to the AIDS model that leads to an inverse demand system having a similar functional form to the AIDS share-based demand system, except that budget shares are a function of quantities rather than prices. The IAIDS model, which was developed independently by Moschini and Vissa (1992) and Eales and Unnevehr (1993), is not a dual to the AIDS model but bears a striking resemblance to it both in terms of functional form and in the way both are derived.

One begins with the specification of a distance function of the form

(8) $$\ln D(u,q) = (1-u) \ln a(q) + u \ln b(q)$$

where u is utility and q is quantity consumed (compare to (1)). The specific functional forms for a(q) and b(q) are given by

$$(9) \quad \ln a(q) = \alpha_0 + \sum_k \alpha_k \ln q_k + \frac{1}{2} \sum_k \sum_j \gamma^*_{kj} \ln q_k \ln q_j$$

$$(10) \quad \ln b(q) = \ln a(q) + \beta_0 \prod_k q_k^{\beta_k}$$

(compare to (2) and (3)). The budget shares for each good can be determined by applying Shepard's lemma as

$$(11) \quad \frac{\partial \ln D(u,q)}{\partial \ln q_i} = \frac{p_i}{x}(u,q)\, q_i = w_i(u,q)$$

where $\frac{p_i}{x}(\mu,q)$ is the utility compensated inverse demand (i.e., expenditure-normalized price) for commodity i and w_i is the budget share for good i. Inverting the distance function to obtain the direct utility function in terms of q, and then substituting the utility function into (11), the inverse AIDS demand functions in share form are obtained as

$$(12) \quad w_i = \alpha_i + \sum_j \gamma_{ij} \ln q_j - \beta_i \ln Q \;,\; i = 1,\ldots,m,$$

where $\gamma_{ij} = \frac{1}{2}(\gamma^*_{ij} + \gamma^*_{ji})$ and Q is a quantity index that is given by

$$(13) \quad \ln Q = \alpha_0 + \sum_k \alpha_k \ln q_k + \frac{1}{2} \sum_k \sum_j \gamma_{kj} \ln q_j \ln q_k \;.$$

In order to enforce the neoclassical restrictions of adding up, homogeneity of degree zero, and symmetry, the coefficient restrictions given by (7) are imposed on the demand system (12) and (13).

IAIDS Model With Advertising and Promotion

The effect of advertising and promotion on the inverse demand for meats was modeled using the translating procedure of Pollak and Wales (1980). In particular, all quantity variables appearing in the IAIDS model (12) and (13) were scaled via multiplication by a variable representing the effective level of advertising and promotion information. Let A_i^* represent generically the stock of effective advertising and promotion information of type i. Note that A_i^* itself will generally be some parametric function of more fundamental observable variables such as the level of expenditure on advertising and promotion of type i. The IAIDS model incorporating advertising and promotion effort is then given by

$$(14)\quad w_i = \alpha_i + \sum_j \gamma_{ij} (\ln q_j + \ln A_j^*) - \beta_i \ln Q^* , \; i = 1,...,m, \quad and$$

$$(15)\quad w_m \equiv 1 - \sum_{i=1}^{m-1} w_i$$

It is straightforward to demonstrate that the distance function defined by

$$(16)\quad \ln D(u,q,A^*) = \alpha_0 + \sum_k \alpha_k (lnq_k + lnA_k^*) + \frac{1}{2} \sum_k \sum_j \gamma_{kj}^* (lnq_k + lnA_k^*)(lnq_j + lnA_j^*) + u \beta_0 \prod_j q_j^{\beta_j}$$

yields the system of budget share equations (14) and (15). By inverting the distance function to solve for the direct utility function, it follows that (recall $D(u,q,A^*)=1$ when obtaining the utility function)

$$(17)\quad u(q, A^*) = \frac{-\left[\alpha_0 + \sum_k \alpha_k (lnq_k + lnA_k^*) + \frac{1}{2}\sum_k \sum_j \gamma_{kj}^* (lnq_k + lnA_k^*)(lnq_j + lnA_j^*)\right]}{\beta_0 \prod_j q_j^{\beta_j}} .$$

Thus, the effect of an incremental change in the level of effective advertising and promotion information A_i^* on the level of utility is given by

(18) $$\frac{\partial u(q,A^*)}{\partial A_i^*} = \frac{-A_i^{*-1}\left[\alpha_i + \sum_j \gamma_{ij}\,(lnq_j + lnA_j^*)\right]}{\left(\beta_0 \prod_j q_j^{\beta_j}\right)},$$

and the effect on the marginal utility of good j is given by

(19) $$\frac{\partial^2 u(q,A^*)}{\partial q_j \partial A_i^*} = \frac{\frac{A_i^{*-1}}{q_j}\left[\beta_j(\alpha_i + \sum_j \gamma_{ij}\,(lnq_j + lnA_j^*)) - \gamma_{ij}\right]}{\left(\beta_0 \prod_j q_j^{\beta_j}\right)}.$$

Given a relationship between advertising and promotion information, A_i^*, and expenditure, A_i, of the form $A_i^* = g(A_i,\delta)$, say, it is evident from (17)-(19) that there is sufficient parameter flexibility in the IAIDS specification for the effect of the A_i's on utility to be negative or positive and for there to be simultaneous interactions of all advertising effects impacting the demand for each commodity. Note that additional flexibility is introduced by the way the A_i^* functions are themselves parameterized, as will be discussed later in the Empirical Model section.

Regarding the impact of changes in the stock of advertising and promotion information on budget shares, note the following share elasticity of commodity i with respect to a change in A_k^*:

(20) $$\frac{\partial \ln w_i}{\partial \ln A_k^*} = \frac{1}{w_i}\left[\gamma_{ik} - \beta_i\left[\alpha_k + \sum_j \gamma_{kj}\left(\ln(q_j) + \ln(A_j^*)\right)\right]\right].$$

Note further that in the context of the IAIDS model the preceding elasticities are also numerically equivalent to the flexibilities of expenditure normalized prices with respect to changes in A_k^*, since

$$(21)\quad \frac{\partial \ln(p_i/x)}{\partial \ln A_k^*} = \frac{\partial \ln(w_i/q_i)}{\partial \ln A_k^*} = \frac{\partial \ln w_i}{\partial \ln A_k^*} .$$

The elasticities and flexibilities (20) and (21) serve to measure the impact of changes in the stock of advertising and promotion information on the budget shares and values of the commodities in the demand system.

Assuming that the stock of effective advertising and promotion information existing in the time period t is some function of current and past levels of advertising and promotion expenditures, say as $A_{it}^*=g(A_{it}, A_{it-1}, A_{it-2},...)$, where A_{it} is the level of expenditure of type i in period t, elasticities with respect to advertising and promotion expenditures in any period t-j can be calculated. These elasticities can be defined in terms of adjustments to (20) as

$$(22)\quad \frac{\partial \ln w_{it}}{\partial \ln A_{k,\,t-j}} = \left(\frac{\partial \ln w_{it}}{\partial \ln A_{kt}^*}\right)\left(\frac{\partial \ln A_{kt}^*}{\partial \ln A_{k,\,t-j}}\right) .$$

That is, the elasticity of budget share w_{it} with respect to advertising and promotion stock, A_{kt}^*, is scaled by the elasticity of A_{kt}^* with respect to advertising and promotion expenditures of type k in period t-j. From (21), it follows that the preceding elasticity calculations also define the flexibilities of expenditure-normalized prices with respect to advertising and promotion expenditures.

Overview of the Japanese Market for Meat Products

The Japanese market for meat products differs from the U.S. market in fundamental ways. These differences are rooted in the effects of government policy, religion, history and culture, and the preferences of Japanese consumers.

The Japanese Consumer

Religion plays an important role in the life of the Japanese as well as in the development of the Japanese diet. Buddhism, introduced into Japan in the early sixth century, forbid the killing of any living being in order for an individual to reach the highest of "realms." The combination of Buddhism and the religion of Shintoism resulted in the Japanese viewing with disfavor the killing of animals and the eating of meat. Shintoism taught that any involvement with death contaminated an individual, and thus bolstered the view of Buddhism. These concepts still, to the present day, exert a negative influence on meat consumption for a subset of the Japanese population.

The culinary arts of the Japanese are also of importance in understanding consumer demand behavior. Traditional Japanese beef dishes are very different from beef dishes consumed in Western countries. As a result of the aversion to the killing of animals by more traditional consumers, meat must be cut in a form that does not show blood. Much of the meat is prepared in wafer-thin slices and then boiled in water, as Shintoism teaches that water is a means of purification. In order for the wafer-thin slices of beef to be successfully prepared in this form, the meat must have a high degree of intramuscular fat or marbling. When lean Western-style beef is prepared in this manner, it can become tough and leathery. For most Japanese consumers, the more marbled the beef, the tastier the dish.

Over time, however, the types of beef dishes have begun to vary. In the 1960s, the introduction of barbeques and grills increased the popularity of hamburger-type dishes as well as curries and stews. Other changes in the preparation of beef dishes resulted from adaptations of the wide variety of cooking methods for pork and chicken. The results of these adaptations were that the range of retail cuts of beef available in Japanese stores increased from the wafer-thin cuts to cube

cuts and steaks. Furthermore, there has been a recent growing awareness of the health benefits of leaner Western-style beef as a result of educational and promotional activities partly funded by U.S. producer organizations. All of these developments have created increased opportunities for more U.S. meats to enter the Japanese market.

Another factor affecting the quantity of beef demanded is the income level of the Japanese population. The high growth rate in the 1960s led to increased expenditure on poultry and pork products. However beef, with its high cost of production and high price, was still too expensive for many people. The results of a recent Japanese consumer survey suggested that higher income consumers expressed a stronger preference for beef than did lower income Japanese consumers (Hayes, 1990), supporting the hypothesis that beef is a luxury food in Japan. A finding that is also seen from consumer surveys is a preference for domestic beef over imported beef. This is especially true if the imported beef is in frozen form, which was largely the case for most imports due to Japanese trade regulations until quite recently.

Japanese Trade Regulations

Japan has historically been a market characterized by significant protectionism. Government policies that restricted the imports of meats into Japan have limited the availability of import opportunities. The first indication of the protectionist attitude in the beef industry came in 1954 when a 10 percent import tariff was imposed. In 1958, the tariff was supplemented with an import quota based on the value of beef imports. In addition, importing firms in Japan were required to have a license and an allocation of foreign exchange before they were able to import beef at all.

In 1961, the Price Stabilization Law for Livestock Products provided for the creation of the Livestock Industry Promotion Corporation (LIPC). This quasi-governmental organization became

responsible for the administration of government policies pertaining to the livestock industry. The LIPC became involved in the beef importing system when it was given the role of overseeing a price stabilization scheme for beef products. The beef import tariff was raised to 25 percent in 1964, and import quotas based on physical quantities were introduced, replacing those based on the value of the imports.

The LIPC was empowered to buy, sell, and hold stocks of imported beef so that it could carry out its mandate to stabilize domestic prices. Price stabilization schemes of the LIPC included such programs as a Merchant Tender System, a Modified Tender System and a Simultaneous Buy/Sell System. The first system specified very narrow quality requirements and restricted imports to mostly frozen beef, with 80 percent of imports obtained through this system. There were two main reasons that imports were restricted to frozen beef. First of all, frozen beef could be stored more easily by the LIPC and facilitated their stock-holding activities in pursuit of price stabilization goals. Secondly, the Japanese consumer preferred fresh, well-marbled beef, so imports in frozen form would not endanger the demand for domestically produced beef.

The introduction of the Merchant Tender System in 1978 allowed the import of chilled beef for the first time. In this system, the LIPC purchased beef from importing firms that tendered the lowest prices and sold it to end-users that offered the highest prices. By 1985 when the Simultaneous Buy/Sell system was instituted, the quality of beef imports was no longer under strict control, but the LIPC allocated quotas to foreign suppliers. By 1988 the LIPC controlled roughly 80 percent of the quantity of beef imported into Japan. However, by 1991, the LIPC's role in regulating the importation of beef was eliminated and quotas were replaced by a 70 percent tariff which was

reduced to 50 percent by 1993. Under GATT, tariffs will be reduced further to 38.5 percent by the year 2000.

The aforementioned programs were all used as a way of controlling the quantity of beef imported into Japan and regulating the quantity of beef available on the market. The control that was exerted in the Japanese market suggests that the quantities of beef were largely predetermined in the market through control mechanisms, and that price cleared the market.

The Market Promotion and Targeted Export Assistance Programs

In order to assist U.S. producers in entering and expanding foreign markets, the U.S. government implemented a program known as the Market Promotion Program (MPP) that is overseen by the Foreign Agricultural Service (FAS). The MPP allocates monies directly to producer groups for generic and branded advertising, and promotion programs in foreign countries with the goal of enhancing the market share of U.S. producers relative to competing suppliers.

The MPP was authorized by the Food, Agriculture, Conservation, and Trade Act of 1990 and replaced the Targeted Export Assistance (TEA) Program. Like the TEA that it replaced in 1990 and the Foreign Market Development (FMD) program that has existed since 1955, the MPP takes a long term market development approach intended to encourage the development, maintenance, and expansion of commercial export markets for U.S. food and agricultural products. Prior to 1986, the FAS had only devoted $6 million a year to these programs through the FMD, whereas by 1991 the FAS commitment had grown to $148 million of which $143 was in TEA/MPP funds and $5 million in FMD funds.

The main goal of the MPP, market development, is broader than the goal of the TEA program which was to counter or offset the adverse effect of unfair foreign trade practices on U.S. agricultural commodity exports. However, many of the guidelines that govern the MPP are very similar to those that governed the TEA program. In order to qualify for the MPP funds, eligible trade organizations must submit marketing plans to the FAS that meet established guidelines, which include a degree of matching funds supplied by the organization. Also, within these guidelines is the need to prove that unfair trade practices exist that hinder demand growth of U.S. commodities in the market in question.

The funding of the advertising/promotional activities is shared by the USDA and the trade or producer group. If the trade/producer group does not contribute matching funding, then monies will be unavailable from the FAS. In the area of beef and pork promotion, the U.S. Meat Export Federation (USMEF), and in the case of poultry, the USA Poultry and Egg Export Council (PEEC), are the commodity group representatives that are responsible for securing the advertising/promotion funds from the FAS. These funds are then used to carry out generic advertising/promotion campaigns in Japan. The advertising/promotion funds that were received by these two organizations were relatively small until 1987, which is the year in which the allocated monies increased substantially.

Data Considerations

Data was collected for this research from various sources and spanned the time period of 1965 to 1994 inclusive. The quantity data on the imports of meats into Japan was obtained from the Livestock Industry Bureau, Ministry of Agriculture, Forestry, and Fisheries, Japan. The import quantity data on beef, pork, and poultry was recorded in kilograms and the data was available on a

per country basis. For non-U.S. produced meats, the quantities of all competing importers was aggregated on a yearly basis and recorded as one total. For the non-U.S. beef category the main countries of origin were Australia, New Zealand, Canada, Ireland, and Mexico. For non-U.S. pork, the main sources were Taiwan, Denmark, Canada, and the Republic of Korea. For non-U.S. poultry, the main countries of origin were Thailand, France, P.R. of China, and Brazil. Japanese-produced quantities of pork and poultry were included in their respective aggregated non-U.S. categories. Japanese beef was disaggregated into two categories, dairy and Wagyu, with dairy beef being added to the non-U.S. category of beef. These aggregations resulted in the formation of seven categories of meats in the study: U.S. beef, pork, and poultry, non-U.S. beef (including Japanese dairy beef), pork, and poultry, and Japanese Wagyu. All aggregate quantities were transformed into per capita quantities via division by the Japanese population.

The prices of the meat categories were determined by dividing the reported total value of the sales of each meat category at the wholesale level by the total quantity consumed. From the quantities and the prices, a meat budget share for each category was developed by dividing the value of each meat category by total meat expenditures.

The advertising and promotion data was obtained from two sources, the USMEF and the PEEC. Advertising data was recorded for beef, pork, and poultry separately with the pork and beef figures obtained from the USMEF and the poultry figures obtained from the PEEC. The reported advertising monies were adjusted to a calendar year basis to account for the differing fiscal years, with the USMEF spanning the beginning of July to the end of June and the PEEC spanning the beginning of October to the end of September. The beef and pork advertising/promotion data for each calendar year were determined by adding together 50 percent of the previous fiscal years'

expenditure and 50 percent of the current fiscal years' expenditure. The poultry advertising/promotion data for each calender year was constructed by adding together 75 percent of the previous fiscal years' expenditure to 25 percent of the current fiscal years' expenditure. Advertising and promotion expenditures were recorded in U.S. dollars and thus needed to be converted to Japanese yen. This was done by multiplying the expenditure by the exchange rate (ER) which was expressed in terms of Japanese yen per U.S. dollar. The advertising and promotion monies were also deflated by the Japanese CPI, which equaled one at the base year of 1990, and by the Japanese population in order to express expenditure on a real per capita basis. Finally, the advertising and promotion data were normalized relative to the base year of 1987, which was the first period in which advertising and promotion expenditures became significant. The advertising monies were recorded as zeros until 1987 since the MPP/TEA program was implemented beginning in 1987.

The Empirical Model

Modeling Stock of Advertising/Promotion Information

The effective stocks of advertising/promotion information in support of U.S. beef, pork and poultry demand that appears in the IAIDS model (14)-(15) were modeled in terms of three alternative parametric functions of real (yen deflated by Japanese CPI) per capita advertising/promotion expenditures, normalized relative to the base year of 1987. The alternative functional forms were designed to analyze whether, and to what extent, carryover effects of advertising/promotion effort were important determinants of the demand for meat commodities in the Japanese market. Letting A_{it} denote the level of advertising and promotion expenditure on commodity i (i=U.S. beef, pork, and poultry, respectively) at time t, and letting A_{it}^{*} denote the corresponding stock of

advertising/promotion information existent in support of the demand for commodity i at time t, the three alternative representations of advertising/ promotion stock are as follows:

(23) $A_{it}^{*} = \exp(\delta_i A_{it})$

(24) $A_{it}^{*} = \exp(\beta_i A_{it}^{d})$, $A_{it}^{d} = \delta_i A_{it} + (1-\delta_i)A_{i,t-1}^{d}$

(25) $A_{it}^{*} = \exp(\sum_{j=1}^{3} \delta_{ij} A_{i,t-j+1})$.

In (24), A_{it}^{d} can be interpreted as depreciated cumulative advertising expenditure at time t.

All three specifications allow for current advertising/promotion expenditure to affect the level of advertising/promotion stock in the current period. In the case of (23), A_{it}^{*} is incremented at a rate of d_i in response to a change in current advertising/promotion expenditure. In the case of (24) and (25), a change in A_{it} results in a $\beta_i\delta_i$ or δ_i rate of change in A_{it}^{*} respectively. Both (24) and (25) allow for advertising/promotion carryover effects to occur. In the case of (24), carryover effects occur if $d_i \neq 1$, in which case the marginal rate effects of advertising expenditure in period t on advertising/promotion information stock in period t_* exhibits a geometric declining weight pattern given by $\beta_i\delta_i(1-\delta_i)^{t_*-t}$, $t_*=t, t+1, t+2,\ldots$. For (25), current period advertising/promotion expenditure is allowed to have an influence on the current advertising/promotion information stock, as well as on stock in the subsequent two years. Carryover effects occur if d_{i2} and/or $d_{i3} \neq 0$, and (25) allows additional flexibility in the pattern of the marginal carryover effects in the subsequent two periods as compared to the geometrically declining pattern of (24).

Note that all three advertising/promotion stock specifications also allow for the possibility that advertising/promotion expenditure has no effect on establishing a positive effective stock of advertising/promotion information, so that advertising and promotion has no effect on commodity

demand. For advertising type i, this situation occurs if $d_i = 0$ in (23) or (24), and if $d_{ij} = 0$ for j=1,2,3 in (25). Thus whether advertising/promotion expenditure has any effect on demand, and if so, whether there are any carryover effects of advertising are testable propositions based on specifications (23)-(25).

Stochastic Specification of Japanese Meat Demand

The empirical model to be estimated consisted of an inverse AIDS budget share system of seven equations of the type (14)-(15) relating to the Japanese demands for U.S. beef, pork, and poultry, non-U.S. beef, pork, poultry, and Japanese Wagyu beef. Annual observations on per capita quantity demanded, expressed relative to the base year of 1987, were used spanning the years 1973-1994. The beginning year of the statistical analysis, 1973, was chosen because it represented the year in which U.S. beef imports increased 15-fold, to a commercially significant level of almost 10,000 metric tons and a 2 percent share of Japanese meat expenditures.

In order to account for the fact that the vector of budget share observations occur in the unit simplex with probability one, the suggestion of Woodland (1979) was followed whereby the vector of budget shares is specified to have a Dirichlet distribution. The Dirichlet distribution for the budget shares is specified as

$$f(w;a) = \frac{\Gamma(\sum_{i=1}^{m} a_i)}{\prod_{i=1}^{m} \Gamma(a_i)} \prod_{i=1}^{m} w_i^{a_i - 1}$$

where $w_m \equiv 1 - \sum_{i=1}^{m-1} w_i$, the a_i's are nonnegative-valued parameters set equal to the respective right hand sides of (14) after they have been multiplied by a positive-valued parameter k which serves to

scale variances and covariances of the w_i's, $G(a_i)$ is the gamma function evaluated at a_i , and $w_i \geq 0$ for all i. It can be shown that under the preceding Dirichlet representation of the w_i's, the expected values of the w_i's are given by the respective right hand sides of (14). This then allows additive errors to be appended to the right-hand sides of the equations in (14) that have zero expectations, consistent with the usual assumptions required for the implementation of nonlinear least squares and/or maximum likelihood estimation techniques. The article by Woodland can be consulted for further details of the stochastic specification, including the form of the contemporaneous variances and covariances that characterize the disturbance terms appended to specification (14).

Estimation Method

The Dirichlet-distributed IAIDS model was estimated via the maximum likelihood approach. The Nelder-Meade nongradient-based estimation algorithm was initially used to improve starting values for use with the more traditional gradient-based search algorithms for a maximum likelihood solution. The Nelder-Meade algorithm was written by one of the authors of this paper[2] in the GAUSS programming language, the details of which are available upon request. Then the Newton-Raphson algorithm contained within the OPTMUM application module of the GAUSS programming language was used to obtain converged values of model coefficients. The standard default tolerance of .00001 for the relative gradient of the Dirichlet-type likelihood function was used as the criterion for judging when convergence was achieved.

The asymptotic covariance matrix of the parameter estimates, on which all tests of hypotheses were based, was calculated in the usual way using the information matrix for the

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Dirichlet-type likelihood function. Thus under the null hypothesis, the usual t and Wald test statistics have asymptotically valid standard normal and c^2 distributions, respectively.

Estimation Results

The three IAIDS models of Japanese meat demand, respectively based on the three advertising stock specifications (23)-(25), were estimated via maximum likelihood, and yielded the goodness of fit measures exhibited in Table 1 under the respective headings Model I, II, III. Based on standard measures of fit between predicted and actual values of budget shares, all three models fit the historical data quite well. Note that the rather large mean absolute percent errors in the case of the U.S. beef equation are attributable to very small budget share values in the beginning of the historical period, resulting in small nominal prediction errors being expressed as large percentage errors. The low mean percentage errors suggest that there is no appreciable bias in the predictions, and the fact that Theil's U-statistic is notably below the value of one (except for Model I--U.S. beef predictions) suggests that the models are useful in predicting turning points in the budget share observations. The Wald-Wolfowitz runs test (see Mittelhammer, 1996, pp. 663-665) was applied to the estimated residuals of each of the equations in the IAIDS model to provide an assessment of whether the residuals could be considered independent over time. Based on the outcomes of the tests, which are asymptotically distributed as standard normal under the null hypothesis of independence, the independence of equation residuals could not be rejected at any of the conventional levels of type I error. In particular, the smallest marginal significance value for rejection of the null hypothesis was .19 across all three IAIDS models.

Table 2 displays the maximum likelihood estimates of the relevant parameters having to do with the effects of advertising and promotion on meat demand. All advertising and promotion

parameters relating to U.S. beef are significant at the .05 level across all models, except for the parameter on the two period lag of advertising/promotion expenditure in Model III, which is significant at the .06 marginal level using a one-sided test (assuming nonnegativity of the effect). On the other hand, none of the parameters relating to the effects of U.S. pork or poultry advertising/promotion are close to being significant at any reasonable level of type I error, and in fact the parameter with the largest t-ratio is in any case wrong-signed.

In order to investigate further the apparent insignificance of the effect of pork and poultry advertising and promotion expenditures on meat demand, joint χ^2 tests of the effects of advertising/promotion expenditure were performed for Models II and III (see Table 3). The results of the Wald tests of the joint significance of advertising/promotion parameters confirm that there is insufficient evidence to reject the hypothesis of no pork and poultry advertising/promotion effect in the case of pork or poultry.

An assessment of the U.S. beef advertising/promotion carryover effect suggests that Model I is inadequate to represent the effect of U.S. beef advertising/promotion efforts. The null hypothesis of no carryover effect is soundly rejected by Wald test in Model III, and is also rejected at the .10 level in Model II (Table 3). Since Model I is nested within both Models II and III, the model is henceforth considered to be inappropriate for further consideration.

In an attempt to discriminate between Models II and III, a comparison of price flexibilities provides no basis on which to choose one model over the other. Table 4 displays direct price flexibilities associated with the models, along with t-ratios based on bootstrapping the asymptotic distribution of the flexibilities using a bootstrap sample size of 1000. The flexibilities all have the *a priori* correct signs, most are estimated with considerable and comparable accuracy, and most are

close in magnitude. Estimates of other flexibilities, not shown here, also do not suggest the superiority of either model.

A clear conceptual difference between Models II and III relates to the fact that all previous expenditures on advertising and promotion exert an influence on current demand to some degree in Model II, whereas only expenditures in the preceding two periods are relevant in Model III. However, as a practical matter, even this distinction is not empirically relevant in the case at hand, since the rate at which advertising/promotion information stock is augmented by advertising and promotion expenditures lagged three periods in Model II is only equal to $\beta(\delta)(1-\delta)^3 = .006$, with even smaller values beyond the three period log (recall Table 2). The most substantial difference between the models relates to the pattern of influence of current and lagged expenditures, where the rates of advertising/promotion stock augmentation are .437, .104, and .025 for the current and first two lags of expenditures in Model II versus .396, .304, and .138 for Model III. While both models suggest similar effects for current advertising and promotion expenditures, Model II suggest a notably more rapid decay in the influence of lagged expenditures than does Model III. However, even here the apparent distinction between the model results based on the point estimates of the parameters is blurred by the fact that 95 percent confidence intervals around the lag coefficients of Model III encompass the decay pattern of Model II, these confidence intervals being (.074, .534) and (-.033, .309), respectively.

Given the lack of a compelling reason for favoring one model over the other, both models were reestimated with the insignificant advertising and promotion effects for pork and poultry eliminated. The goodness of fit statistics for the reduced models are displayed in the last two

columns of Table 1. The statistics are little changed from their full model counterparts, so the comments about the values made earlier apply as well to these reduced model results.

Reduced model results for advertising/promotion coefficients, and price flexibilities with respect to advertising/promotion expenditures and quantities consumed are displayed in Tables 5-7. The values of the parameter estimates associated with advertising/promotion effects (Table 5) are close to the corresponding estimates obtained from the full models both in terms of magnitude and t-ratios. Decay patterns are thus similar between the full and reduced models, with Model II again implying the more rapid decay of the effect of advertising and promotion expenditures. However, similar to the previous comparison between the models, the decay pattern of Model II is contained within 95 percent confidence intervals around the decay pattern of Model III. Mean level direct price flexibilities with respect to quantities consumed are also quite similar between the full and reduced models, as a comparison of Tables 4 and 7 reveals. The price flexibilities remain consistent with *a priori* expectations of negativity.

The price flexibilities with respect to advertising/promotion expenditures were calculated both for 1987, the period in which the MPP/TEA program began, as well as for the last period in the data set, 1994. These flexibilities, along with their t-ratios based on bootstrapped standard errors from a bootstrap sample of 1000 observations, are displayed in Table 6. Over half of the estimated flexibilities are statistically significant at the conventional .05 level of type I error. Notably significant are the direct positive effects of U.S. beef advertising and promotion expenditures on the demand for U.S. beef as well as the indirect negative effects of these expenditures on the demand for non-U.S. beef. Given that lagged values of advertising and promotion expenditures impact current demand for meat commodities, it is also of interest to measure the cumulative effect of

advertising expenditures on demand over time. Such measures are presented in the discussion section below.

Discussion

Based on either of the Models II or III, there is convincing evidence in support of the conclusion that U.S. beef advertising and promotion expenditures in the Japanese market exert a significant positive influence on the demand for U.S. beef. Likewise, there is a lack of evidence that either U.S. pork or poultry advertising and promotion expenditures had an expansionary effect on the demand for U.S. pork or poultry products.

The effect of U.S. beef advertising and promotion expenditures is not entirely dissipated in the period in which the expenditures occur. There is strong evidence that the effects of advertising and promotion expenditures carry over for at least an additional year beyond the point of initial expenditures. There is somewhat weaker, albeit still notable, evidence that the effects of advertising and promotion carryover to some degree into the second year beyond the point of initial expenditure. Regarding the rates at which expenditures add to the stock of advertising and promotion information, the final version of Model II indicates that current through two-year lagged expenditures impacts stock at the respective rates .463, .090, and .018 (see Table 5). Thus, the effectiveness of a given period's advertising and promotion expenditure in augmenting advertising and promotion stock is depreciated by approximately 80 percent per year in Model II, with the cumulative rate of stock augmentation for a given expenditure level being .571 through the second lagged period, and .575 overall.

The results of Model III suggest that there is a less rapid depreciation in the effectiveness of advertising and promotion expenditures over time. In particular, the depreciation rate is roughly

one-third per year through the second year, at which point the expenditure becomes ineffective in augmenting the stock of advertising and promotion information.[3] The cumulative rate of stock augmentation for a given expenditure level equals .808 in Model III (Table 5) through the second year.

Regarding the effectiveness of advertising and promotion expenditures on augmenting the demand for U.S. beef in Japan, the flexibility of U.S. beef price with respect to a change in current advertising and promotion expenditures is estimated to be between .110 in Model III to .128 in Model II when calculated at the beginning of the MPP/TEA program period (Table 6). In order to provide a guideline measure for the marginal per dollar return of incremental advertising and promotion expenditures on the value of U.S. beef sales in the 1987 period, the flexibilities were applied to the existent 1987 wholesale value of beef sales adjusted downward by tariffs, markups, and ocean freight costs. In particular, the wholesale commission was assumed to be 3.5 percent, the trading company markup equaled 15 percent, the tariff was 25 percent, and the ocean freight cost was assumed to be $.28 per pound (see Wahl and Suzuki, 1993). The marginal per dollar return was calculated to be between 15.56 to 1 in Model III to 18.11 to 1 in Model II. Based on a 95 percent confidence interval for the price flexibilities, lower bounds on the marginal per dollar returns ranged between 8.05 and 10.62 to 1. Note these levels of return are not adjusted for additional costs, which would include such things as production, insurance, and domestic (U.S.) transportation costs, so the net marginal return per advertising and promotion dollar could still be significantly less than the reported figures. Furthermore, it was not possible to account for the potentially large concomitant

[3] The inclusion of additional expenditure lags in the context of Model III resulted in insignificant advertising and promotion coefficients.

and correlated level of advertising and promotion expenditures made by private firms both in the U.S. and in Japan in support of enhancing the demand for specific U.S. beef products both in retail stores and restaurants. These latter expenditures would act synergistically with MPP/TEA efforts and should rightfully be accounted for by adjusting downward the demand enhancing effects attributed to MPP/TEA efforts.

The flexibility of U.S. beef price with respect to advertising and promotion expenditure was estimated to be between .200 (Model III) and .246 (Model II) by the end of the period analyzed (Table 6). Based on the level of advertising and promotion expenditure and the adjusted value of U.S. beef sales existent in 1994 (now based on a 50 percent tariff, with the other adjustments as described above), the marginal return to advertising and promotion expenditure is estimated to be between 13.06 and 16.08 to 1 for Models III and II, respectively. A lower bound on these marginal returns based on a 95 percent confidence interval for the price flexibility is calculated to be between 6.73 and 9.53 to 1. The same caveats stated previously regarding the optimistic nature of these marginal return figures for judging the effectiveness of MPP/TEA expenditures apply equally well here. Comparing the marginal returns at the beginning and end of the 1987-1994 period reveal that the effectiveness of advertising and promotion expenditures changed little during the period, with perhaps a slight decrease in effectiveness being realized as the MPP/TEA program matured.

The U.S. beef advertising and promotion efforts had both halo and substitution effects on a subset of the meat commodities, and also had no significant impact on others. In particular, while the estimated coefficients for either Model II or III suggest that U.S. poultry and pork demand are detrimentally affected by U.S. beef advertising and promotion, neither effect is statistically significant at conventional levels of type I error either at the beginning or end of the 1987-94 period

(Table 6). The demand for non-U.S. beef and pork are also estimated to be detrimentally impacted U.S. beef advertising/promotion, the former effect being unequivocally statistically significant while the latter is marginally significant at the end of the period of analysis but not at the beginning. Thus, there is evidence that advertising and promotion of U.S. beef does result in the displacement of demand for some competitors' meat products.

A small halo effect in support of Japanese Wagyu beef demand is estimated to have been statistically significant at the end of the analysis period, and marginally significant at the beginning of the period. Thus the promotion of high quality, grain-fed U.S. beef appears to have small but positive spillover effects on the demand for Wagyu. There is also a positive and significant halo effect on the demand for non-U.S. poultry, an explanation of which is not readily apparent.

In order to provide a measure of the impact of the advertising and promotion carryover effects on the demand for U.S. beef in Japan, a scenario was simulated whereby the entire path of advertising and promotion expenditures from 1987 to 1994 was increased by 1 percent over historical levels, and the resultant increase in wholesale dollar value of U.S. beef sales was calculated. Model III implied that dollar value would increase by .465 percent while Model II predicted that dollar value would increase by .457 percent. Translating these gains into an adjusted marginal return[4] to advertising and promotion expenditure resulted in values of 26.51 to 1 and 27.18 to 1, for Models II and III, respectively. Setting advertising parameters at their lower bound values based on 95 percent confidence intervals yields a lower-bound on the adjusted marginal returns of between 8.67 to 14.98 to 1 for Models III and II, respectively. As before, it should be carefully

[4] Adjustments were as stated previously, with the tariff rates during the 1987-94 being 25 percent through 1990, 70 percent in 1991, 60 percent in 1992, and 50 percent for 1993 and 1994.

noted that these figures are not net of a number of production and marketing costs and have not been adjusted downward to reflect concomitant and synergistic advertising and promotion efforts conducted by private U.S. and Japanese firms in support of specific beef products. Thus, it is to be expected that the net impacts of increased MPP/TEA expenditures on the demand for U.S. beef in Japan would be less than the measures presented here. Nonetheless, the scenario illustrates the synergistic effects of applying a continuous stream of advertising and promotion effort, and suggests that MPP expenditures are best applied in a consistent and sustained manner.

Concluding Comments

Based on the inverse AIDS model of Japanese consumer demand for meat analyzed in this study, it can be concluded that MPP/TEA advertising and promotion expenditures in support of U.S. beef demand has been a significant success in strengthening Japanese demand for U.S. beef. Insufficient evidence was found to make a similar claim regarding advertising and promotion expenditures in support of either U.S. pork or U.S. poultry demand.

One cannot conclude on the basis of this study that pork and poultry advertising and promotion expenditure is necessarily ineffective in supporting the demand for U.S. pork and poultry. It may be the case that such expenditures have served to protect or maintain market share in the face of competition from other domestic and foreign suppliers, even though such efforts, at the level they were conducted, have not expanded market share. It is known that Australia, New Zealand, and other foreign competitors actively promote their meat products in Japan, and in the absence of the availability of data on these competitive advertising and promotion activities, the share-protecting aspects of advertising and promotion activities can not be appropriately modeled or assessed. In fact

a zero impact of expenditures in the context of the current model in consistent with the maintenance of market shares.

It should also be noted that the MPP/TEA program in support of U.S. beef demand is notably larger in scope than either the pork or poultry program. In particular, the beef program is nearly three times the size of the poultry program and over four times the size of the pork program. It may be that the latter two programs have not achieved the critical size necessary to have market-share expanding effects on consumer demand.

Finally, as with all econometric studies, the results of the analysis are dependent on the data used and the functional forms of the models estimated. While the model appeared to fit the historical data very well, and although the IAIDS model utilized in the analysis is a flexible functional form, there are a number of other flexible functional form choices that could be investigated. Also, enriching the data set with information relating to competitors' advertising and promotion efforts would provide an expanded context within which to judge the effectiveness MPP/TEA expenditures. The authors were unable to secure data on foreign competitors' advertising and promotion effort. It could be profitable for future research to investigate the sensitivity of the conclusions contained in this paper to other forms of demand systems and to other methods of accounting for advertising effort within the demand systems. Securing data regarding foreign competitors' advertising and promotion efforts could also lead to refined analyses of the effectiveness of MPP/TEA efforts that may enhance or alter the conclusions of the current study.

Table 1. Goodness of Fit Measures for Models I, II, and III

Fit Measures*		Model I	Model II	Model III	Reduced Model II	Reduced Model III
R^2	U.S. Beef	.94	.95	.95	.95	.95
	U.S. Pork	.94	.94	.94	.94	.94
	U.S. Poultry	.86	.78	.86	.79	.78
	Non-U.S. Beef	.91	.93	.94	.93	.93
	Non-U.S. Pork	.93	.94	.94	.94	.94
	Non-U.S. Poultry	.97	.97	.97	.97	.97
	Japanese Wagyu	.84	.86	.87	.86	.87
MAPE %	U.S. Beef	16.38	16.39	17.08	16.45	16.99
	U.S. Pork	10.51	9.26	9.77	9.78	9.67
	U.S. Poultry	8.87	8.32	7.86	8.40	8.37
	Non-U.S. Beef	3.85	3.15	2.98	3.13	2.98
	Non-U.S. Pork	4.62	4.23	4.24	4.34	4.23
	Non-U.S. Poultry	11.05	10.32	10.12	10.32	10.21
	Japanese Wagyu	3.81	3.45	3.39	3.47	3.36
MPE %	U.S. Beef	-3.92	-3.74	-3.80	-3.78	-3.73
	U.S. Pork	-2.24	-1.88	-1.88	-1.98	-1.90
	U.S. Poultry	-2.83	-2.68	-2.36	-2.73	-2.59
	Non-U.S. Beef	-.15	-.11	-.09	-.11	-.10
	Non-U.S. Pork	-.40	-.37	-.35	-.37	-.36
	Non-U.S. Poultry	-2.79	-2.40	-2.27	-2.42	-2.30
	Japanese Wagyu	-.15	-.13	-.12	-.13	-.12
Residual Runs Test (z-stat)	U.S. Beef	-.44	-.87	-.87	-.87	-.87
	U.S. Pork	-1.31	-1.31	-1.31	-1.31	-1.31
	U.S. Poultry	-1.31	-.44	-.44	0.00	0.00
	Non-U.S. Beef	-.87	-.87	0.00	-.87	0.00
	Non-U.S. Pork	-1.31	-1.31	-.44	-1.31	-1.31
	Non-U.S. Poultry	0.00	-.44	-.44	-.44	-.44
	Japanese Wagyu	-.87	-.87	-.87	-.87	-.87
Theil's U-Statistic	U.S. Beef	1.03	.72	.62	.73	.62
	U.S. Pork	.29	.29	.31	.30	.30
	U.S. Poultry	.61	.56	.62	.58	.57
	Non-U.S. Beef	.87	.75	.71	.75	.72
	Non-U.S. Pork	.37	.34	.32	.35	.34
	Non-U.S. Poultry	.60	.63	.67	.63	.67
	Japanese Wagyu	.67	.62	.61	.62	.60

*NOTE: MAPE is the mean absolute percent error in the prediction of budget shares, MPE is the mean percent error, the residual runs test is the Wald-Wolfowitz test for independence, and Theil's U-Statistic is Theil's measure of turning point prediction accuracy.

Table 2. Advertising/Promotion Coefficients and T-Values

	Model I	Model II		Model III		
				Current	Lag 1	Lag 2
	d	b	d	d_1	d_2	d_3
U .S. Beef	.614 (5.24)	.575 (5.29)	.760 (5.21)	.396 (3.74)	.304 (2.59)	.138 (1.58)
U.S. Pork	-.021 (-.44)	-.185 (-.31)	.004 (.17)	-.006 (-.14)	.020 (.406)	-.010 (.-.21)
U.S. Poultry	-.290 (-1.03)	.0001 (.00006)	145.8 (.00006)	-.361 (-1.39)	-.086 (-.27)	.150 (.41)

Table 3. Tests of Advertising/Promotion Hypotheses

Test Type	Parameter Restrictions	Test Stat	Probability
Model II: Pork and Poultry advertising/promotion has no effect	$d_2 = d_3 = 0$	c_2^2=.087	.96
Model III: Pork and Poultry advertising/promotion has no effect	$d_{ij} = 0$, i=2,3, j=1,2,3	c_6^2=3.71	.72
Model II: No carryover effect for Beef advertising/promotion	d=1	c_1^2=2.87	.09
Model III: No carryover effect for Beef advertising/promotion	$d_2 = d_3 = 0$	c_2^2=14.02	.001

Table 4. Mean Level Direct Price Flexibilities

	Model I		Model II		Model III	
Own Price Flexibility	Flexibility	T-Value	Flexibility	T-Value	Flexibility	T-Value
U.S. Beef	-.754	-24.01	-.820	-7.20	-.836	-8.13
U.S. Pork	-.306	-5.98	-.283	-2.90	-.228	-1.81
U.S. Poultry	-.343	-2.58	-.293	-1.69	-.343	-1.06
Non-U.S. Beef	-.328	-3.05	-.244	-2.24	-.205	-1.88
Non-U.S. Pork	-.441	-6.32	-.410	-5.93	-.420	-6.37
Non-U.S. Poultry	-.698	-5.17	-.784	-5.79	-.784	-6.14
Japanese Wagyu	-.222	-3.27	-.260	-3.99	-.262	-4.32

Table 5. Final Advertising/Promotion Coefficients and T-Values

Advertising/Promotion for Beef Only					
	Model II		Model III		
	b	d	d		
			current	lag 1	lag 2
U.S. Beef	.575	.805	.390	.288	.130
	(5.37)	(5.79)	(3.91)	(2.63)	(1.52)

Table 6. Final Model Advertising/Promotion 1987 and 1994 Flexibilities

	Model II				Model III			
	1987		1994		1987		1994	
	Flexi-bility	T-Value	Flexi-bility	T-Value	Flexi-bility	T-Value	Flexi-bility	T-Value
U.S. Beef	.128	4.74	.246	4.81	.110	4.06	.200	4.04
U.S. Pork	-.023	-.93	-.054	-1.17	-.020	-.99	-.047	-1.22
U.S. Poultry	-.004	-.15	-.098	-.806	-.0004	-.02	-.081	-.78
Non-U.S. Beef	-.018	-4.49	-.104	-4.67	-.016	-4.05	-.088	-3.95
Non-U.S. Pork	-.009	-1.40	-.045	-1.89	-.007	-1.43	-.039	-1.94
Non-U.S. Poultry	-.049	2.03	.130	2.30	.041	2.04	.106	2.26
Japanese Wagyu	.008	1.85	.039	3.05	.007	1.90	.034	2.80

Table 7. Final Mean Level 1987 and 1994 Direct Price Flexibilities

	Model II		Model III	
	Flexibility	T-Value	Flexibility	T-Value
U.S. Beef	-.828	-7.57	-.832	-7.95
U.S. Pork	-.266	-3.87	-.260	-3.79
U.S. Poultry	-.330	-2.73	-.335	-2.87
Non-U.S. Beef	-.250	-2.28	-.231	-2.25
Non-U.S. Pork	-.421	-5.94	-.420	-6.25
Non-U.S. Poultry	-.788	-5.86	-.792	-5.99
Japanese Wagyu	-.265	-4.12	-.270	-4.33

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