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Japanese Beef Policy and GATT Negotiations: An Analysis of Reducing Assistance to Beef Producers*

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Introduction

Since at least the mid-1970s, Japan and its beef import suppliers, the U.S. and Australia in particular, have engaged in heated negotiations on the level of the Japanese beef import quota. U.S. negotiators have demanded that Japan completely liberalize beef imports. The Japanese have responded in a piecemeal fashion, increasing the quota by comparatively small amounts in an apparent attempt both to appease U.S. interests and to minimize the opposition of the politically powerful domestic cattle producers. The most recent Japanese concession was an agreement in the fall of 1984 to expand the total beef import quota by 9,000 metric tons (mt) per year for four years, bringing total imports to 177,000 mt by early 1988.

Discussions on the level of the quota beyond 1988 will coincide with more general multilateral discussions on agricultural protectionism worldwide under the auspices of the General Agreement on Tariffs and Trade (GATT). A major focus of the GATT discussions will be progressive reduction of agricultural support. A measure of relative levels of agricultural protection known as Producer Subsidy Equivalents (PSEs), has been recently proposed by the United States as the main vehicle for GATT commitments in agriculture in the upcoming negotiations (OECD). If acceptable to participating countries, a gradual and balanced reduction of PSEs would become the focus of GATT negotiations.

Previous analyses of Japanese beef import policy have considered various policy schemes designed to liberalize imports (Hayami, Anderson, Kagatsume and Zwart, Williams, Wahl and Williams (1987a)). These studies, however, have not considered what the effects of a negotiated reduction in Japanese support of the beef industry (such as a reduction in the PSE over time) might imply for the future of the Japanese beef industry. At the same time, most of these studies have failed to recognize that any agreement by the Japanese that threatened to significantly reduce support of beef production and liberalize beef imports would be perceived by producers to be a significant change in policy. As a consequence, they would

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tend to behave much differently with respect to price changes following an agreement to progressively reduce beef support than in the absence of such an agreement.

The general dynamic effects of a reduction in the level of Japanese assistance to beef producers (i.e., a reduction in the Japanese beef PSE) between 1988 and 1996 are measured in this study using an annual, simultaneous equations, econometric simulation model of the Japanese livestock industry. Beef imports are first allowed to increase through the end of the period at the current rate of 9,000 mt per year to generate a baseline forecast. Then the model is simulated over the forecast period under various assumptions regarding the rate of reduction of the Japanese PSE. The resulting changes in the supply, demand, and prices of livestock and meat in the model from the baseline forecast levels over the period can be considered to be measures of the likely effects of negotiated reductions of Japanese support of beef production.

First, some discussion of the Japanese beef industry and policy is provided as background to the presentation of the analytical model and the analysis of the PSE reduction simulation results. Next, the theoretical basis for analyzing the effects of a reduction in Japanese support for beef production is considered. The econometric model and analytical technique utilized are then briefly characterized followed by a simulation analysis of the effects of the beef PSE reductions. Finally, some implications for current discussions on a new import quota agreement are drawn.

The Japanese Beef and Livestock Industry and Policy

Japanese cattle inventories are composed of native beef (Wagyu) and dairy cattle. Wagyu are raised in small herds by a large number of farmers, mostly as a sideline to crop production. In contrast, dairy farming is a highly specialized activity, and herds are correspondingly larger. However, both Wagyu and dairy heifers and steers are fattened for slaughter.

Until the 1960s, Wagyu cattle were used largely as draft animals. As machinery replaced animal power in Japanese agricultural production during the late 1950s and 1960s, however, the number of Wagyu cattle began to drop. The decline of the Wagyu industry continued until the early 1980s when inventories stabilized and began to increase slightly. The decline of the Wagyu industry occurred despite the preference of Japanese consumers for Wagyu beef and the government beef price support policy.

The national dairy herd was less than one-tenth the size of Wagyu inventories during the early 1950s. By the late 1960s, however, dairy cattle numbers had increased to about the size of the declining Wagyu herd. The growth of the dairy industry, however, has been more related to the increasing profitability of milk production over time than to the economics of beef production (Longworth). Beef from the slaughter of dairy cattle accounts for only about 10% of the income of most dairy farmers (BAE). Even so, dairy cattle accounted for about 61% of total slaughter in 1985 compared to 12% in 1962.

A rapid increase in the per capita income in Japan has resulted in a rapidly increasing demand for beef. During the 1950s and 1960s, the Japanese government gradually increased the beef import quota allowing a slow increase in both imports and per capita consumption of beef. In 1973, however, the government more than doubled the quota in an effort to hold down beef prices and reduce general inflationary pressures (Longworth). The subsequent explosion of beef

imports and consumption in that year reduced domestic beef production, prompting the government to suspend the quota in late 1973 and to completely close the Japanese beef market in 1974 through the first half of 1975. As a consequence, the retail price of beef jumped by nearly 110% between 1972 and 1976 after increasing by only 5% over the previous five year period. Following the easing of controls on beef imports in 1975, per capita consumption of beef has continued to grow, although at a lower average annual rate than in previous years.

On average over the last 20 years, the per capita consumption of beef has not expanded nearly as rapidly as that of pork or chicken meat. In 1960, for example, per capita beef, pork, and chicken meat consumption were nearly the same at about 1 or 2 kg/year. By 1983, per capita pork and chicken meat consumption had jumped to 13.1 kg/year and 11.0 kg/year, respectively, compared to that of beef at only 5.2 kg/year. Given the restrictive beef import quota, this disparity in growth rates reflects a similar disparity in relative rates of production and an opposite disparity in price movements over time. The more rapid production growth of pork and chicken meat has been due primarily to the rapid adoption of modern confinement feeding technology for hogs and chickens in Japan over the last 20 years. Consequently, the real retail price of beef in Japan increased by 41% between 1960 and 1983 while those of pork and chicken meat decreased by 44% and 46%, respectively.

Since Japanese beef imports began in the early 1950s, Australia has been the major export supplier. New Zealand entered the market in the late 1950s but has since lost market share almost continually. By 1972, the Australian share of Japanese beef imports stood at about 91%. The U.S. became the second largest exporter of beef to Japan in 1973 with its first sizeable shipment of 9,500 mt, about 7% of total imports. The U.S. share continued to grow after import restrictions were eased in 1975, reaching about 30% by 1985. Likely reasons for the relative increase in the U.S. share include the decline in the import price of U.S. compared to Australian, New Zealand, and Japanese beef, the reported preference of Japanese consumers for U.S. grain-fed beef as opposed to grass-fed beef from other countries, and the cooperative effort of the U.S. Department of Agriculture and U.S beef producers to promote U.S. beef in Japan.

The import quota is the main tool of the Japanese government to support the domestic cattle industry and encourage beef production. Through the complicated import quota structure, the government attempts to maintain the established domestic beef target prices. Then through a fine tuning mechanism of purchasing and storing or releasing beef from stocks (the beef price stabilization scheme), the government stabilizes the domestic price of beef around the target within a politically and socially acceptable range (the upper and lower stabilization prices). As a consequence, Japanese domestic beef prices tend to be higher and more stable than otherwise might be the case.

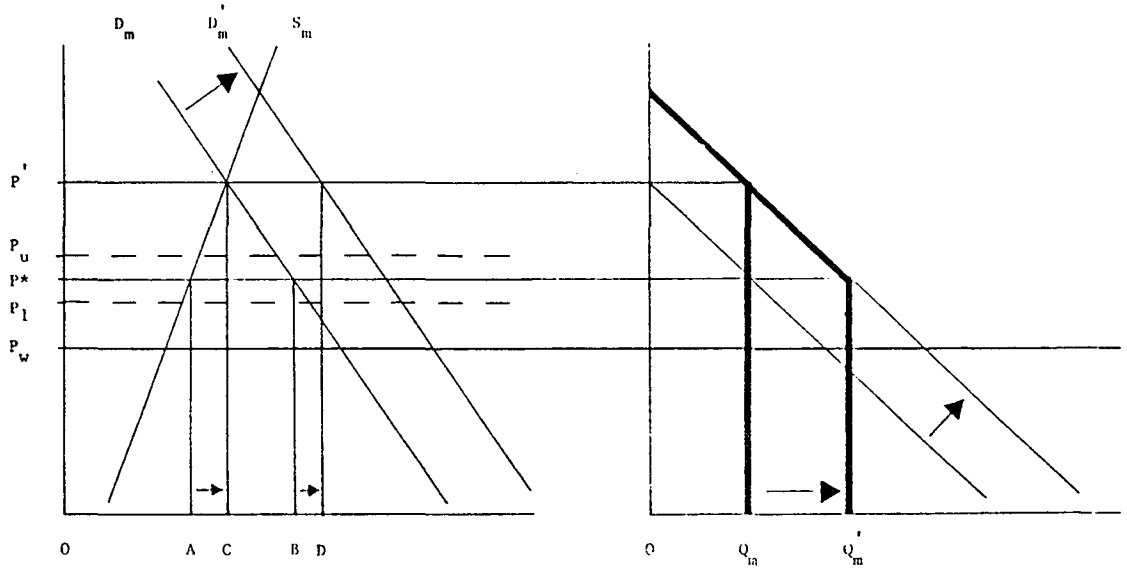
The extent of protection afforded beef producers in Japan can be measured using the Producer Subsidy Equivalent concept. In general, protection of the production of a given commodity in a given country implies a direct or indirect transfer of income from the government and/or consumers to producers of that commodity (Tangermann, Josling, and Pearson). The PSE for a given commodity and country is a measure of that transfer, ie., the implied subsidy received by producers. In other words, the PSE is the cash payment (subsidy) to farmers that would substitute for all direct and indirect government support policies and result in no change in farm income. The PSE is usually calculated as the difference between the domestic and world prices of the commodity of interest times domestic production (which accounts for trade-distortion policies) plus the value of all other government transfers that directly or indirectly support production of that commodity.

As a measure of the magnitude of producer support, the calculated PSE is usually expressed in relation to one of several bases, including domestic output, domestic output valued at domestic prices, or domestic output valued at world prices. In the latter case, if only trade distorting policies are included, the PSE is comparable to an ad valorem tariff (Tangermann, Josling, and Pearson). Some agreement on exactly what policies to include in the calculation of PSEs would have to be reached before they could actually be used as the basis for negotiations. Tangermann, Pearson, and Josling suggest that it is likely that a definition of PSE would be adopted "such that only trade distorting policies would be included, since in international negotiations the principal interest is trade implications rather than income transfers" (p. 5). In this study, therefore, "PSE" includes only the trade distorting policy transfers to producers expressed as a percent of domestic production valued at world prices. In a recent study, the U.S. Department of Agriculture calculated PSEs in a large number of countries and concluded that Japanese beef producers are among the most highly protected of all world producers of agricultural commodities. Japanese milk producers, however, were found to be supported at even a higher level.

Theoretical Considerations

The rapidly increasing demand for beef in Japan has required the government to allow imports to increase over time in order to keep prices from increasing significantly above the established stabilization range. As illustrated in figure 1, an increase in the domestic demand for beef from D_m to D'_m means that either the import quota must be allowed to increase from

Figure 1. Japanese Beef Import Quota Policy



OQ_m to about OQ'_m or price will tend to rise above the stabilization range (P_u to P_l) to P'. Price changes within the established range are not considered by producers to be a signal of future price movements because the government is expected to intervene to keep prices within the established limits. A failure to allow imports to increase rapidly enough over time to

satisfy growing demand would result in the inability of the government to hold prices at or below the upper price stabilization limit and producers would respond accordingly.

A negotiated reduction in the level of support provided to Japanese cattle producers through a progressive reduction in the beef PSE, however, would signal a significant change in policy. Beef producer response to price changes in this situation would be much different than observed historically. This change in producer behavior given such a structural shift in policy must be accounted for explicitly in order to derive plausible measures of the impacts of a reduction in the Japanese beef PSE over time. In general, producer behavior can be represented by the following standard theoretical breeding cattle inventory model:

$$(1) \quad Y^*_t = f(P^e_{t+1}, Z_t)$$

where Y^*_t is the desired breeding herd size at the end of period t, P^e_{t+1} is the expected profitability of raising cattle in the following period (the expected price of cattle deflated by feed price in period t+1), and Z_t represents other variables such as technical change that may affect the desired ending herd size in period t.

Jarvis has suggested that changes in beef prices could be expected to have two opposing effects on cattle raisers' herd size decisions. A cattle price decline, for example, would lead cattle producers to expect a continued decline in prices, leading them to retain fewer heifers in the breeding herd and thereby avoid profit losses from the expected lower prices in the future. This is essentially the Jarvis cattle producer investment behavior. On the other hand, the cattle price decline would induce farmers to cull out fewer cows and immediately hold back heifers suitable for replacement instead of sending them to slaughter to avoid losses from the lower prices. This is analogous to the Jarvis cattle producer consumption behavior. Empirical analyses of U.S. and Argentine cattle producer behavior suggest that the investment effects outweigh the consumption effects in those countries (Rucker, Burt, and LaFrance and Jarvis, respectively).

A standard form of equation (1) for estimation can be derived by assuming a partial adjustment framework for inventories and adaptive price expectations:

$$(2) \quad Y_t - Y_{t-1} = \tau(Y^*_t - Y_{t-1})$$

$$(3) \quad P^e_{t+1} - P^e_t = \theta(P_t - P^e_t)$$

where τ is the coefficient of adjustment, θ is the coefficient of expectation, and $0 \leq \tau, \theta \leq 1$. Equation (2) suggests that primarily because of biological restrictions and the cost of adjustment, changes in the breeding herd size take time, i.e., the breeding herd cannot adjust fully in one year to the long-run desired level. Equation (3) assumes that the change in expected price in period t+1 is proportional to the current error in forecasting. In other words, producers update their expectations about future price movements based on current deviations in price from the expected level. If θ is close to zero, then producers consider current deviations in price from expected levels to be temporary and do not substantially alter their expectations about future price movements. A value of θ close to one, on the other hand, indicates that producers consider the deviations to be more permanent and update their expectations each year by about the full extent of the current forecast error.

Assuming a linear form of equation (1) and substituting equations (2) and (3) into that equation yields the following breeding inventory model for estimation:

$$(4)\quad Y_t = \alpha_0 + \alpha_1 P_t + \alpha_2 Y_{t-1} - \alpha_3 Y_{t-2} + \alpha_4 Z_t - \alpha_5 Z_{t-1}$$

where $\alpha_0 = \tau\theta a$,
$\alpha_1 = \tau\theta b$,
$\alpha_2 = [(1-\tau) + (1-\theta)]$,
$\alpha_3 = (1-\tau)(1-\theta)$,
$\alpha_4 = \tau c$, and
$\alpha_5 = \tau(1-\theta)c$.

Also, a is the intercept and b and c are the coefficients of the variables in the linear form of equation (1) and other all variables are as previously defined. The value of θ can be calculated directly from the estimated coefficients of equation (4). The remaining parameters (τ, a, b, and c) can be derived by a procedure suggested by Maddala (pp. 144-146) given a value for θ.

Assuming no change in Japanese beef policy in the future (i.e., Japanese beef imports continue to rise at about the current rate), the value of θ would not be expected to change from its historical level. Consequently, equation (4) as estimated from historical data can be incorporated into a simultaneous equations model of the Japanese livestock industry to generate a baseline forecast of Japanese breeding cattle inventories. The forecasted values of inventories would help determine the baseline forecast levels of domestic beef supply and, therefore, of domestic beef prices and consumption in the simultaneous model.

If the Japanese government agreed to progressively reduce the level of the beef PSE, however, domestic beef prices would likely fall, inducing Japanese cattle producers to more fully incorporate the resulting price forecast errors into their expectations about future price movements. That is, if the price of cattle was lower than expected in any given year and producers believed that this was the result of an announced change in policy to reduce support to beef producers, then producers would expect the price decrease to continue. This implies that θ would tend to increase given an agreement by the Japanese government to reduce intervention in the domestic cattle industry. Consequently, a realistic measure of cattle producer and, therefore, domestic beef supply response to a reduction in government support of domestic beef production over the forecast period is possible by using equation (4) to alter the estimated coefficients in the breeding inventory equations to reflect an increase in θ before simulating the effects of a reduction in the beef PSE. Unfortunately, the extent to which θ should be increased is unknown so that any particular choice is arbitrary. All that is known is that given a reduction in the beef PSE, θ must lie between the historical, estimated level and one. Wahl and Williams (1987a) indicate that even though the maximum theoretical value for θ is one, the maximum feasible values for θ that are consistent with the biological restrictions on the year-to-year changes in the Japanese breeding herd sizes for Wagyu and dairy cattle are .77 and .81, respectively. Given the extreme nature of a shift from the current, slowly increasing import quota to a negotiated, progressive reduction in support to beef producers, the maximum level of θ would likely most nearly approximate the price responsiveness of domestic beef producers in that situation.

An underlying assumption of the foregoing discussion is that imported beef is highly substitutable for Japanese-produced beef. However, there are several grades of Japanese beef (for both dairy and Wagyu beef cattle) and several forms of imported beef (chilled and frozen, grain-fed and grass-fed). There is also a great deal of controversy as to the substitutability of the different grades and forms of domestic and imported beef. Longworth suggests that U.S. choice, grain-fed beef, which makes up the bulk of U.S. beef exports to Japan, is "comparable in quality not only to the best dairy steer but also to all except super-grade Wagyu meat." Mori, on the other hand, concludes that "imported U.S. high quality beef and domestically

produced dairy beef, not to speak of Wagyu beef of the higher grades, are two different commodities..." suggesting very low or even zero substitutability. Thus, the lower the degree of substitutability between import-quality beef and Wagyu beef, the less would be the expected impact of liberalizing beef imports on the Wagyu industry in Japan.

The Japanese Livestock Industry Model

The dynamic effects of a progressive reduction in the Japanese beef PSE over 10 years (1988 through 1997) are measured in this study using an annual, simultaneous equations, econometric model of the Japanese livestock industry. The 70-equation model contains three simultaneous blocks: the Wagyu and dairy cattle and beef sector, the hog and pork sector, and the chicken and chicken meat sector. Each block contains two main components: (1) live animal supply (breeding herd, slaughter livestock inventories, animals raised, and imports) and slaughter demand and (2) meat supply (production and imports) and consumption.

The parameters of the behavioral equations were estimated using two-stage least squares and data for 1962 to 1985. The statistical structure of the full model (a revised and expanded version of the original Japanese livestock industry model developed by Williams), along with validation statistics, is discussed elsewhere in detail (Wahl and Williams, 1987b). The model has been further enhanced for this study by incorporating a meat expenditure system on the demand side of the model. Because of space limitations, only a general characterization of the model can be attempted here.

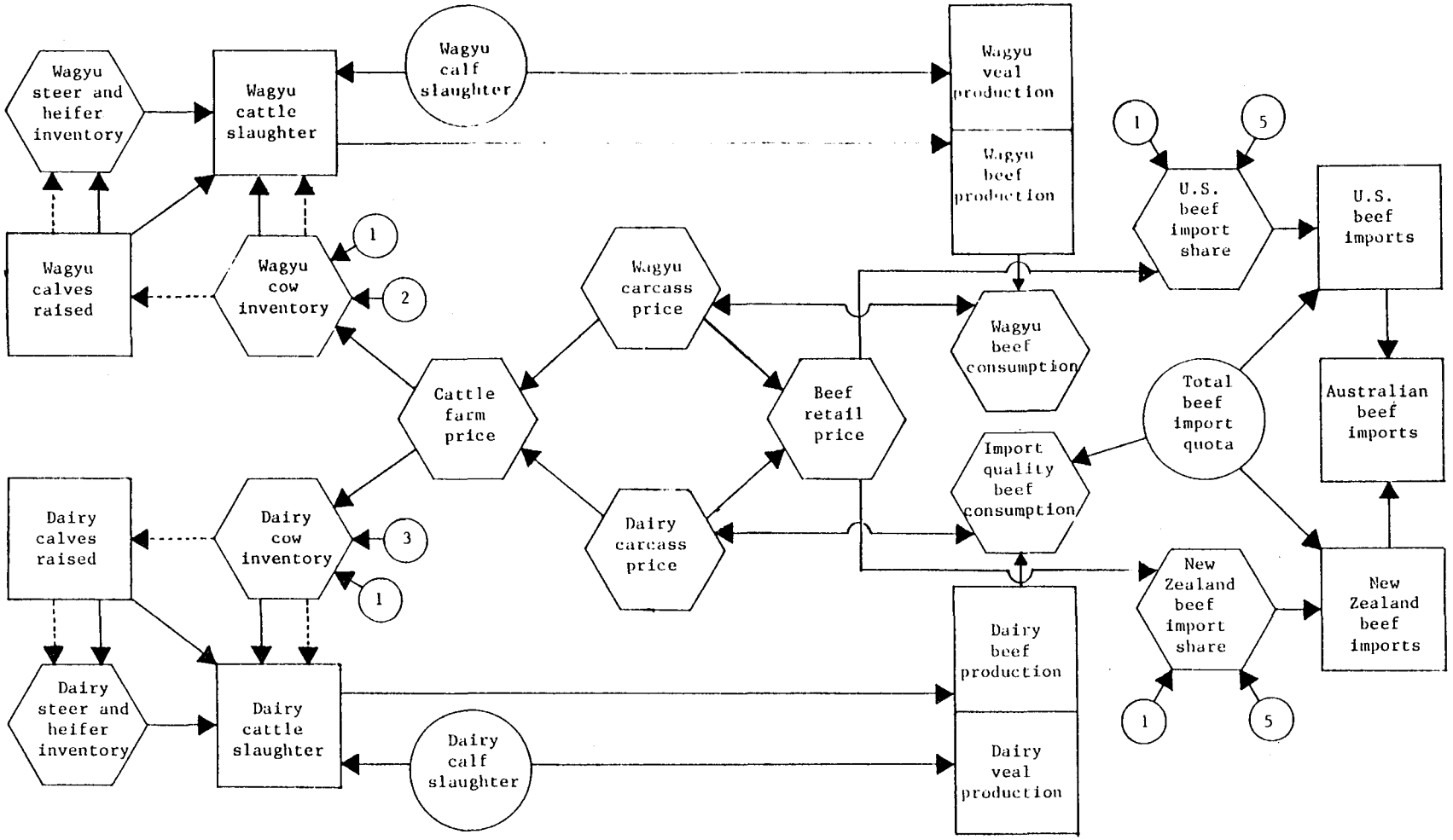
Schematic Representation of the Model

The major economic and biological relationships in the cattle and beef sector block of the model are schematically diagrammed in figure 2. The hog and chicken sector blocks are similar in structure to the cattle block. The three blocks are linked together through the meat expenditure system. The cattle block is somewhat more complicated than the hog or chicken blocks because it includes both the Wagyu and dairy cattle and beef subsectors, substantially increasing the number of equations in the block. Also some detail on Japanese beef imports by source is included (right-hand side of figure 2). Following the market share approach outlined by Meilke and Griffith, the shares of Japanese beef imports accounted for by competing beef exporting countries are specified as functions of real domestic and import prices of beef and a lagged dependent variable to represent partial adjustment behavior.

Wagyu cattle inventories include the cow or breeding herd (mature cows and heifers over two years old) and steers and heifers (generally the upper half of figure 2). Specification of the Wagyu breeding inventory equation follows equation (4). A Wagyu cattle raiser responds to changes in the profitability of producing calves by adding heifers or culling cows to alter the size of the breeding herd. Heifers not added to the herd and cull cows are fed for slaughter. Some cows must be culled each year due to health problems, requiring some heifers to be added each year as replacements to maintain a given herd size. An approximation of the number of Wagyu cows used for draft purposes is included to account for the structural change in the Wagyu industry during the 1960s (Hayami and Ruttan).

Because the primary calving season in Japan is early spring and because the gestation period for cattle is less than a year (9 months), the size of the breeding herd at the beginning of the year determines the biological upper bound on the number of Wagyu calves raised during that year. Not every cow will successfully raise a calf in every year due to disease and

Figure 2 : Japanese Livestock Industry Model : Wagyu and Dairy Cattle and Beef Sectors.



adverse weather conditions so that the annual calving rate will be less than unity. The calving rate times the beginning cow inventory determines the number of calves raised during that period. Calves may be retained in the breeding herd, slaughtered for veal, or placed on feed depending on the relative profitability of the alternative uses.

Wagyu steer and heifer inventories at the end of a given year are determined primarily by the number of calves raised in the current and previous two periods using a polynomial lag structure. The estimated coefficients indicate that at the end of a given year 41% of the steers and heifers in inventory were born in the current year, 36% in the previous year, and 23% two years previously. This represents the flow of calves through steer and heifer inventories as their ages increase and is consistent with the biological process. Also, variables are included to account for technological progress leading to a more lengthy feeding period and the structural change that led to a decline in the use of Wagyu cattle for draft purposes. Wagyu steers are placed on feed at about 10 months of age and then fed a ration that consists of an increasing proportion of corn. The feeding period has varied considerably over time in Japan. In the early 1960s, cattle were fed for only about 6 months when the draft cattle herd was diminishing rapidly. The feeding period increased to about 19 months by the 1980s along with increasing consumer demand for highly marbled meat which requires a longer feeding period and a more maturity. Most Wagyu heifers are fed for slaughter. However, those heifers of suitable quality for breeding are segregated from the other calves at about 10-12 months of age. These replacement heifers are kept until they are approximately 16-18 months of age at which time a decision is made to breed them or place them on feed. Of the heifers retained, those that are not successfully bred are also placed on feed.

Wagyu cattle slaughter is determined in the market clearing condition for Wagyu cattle as the difference between the supply of cattle (beginning inventories and cattle raised) and the number of cattle in inventories at the end of the year. Wagyu beef supply is calculated as the average Wagyu slaughter weight times the number of cattle slaughtered. Wagyu cattle slaughter weights are exogenous since they reached their approximate biological limits during the 1970s and are expected to gradually decline in the future (Simpson).

Wagyu beef consumption, along with the consumption of dairy and imported beef, pork, and chicken meat, are determined within the context of a total meat demand system. The Linear Approximate Almost Ideal Demand System (LA/AIDS) proposed by Deaton and Muellbauer used to estimate the parameters of the meat demand system and is discussed in some detail below.

The Wagyu steer carcass price is determined by the interaction of the supply and demand for Wagyu cattle. The farm price of cattle, the price received by farmers for fed cattle, is determined by the carcass price and enters the breeding inventory behavior equations.

The structure of the dairy cattle sector (generally the lower half of figure 2) is similar to that of the Wagyu sector. The major difference is that dairy cattle producers respond primarily to the profitability of producing milk relative to costs rather than to the price of slaughter cattle in making decisions about the breeding herd size. Since the late 1960s, there has been an increasing demand for dairy steers for feeding and slaughter to supplement the domestic supply of beef.

Because the primary decision that determines the supply of slaughter cattle is made by cattle raisers, the supply of cattle for slaughter and, consequently, beef production (both Wagyu and dairy) at any point in time are relatively fixed due to the lengthy production lags. The biological restrictions and dynamics involved in the beef production process dictate that in the

short run a decrease in the profitability of feeding will have little effect on beef supplies except that farmers may initially cull fewer cows. Over the intermediate run, overall slaughter and beef supply will increase as farmers add fewer heifers to the cow herd and cull more cows. The long run effects, however, of the decrease in profitability will be a decrease in slaughter and beef supply as the smaller breeding herd leads to a decrease in inventories of slaughter steers and heifers.

Given the domestic production of dairy beef in each year, the beef import quota level determines the amount of import-quality beef (dairy and imported beef) available for consumption (converted to retail weight). As is the case for Wagyu beef, import-quality beef demand is determined within the meat demand system. The retail price of beef is determined by the interaction of the supply and demand of import-quality beef as affected by other variables such as changes in prices and relative consumption levels of pork, chicken meat, and fish.

The Japanese Meat Demand System

A reduction in the protection of Japanese beef producers would have consequences far beyond the beef sector alone. Changes in the price and quantity demanded of beef would affect the demand for other meats, which in turn would alter the price and, therefore, the supply of other meats. In turn, the supply adjustments occurring in these other livestock markets would produce a second round of effects in the beef market. This process would continue until a new equilibrium is reached. Such feedback effects are usually ignored in single equation demand estimation, thereby producing biased results. The feedback effects, however, are of crucial importance when the likely magnitude of the price changes, as well as the period over which such changes are expected to occur, are relatively large.

The reliability of the analytical conclusions also requires internal consistency in the empirical model utilized. For example, the sum of predicted consumer expenditures on individual meat items should equal the predicted expenditures on all meats. At the same time, the income-compensated effect of a change in beef prices on pork demand should equal the income-compensated effect of a change in pork prices on beef demand. Consequently, the meat demand subsystem in the model must conform to the theoretical restrictions of homogeneity, Slutsky symmetry, and adding up. This requires a systems approach to demand estimation. The choice of the level of aggregation is also of concern. Ideally, a system including the entire food sector, or even all goods, should be specified and estimated. However, data limitations make this impractical if not impossible. Consequently, the meats group is assumed to be separable from other expenditure groups in this study. Although quite restrictive, this assumption leaves some questions unanswered. Should fish be considered as a meat? Should Wagyu and dairy beef be treated as separate commodities? Should imported and domestically produced meats be treated as perfect substitutes? The approach taken here to answer these and similar questions was to estimate the least restrictive model possible within the confines of data available and to regard each question as a testable hypothesis.

The treatment of dairy and Wagyu beef as separate commodities is relatively easy to implement. The Japanese publish separate price and quantity data for each beef type at the wholesale level (MAFF). However, the dividing line between dairy and Wagyu beef is somewhat indistinct in the early years of the analysis. Wagyu cattle were originally bred and used as draft animals. Consequently, much of the Wagyu beef was of poor quality as late as the 1960s. To more accurately represent the quality difference in Wagyu meat over time, a declining proportion of the slaughter of mature draft animals was included in the slaughter figures for

the dairy herd prior to about the early 1970s.[1] The term "native-quality beef" is used to refer to the Wagyu beef consumption that does not include the consumption of the meat from lower quality Wagyu cattle. Similarly, "import-quality beef" includes the beef from dairy cattle as well as the meat from the lower quality Wagyu cattle. Native-quality beef, therefore, represents beef of a higher price and quality than import-quality beef. This quality differentiation becomes irrelevant after the early 1970s, however, when draft animal use became obsolete.

The LA/AIDS demand system was chosen to estimate the parameters of the demand system in this study because it combines the best of the theoretical features of both the Rotterdam and translog models with the ease of estimation of the Linear Expenditure System (LES). The LA/AIDS system gives an arbitrary first order approximation to any demand system, satisfies the axioms of choice exactly, and aggregates perfectly over consumers (Deaton and Muellbauer). In addition, LA/AIDS is directly nonadditive (Blanciforti and Green, 1983a). Although LA/AIDS does not implicitly impose the theoretical restrictions of homogeneity, Slutsky symmetry, and adding up, these restrictions can easily be imposed. These last two characteristics are particularly important for analysis of Japanese meat demand, because there is no empirical evidence that native and import-quality beef are perfect or even close substitutes in Japan as has been assumed by many authors (e.g., Hayami and Williams). Using a directly additive system such as the LES would imply independent marginal utilities between native and import-quality beef. In addition, the facility with which the theoretical restrictions can be imposed with LA/AIDS is important to researchers in that Japanese demand data has not been mined to the same extent as data from the U.S., Britain, and the Benelux countries. As such it offers a fresh data set with which to evaluate demand systems modeling in general.

The expression for the budgetary share (W) allocated to the ith meat item using the LA/AIDS is as follows:

$$(5) \quad W_i = \alpha_i + \sum_{j=1}^{n} \gamma_{ij} \ln P_j + \beta_i \ln \left(\frac{X}{P}\right)$$

where P_j is the price of good j, X is the per capita expenditures on all five meats, and P is a suitable price index. Deaton and Muellbauer suggest the use of Stone's index (defined as log P $= \Sigma W_i \ln P_i$). Adding up, homogeneity, and Slutsky symmetry can be imposed on the LA/AIDS system by restricting the parameters of the system so that:

$$(6) \quad \sum_{i=1}^{n} \alpha_i = 1; \quad \sum_{i=1}^{n} \gamma_{ij} = 0; \quad \text{and} \quad \sum_{i=1}^{n} \beta_i = 0;$$

$$(7) \quad \sum_{j} \gamma_{ij} = 0; \text{ and}$$

$$(8) \quad \gamma_{ij} = \gamma_{ji}.$$

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[1]The proportion of mature draft animals to be included in the dairy slaughter numbers was calculated using an index of the horsepower equivalent of draft animals (Hayami and Ruttan).

Provided equations (6), (7), and (8) hold, the estimated demand functions add up to the total expenditure (6), are homogeneous of degree zero in prices and income taken together (7), and satisfy Slutsky symmetry (8) (Deaton and Muellbauer, p. 314).

The meats and fish groups were assumed to be weakly separable from other food groups as well as from other commodities. Consequently, a system of five equations for native-quality beef, import-quality beef, pork, chicken, and fish was estimated using OLS. The column headed $\Sigma\gamma_{ij}$ in Table 1 is the row sums of the unconstrained γ_{ij} matrix, i.e., the sum of the own and cross-price effects from the original OLS regression. Under homogeneity, this term should be zero (Deaton and Muellbauer, p. 319). The t statistics presented beneath the $\Sigma\gamma_{ij}$ terms (in parentheses) are the square roots of the F-ratios obtained by comparing the sum of the squared errors of the unconstrained OLS equation with those obtained when homogeneity was imposed. None of these t-statistics are significant, implying that homogeneity is accepted by the data. Consequently, homogeneity was imposed on the system by dividing all meat prices by the fish price and by then calculating the fish price coefficient using the homogeneity restriction that $\Sigma\gamma_{ij} = 0$. The results of these regressions are presented in the remaining columns of table 1. The estimates of β_i classify pork and fish as necessities while other meats are classified as luxuries. The parameters for the fish share equation were calculated using the adding up restrictions (6). These restrictions are costlessly imposed. That is, those parameters calculated using the restrictions are identical to those that would be estimated using OLS.

Table 1. The Parameter Estimates and Tests of Homogeneity[a]

Commodity	α_i	β_i	γ_{i1}	γ_{i2}	γ_{i3}	γ_{i4}	γ_{i5}	$\Sigma\gamma_{ij}$	$\bar{R}^2$	DW
Native Quality Beef	0.155 (1.92)	0.043 (0.96)	-0.0076 (-4.36)	0.032 (2.25)	0.037 (1.92)	0.018 (1.31)	0.011	-0.001 (-1.12)	.85	1.17
Import Quality Beef	0.141 (1.47)	0.033 (0.64)	0.058 (2.84)	-0.062 (-3.69)	-0.010 (-0.46)	-0.033 (-1.99)	-0.047	-0.014 (-0.811)	.96	1.72
Pork	-0.041 (-0.36)	-0.110 (-1.94)	0.069 (2.81)	0.018 (0.93)	0.033 (1.20)	-0.096 (-4.81)	-0.024	0.034 (1.52)	.83	1.65
Chicken	0.364 (3.04)	0.091 (1.42)	0.015 (0.59)	0.009 (0.44)	-0.045 (-1.58)	0.043 (2.06)	-0.022	0.01 (0.43)	.72	0.65
Fish	0.381	-0.057	-0.066	0.003	-0.015	0.068	0.082	-0.038 (-1.21)		

[a] t statistics for estimated coefficients are shown in parentheses.

Because the sum of the expenditure shares must sum to one by definition, the contemporaneous covariance matrix for the entire system is singular. Hence, one of the five equations is redundant. That is, the parameters of one of the equations can be derived from the parameters of the other four equations by using the adding-up restrictions. The fish equation was chosen for deletion. The estimation procedure used to estimate the parameters of the system was the iterative, seemingly unrelated regressions procedure of SHAZAM, version 5.15. This estimation procedure provides maximum likelihood estimates that are invariant to the equation chosen for deletion (Chalfant, 1987).

Slutsky symmetry was imposed on the parameters of the system (table 1). Symmetry cannot be tested on an equation by equation basis. A test statistic such as the asymptotic likelihood ratio test statistic for the system as a whole is required. The six Slutsky symmetry restrictions were imposed on the system which was then estimated using the iterative seemingly unrelated regression technique. The imposition of Slutsky symmetry automatically imposes homogeneity in the LA/AIDS (McKenzie and Thomas). Consequently, the unrestricted model for testing Slutsky symmetry alone had homogeneity imposed. Slutsky symmetry was accepted at the one percent level but rejected at the five percent level. The asymptotic likelihood ratio test is, however, likely to over-reject in small samples (Anderson and Blundell). Pudney has suggested a degree of freedom adjustment to compensate for this over-rejection. This adjustment may be written as

$$(9) \quad \psi^* = \psi + nT \log [(nT-P_1)/(nT-P_0)]$$

where ψ^* is the adjusted likelihood ratio statistic,
ψ is the unadjusted likelihood ratio statistic,
n is the number of equations,
T is the number of observations,
P_1 is the number of parameters before the restrictions in question are imposed, and
P_0 is the number of parameters after the restrictions have been imposed.

When this small sample adjustment is made, Slutsky symmetry is accepted even at the five percent level.

Both Marshallian and Hicksian measures of elasticities can be computed from the estimated parameters of the LA/AIDS model as follows:

$$(10) \quad \epsilon_{ii} = -1 + \gamma_{ii}/W_i - \beta_i,$$

$$(11) \quad \epsilon_{ij} = \gamma_{ij}/W_i - \beta_i(W_j/W_i),$$

$$(12) \quad \delta_{ii} = -1 + \gamma_{ii}/W_i + W_i, \text{ and}$$

$$(13) \quad \delta_{ij} = \gamma_{ij}/W_i + W_j$$

where ϵ denotes Marshallian elasticities and δ denotes the income-compensated or Hicksian measure. Expenditure elasticities can be obtained from the following expression:

$$(14) \quad \eta_i = 1 + \beta_i/W_i .$$

These elasticities have been calculated for the demand system with and without the imposition of Slutsky symmetry and are presented in table 2. These latter estimates are the ones used in the remainder of the study. For comparative purposes, estimates of similar elasticities for the

Table 2. Japanese and U.S. Meat Demand and Expenditure Elasticities[a]

Quantity	Price or Expenditure	Compensated Elasticities for Japan (Slutsky Symmetry and Homogeneity Imposed)	Marshallian Elasticities for Japan (only Homogeneity Imposed)	Marshallian Elasticities for Japan (Slutsky Symmetry and Homogeneity Imposed)	Marshallian Elasticities for U.S. (Slutsky Symmetry and Homogeneity Imposed)
		% Change in Quantity Demanded From a 1% Change in Price or Expenditure			
NQ Beef					
	NQ Beef	-2.13	-2.38	-2.27	
	IQ Beef	0.71	0.54	0.57	
	Pork	1.21	0.65	0.96	
	Chicken	0.47	0.31	0.27	
	Fish	-0.23	-0.22	-0.71	
	Expenditure	2.33	1.74	2.33	
IQ Beef					
	NQ Beef	0.46	0.63	0.21	
	IQ Beef	-1.34	-1.76	-1.56	-.37
	Pork	0.42	-0.14	0.14	0.27
	Chicken	0.03	-0.41	-0.21	0.08
	Fish	0.42	0.56	-0.06	0.0
	Expenditure	2.59	1.39	2.59	1.28
Pork					
	NQ Beef	0.29	0.79	0.90	
	IQ Beef	0.16	0.40	0.51	0.52
	Pork	-0.73	-0.74	-0.80	-0.67
	Chicken	-0.23	-0.26	-0.19	0.10
	Fish	0.51	-0.05	0.14	0.04
	Expenditure	0.29	0.40	0.29	.99
Chicken					
	NQ Beef	0.15	-0.20	0.19	
	IQ Beef	0.02	-0.14	-0.01	0.34
	Pork	-0.29	-0.29	-0.51	0.24
	Chicken	-0.64	-0.85	-0.79	-0.51
	Fish	0.77	0.41	0.32	-0.07
	Expenditure	0.83	1.52	0.83	.21
Fish					
	NQ Beef	-0.03	0.23	0.06	
	IQ Beef	0.08	0.26	0.09	.19
	Pork	0.25	0.06	0.06	.16
	Chicken	0.29	0.27	0.17	-0.12
	Fish	-0.60	-0.93	-1.03	-0.23
	Expenditure	0.95	0.89	0.95	.15

[a]NQ Beef is Native-Quality beef and IQ Beef is Import-Quality Beef.

U.S. by Chalfant are also presented in table 2. Chalfant employed a nearly identical estimation procedure to the one used here with annual data from 1947 to 1978. The estimated elasticities in this study for the Japanese meat demand system are, in general, in accordance with a priori expectations. All own-price elasticities are negative while most of the compensated cross-price elasticities are positive. It would appear that chicken is a complement of both import-quality beef and pork. This is not true for the U.S. data which indicates that chicken is complementary to fish. The elasticities in the chicken equation are, however, highly suspect. Poultry producers can respond to price increases within two months. Annual models ignore this potential for an intra-year response and cannot be expected to provide accurate estimates of these cross-price effects. Note that for all meats, the own-price elasticity of demand is greater in Japan than in the U.S. This is particularly true for beef and implies that any reduction in the Japanese beef import barrier would lead to a large increase in demand for import-quality beef.

The estimated expenditure elasticities indicate that both native and import-quality beef are luxury goods in Japan (table 2). If meat expenditures increase by ten percent, the quantity of native and imported beef demanded will increase by 23% and 26%, respectively. The expenditure elasticity of demand for import-quality beef is also greater than that of native-beef. This result is somewhat surprising because native quality beef is much more expensive than import-quality beef. Japanese consumers consider native-quality beef to be a much more desirable commodity than imported beef (Miyazaki). Nevertheless, the import-quality beef expenditure share more than doubled over the sample period while the native beef expenditure share was virtually constant over the same period.

The income elasticity of demand for meats was estimated to be 1.54 by Sasaki and Fukagawa. A 10% increase in real income, therefore, implies that the demand for import-quality beef would increase by almost 40%. This figure was derived by multiplying the expenditure elasticity for import-quality beef by the income elasticity of demand for the meat group as a whole (Blanciforti and Green, 1983b).

The Japanese expenditure elasticities for both poultry and fish are greater than the pork expenditure elasticity. Again, this is not the case for the United States where poultry has the lowest expenditure elasticity of all meats. The implication is that pork occupies the same position in Japanese spending priorities as poultry does in the U.S. Increased pork consumption is not an automatic consequence of income growth as is the case for beef. Consequently, increased pork consumption in Japan will likely occur only if pork prices fall, regardless of changes in real income. In general, the estimated cross-price elasticities for fish are not significantly different from zero. It may be that the meats and fish groups should be treated as separate commodities in Japan. This possibility is the focus of ongoing research which uses the method proposed by Pudney.

The compensated cross-price elasticities for import-quality beef in the native beef equation and for native beef in the dairy equation are relatively large (table 2). This indicates that native and imported beef are net substitutes. It is relatively simple to construct an asymptotic likelihood ratio test to determine whether native and import-quality beef are, in fact, perfect substitutes. To see how this might be done, consider the results that might be expected in Chalfant's model if the U.S. beef expenditure share was subdivided into beef from the traditional English breeds and beef from the nontraditional breeds. These expenditure shares need not be similar but each would be expected to react in a similar manner to relevant price changes if, in fact, these two beef types are perfect substitutes. Also, the prices of these two types of beef would be expected to be perfectly correlated even when the relative quantity supplied of each beef type is changed. If this were not the case, consumers would

refuse to purchase the higher-priced of the two beef types which they consider to be identical. Therefore, to test the hypothesis that Wagyu and import-quality beef are perfect substitutes, the price and expenditure coefficients in the native-quality beef equation were restricted to equal those in the import-quality beef equations. The intercept terms were not restricted. Again, using the asymptotic likelihood ratio test, the null hypothesis of perfect substitutability of native and import-quality beef can be rejected at the five percent level of confidence. This result is of particular relevance for this analysis. The Japanese government has restricted beef imports in order to protect the native beef industry. This policy implies that native and imported beef are near-perfect substitutes. This does not appear to be the case, however. Any decrease in dairy beef prices will influence native beef demand only through the cross-price elasticity.

The behavior of the cross price elasticity between native and dairy beef over the sample period is presented in figure 3. Although there is some basis for arguing that native and import-quality beef have become closer substitutes, it is unlikely that they will become perfect substitutes over the forecast period. As long as this is the case, the appropriate procedure is to treat native and import-quality beef as separate but related goods. A model which assumes that changes in the price of imported beef cause a one-for-one reduction in native beef prices would greatly overestimate the impact of beef import liberalization on the native beef industry in Japan. Such a model would implicitly use a cross-price elasticity of demand of infinity while the results presented above indicate that the elasticity is less than one.

Simulation Analysis of A Progressive Reduction in the Japanese Beef PSE

To simulate the likely dynamic effects of a reduction in the Japanese beef PSE on the Japanese livestock industry, with particular emphasis on the cattle and beef sector, a forecast baseline was first established for 1987 through 1996[2]. The Japanese beef import quota was assumed to continue increasing by 9,000 mt per year through the end of the forecast period. Because of the Japanese policy to stabilize beef prices, albeit at a higher level than otherwise, the estimated values of the price expectations coefficients (θ) in the breeding inventory equations for both Wagyu and dairy cattle are significantly less than one (.55 and .63, respectively). Consequently, conditioning the forecast on an assumption of future increases in the import quota and using the coefficients estimated from the historical sample data for forecasting beyond the sample period amounts to assuming no significant change in Japanese import policy over the forecast period. This implies that producers continue to perceive price changes over the baseline forecast period to be temporary to a large extent.

The primary objective in simulating a reduction in the beef PSE is to determine what the likely changes would be in native and domestic beef supplies, consumption, and prices as well as the levels of total beef imports and imports by foreign supplier. What would likely happen, however, depends crucially on how producers would respond to a reduction in support from the government. The typical analytical procedure would be to simply simulate the model over the forecast period assuming some schedule of reduction in the level of the PSE. The changes in the model variables from their baseline values in the simultaneous system would be taken as a measure of the impact of the PSE reduction on the Japanese livestock industry. Lucas, among others, however, has questioned this procedure because a policy change alters the underlying

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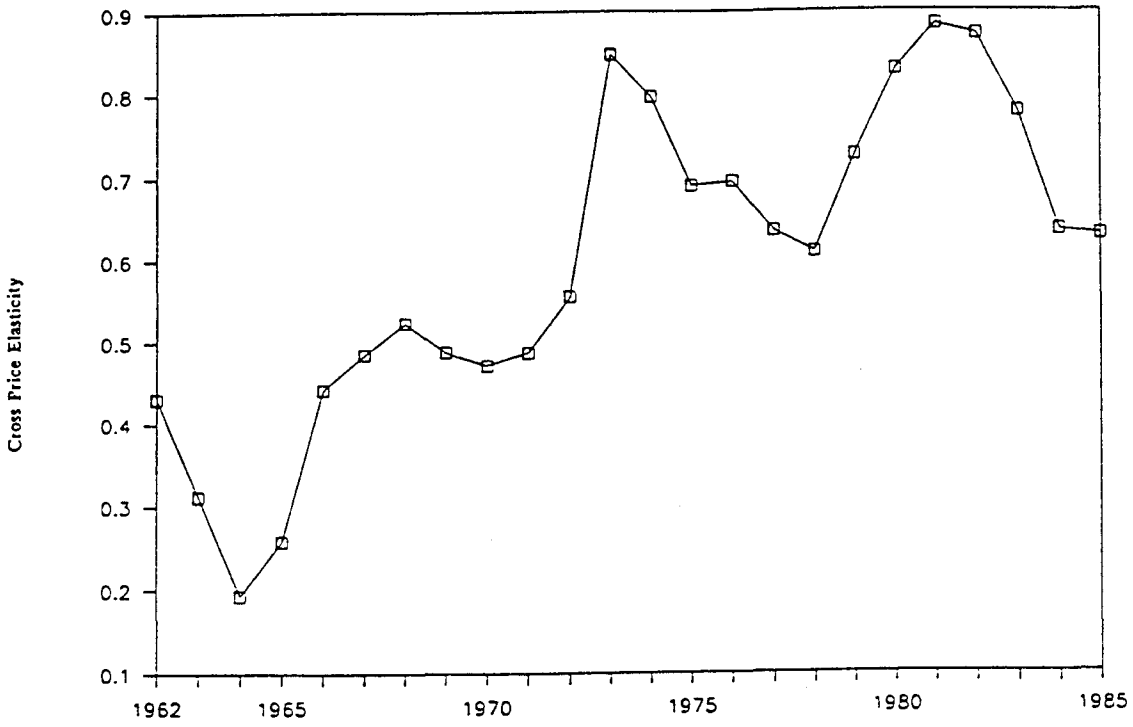
[2] Actual data were available for most variables in the Japanese Livestock Industry Model through 1986.

Figure 3 : Native vs Import Quality Beef Cross Price Elasticity.



structure of a market. Thus, such a permanent shift in beef import policy would result in permanent changes in Japanese beef prices so that the estimated values of θ in the breeding inventory equations would be inappropriate to use for the forecast simulation analysis. This is because producers would likely be more responsive to price changes given the changed policy environment than otherwise would be the case. As a consequence, the typical simulation analysis would tend to underestimate the effects of a Japanese beef PSE reduction.

A more representative measure of cattle producer and, therefore, domestic beef supply response to reduced support from the government over the forecast period is possible by using equation (4) to alter the estimated coefficients in the breeding inventory equations to reflect an increase in θ before simulating a reduction in the PSE level. Because of the extreme nature of the policy shift, the maximum increase possible in θ was assumed. As such, the simulation results represent an upper limit on the likely impacts of a reduction in the beef PSE level.

Choice of a Japanese Beef PSE Adjustment Path

Although the objective of agricultural trade liberalization talks will be to reduce government subsidization of producers over some specified number of years, how that would actually be accomplished is not clear. The adjustment path chosen is crucial both for modeling purposes as well as for political reasons. Proposals that require most of the adjustment to occur in the years immediately following the agreement, as has been the case in previous GATT negotiations, may well imply politically unacceptable adjustment costs. At the same time, agreements that delay the brunt of the adjustment until the latter years of the agreement

would be wasteful to the extent that over production would continue. In addition, these latter agreements may break down when the time to make the adjustments finally arrives.

Several alternative adjustment formulas are available. Perhaps the most intuitive and reasonable from a modeling viewpoint is to reduce the PSE by 1/X of the initial PSE level in each year, where X is the number of years over which the PSE is to fall to zero. This is shown as the diagonal line in figure 4. Unfortunately, this concept may not appeal to trade negotiators because the measured level of PSEs in each year would depend on both domestic policies and world price levels. Countries are unlikely to agree to a PSE adjustment system which makes domestic agricultural policy a function of potentially volatile world prices. Indeed, the motivation for the protectionist policies of many countries is to protect domestic markets from the frequent wild swings in world prices. Hence, it seems unlikely that countries would accept a proposal that would immediately transfer this volatility to domestic prices and markets, at least until the impact of liberalization had stabilized world prices. The agreed-upon adjustment path, therefore, will likely have to allow for annual changes in the level of world prices.

A second alternative is the Swiss formula considered in the Tokyo Round of the GATT negotiations (Tangermann, Josling, and Pearson). This formula can be written as:

$$(15)\quad PSE_t = aPSE_{t-1}/(a+PSE_{t-1})$$

where PSE_{t-1} is the PSE level in the year previous to the first year of the implementation of the reduction, PSE_t is the PSE level which must be achieved in a give year, and a is the negotiated coefficient of adjustment. The formula allows for annual changes in world price levels. For example, even though a sudden drop in world prices in a given year of the agreement would increase the measured PSE for that year, the formula automatically adjusts the target PSE upward for the following year. However, the nature of the formula guarantees that for all practical levels of the negotiated coefficient, the brunt of the adjustment will be borne in the early years of the agreement. This is demonstrated in figure 5 in which the PSE adjustment paths for several values of the adjustment coefficient (a) are presented. The rapid adjustment of PSEs with this formula may be more suited to the industrial trade barriers considered in the Tokyo Round than to agriculture. Adjustment costs in agriculture would be relatively high. At the same time, the level of protectionism in agriculture is greater now than was the case during the Tokyo Round. Also, the Swiss formula does not allow for a reduction of a given PSE to zero over a given number of years. Unless the value of the adjustment coefficient is zero, the value of the PSE will never reach zero.

A third alternative is a modification of the Swiss formula which combines the features of the first two alternatives:

$$(16)\quad PSE_t = \frac{R}{X}\, a\, PSE_{t-1}/(\frac{R}{X}\, a + PSE_{t-1})$$

where X is the negotiated length of the adjustment period and R is the number of years remaining in the agreement. This formula allows for a wide range of adjustment paths as demonstrated in figure 6. The advantage of the modified formula is that a target date by which zero producer protection must be achieved can be stipulated.

The three PSE adjustment paths assumed in this paper are shown in figure 4. A 10-year time horizon was chosen arbitrarily for this study. The diagonal line represents a reduction in the initial PSE level of one-tenth annually. The concave line is the adjustment which would occur with an adjustment coefficient value of .5 in the Swiss formula as suggested by

Figure 4 : Alternative PSE Adjustment Paths.

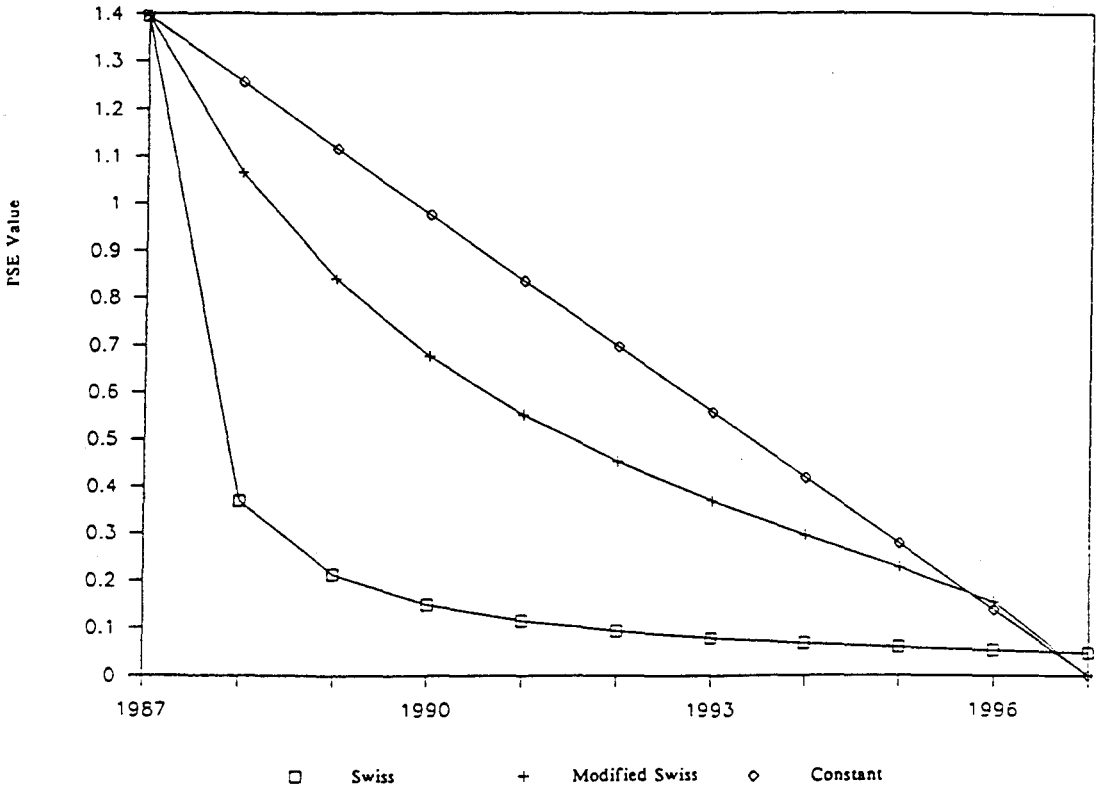
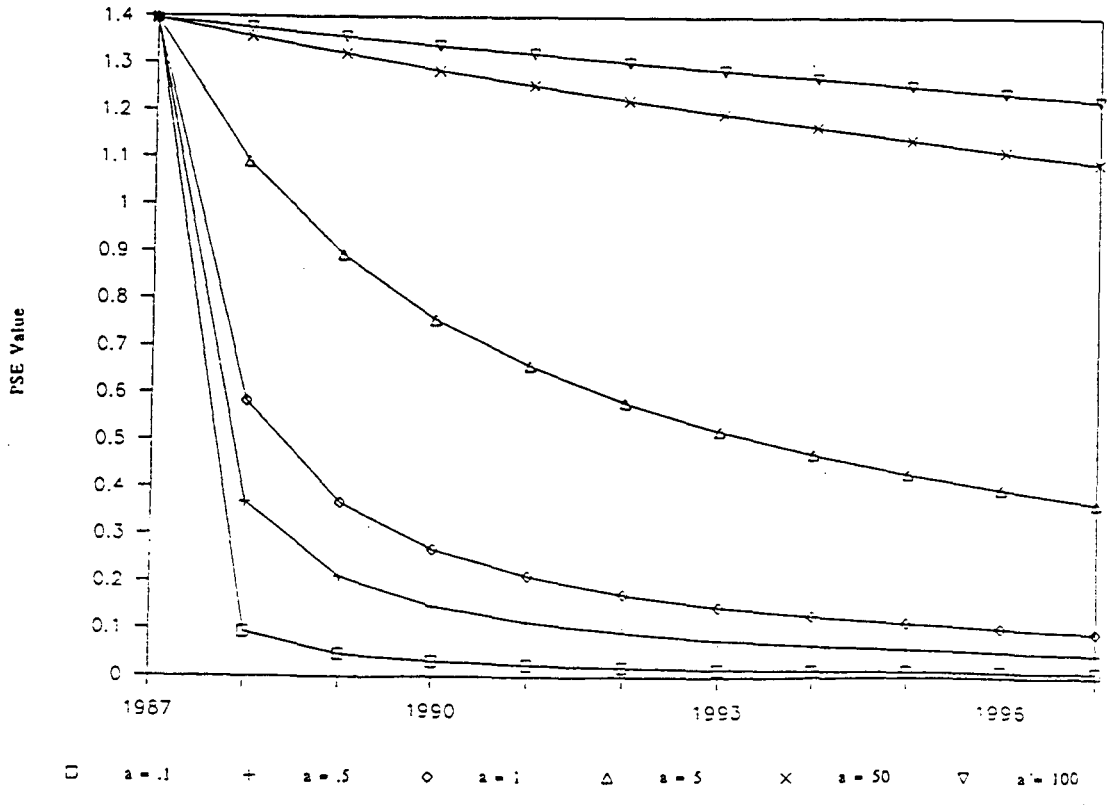


Figure 5 : Alternative Swiss Formula PSE Adjustment Paths.



Tangermann, Josling, and Pearson. The S-shaped line represents the modified Swiss formula adjustment path with an adjustment coefficient value of 5.

The Baseline Forecast (1987 to 1996)

The baseline forecasts of Japanese beef consumption and production are presented in figure 7. Given the assumed annual increase in the import quota, the rate of growth of domestic dairy beef production in Japan is forecast to decline somewhat over the forecast period to 3% from nearly 5% between 1976 and 1986. This rate of growth, however, is higher than the nearly zero growth rate experienced between 1981 and 1986. At the same time, the average annual growth rate of Wagyu beef production is also expected to decline to less than 1% over the forecast period compared to a nearly 4% growth rate between 1976 and 1986. Consumption of import-quality beef (domestic dairy and imported beef), however, is forecast to grow at about the 3% to 4% average annual rate experienced during 1981 to 1986 but much below the nearly 10% annual growth rate achieved between 1976 and 1980. Consequently, the gap between domestic production and consumption of import-quality beef is forecast to continue growing.

PSE Reduction Simulation Results

Recalling that the PSE as defined here is comparable to an ad valorem tariff, the import quota in the model was first replaced by its tariff equivalent, i.e., the properly defined PSE. Progressive reduction of the PSE, therefore, implied a gradual narrowing of the percentage difference between the predicted world price of beef (the weighted average CIF price of imported beef) and the predicted internal Japanese price of dairy beef (i.e., the dairy steer carcass price) over a 10-year period. Consequently, the price of dairy beef in Japan approached the world price by 1997. Imports are endogenously determined in this case as the difference between the domestic demand and supply of import-quality beef.

Forecasts of many of the exogenous variables in the model were based on the 10-year forecast of the Food and Agricultural Policy Research Institute (FAPRI). Unfortunately the FAPRI forecast extends only to 1996 forcing the PSE reduction simulations to halt in 1996 as well. Nevertheless, the PSE reduction is assumed to occur over the 10-year period of 1988 to 1997. The simulated values of selected variables for the three PSE reduction paths are presented in figures 8 through 15.[3] In general, the Swiss formula (with the adjustment coefficient term set at .5) resulted in the most dramatic changes in the model variables because of the large decline in the PSE required by the formula in the first years of the assumed agreement period (1988 through 1997).

The Dairy Beef Sector

In the baseline, the dairy breeding herd continues the growth pattern of the late 1970s, growing by 2% to 3% annually until the early 1990s and then leveling off somewhat in the final years of the forecast (figure 8). This is due largely to two factors. First, the profitability of milk production is projected to continue to rise as the highly protective Japanese milk producer support policy maintains milk prices at a relatively high and increasing level. Second, the

[3] The full results are available from the authors on request.

Figure 6 : Alternative Modified Swiss Formula PSE Adjustment Paths.

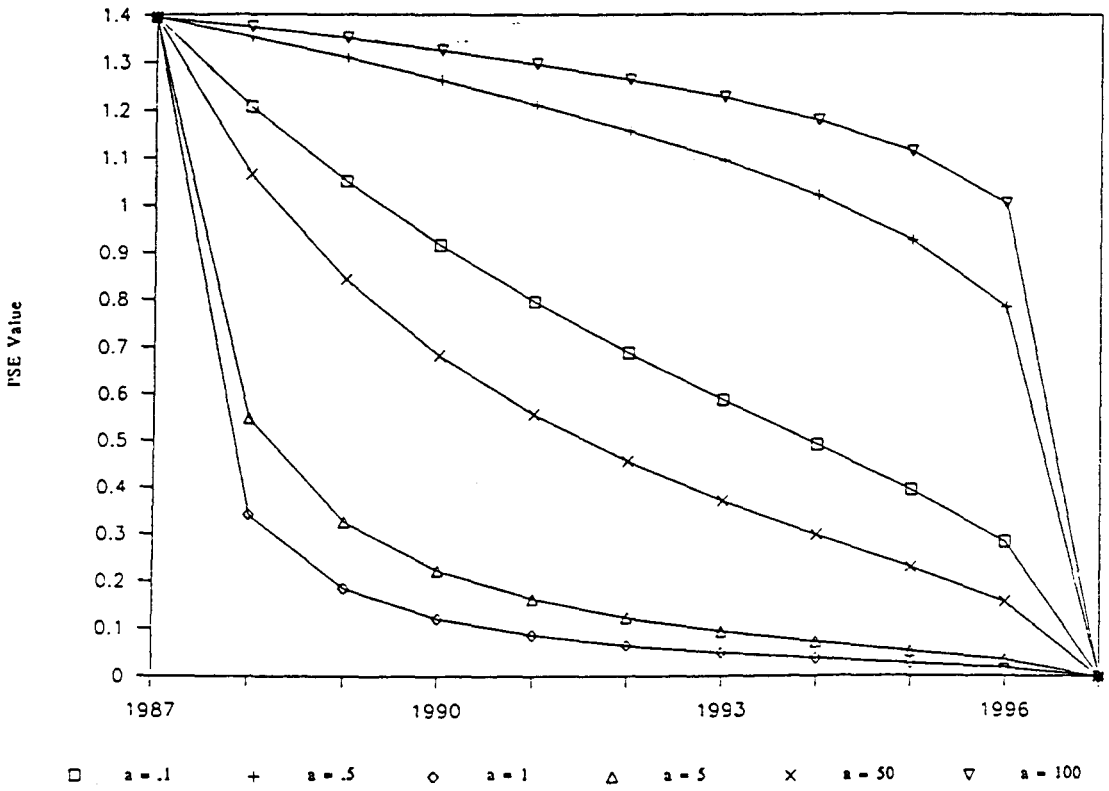


Figure 7 : Japanese Beef Consumption, Production, and Imports : Actual and Baseline Forecast.

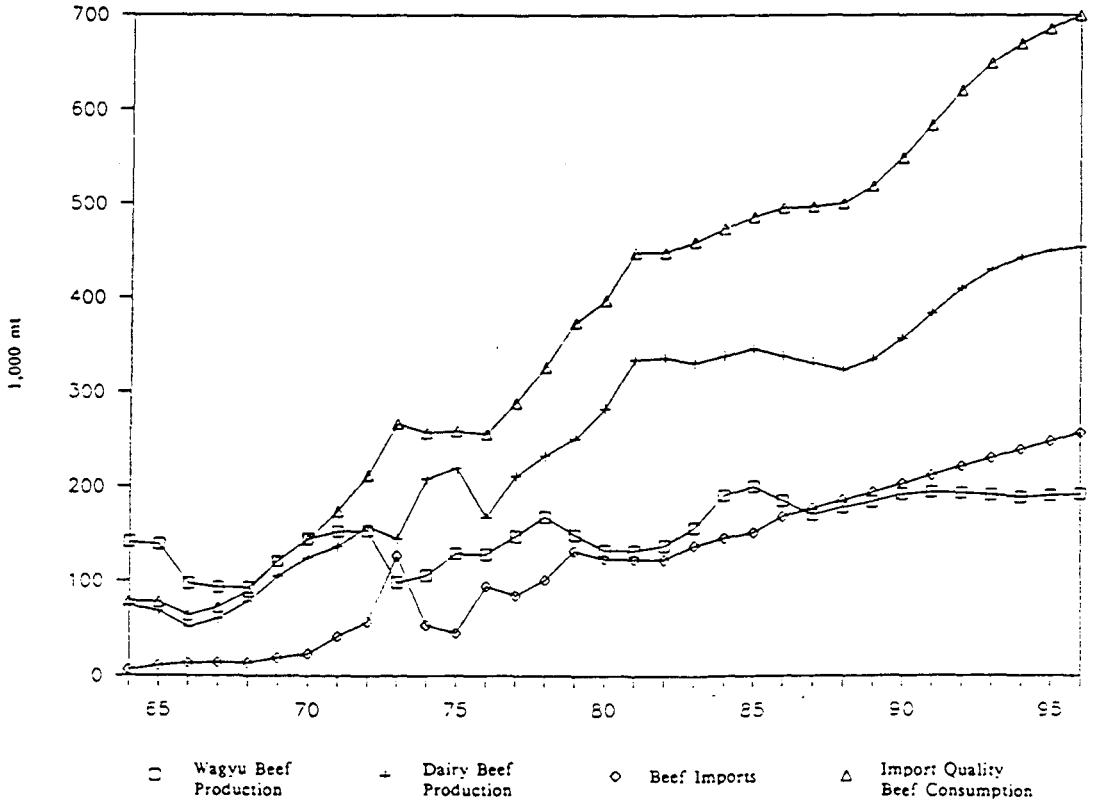


Figure 8 : Dairy Cattle Breeding Herd Ending Inventory.

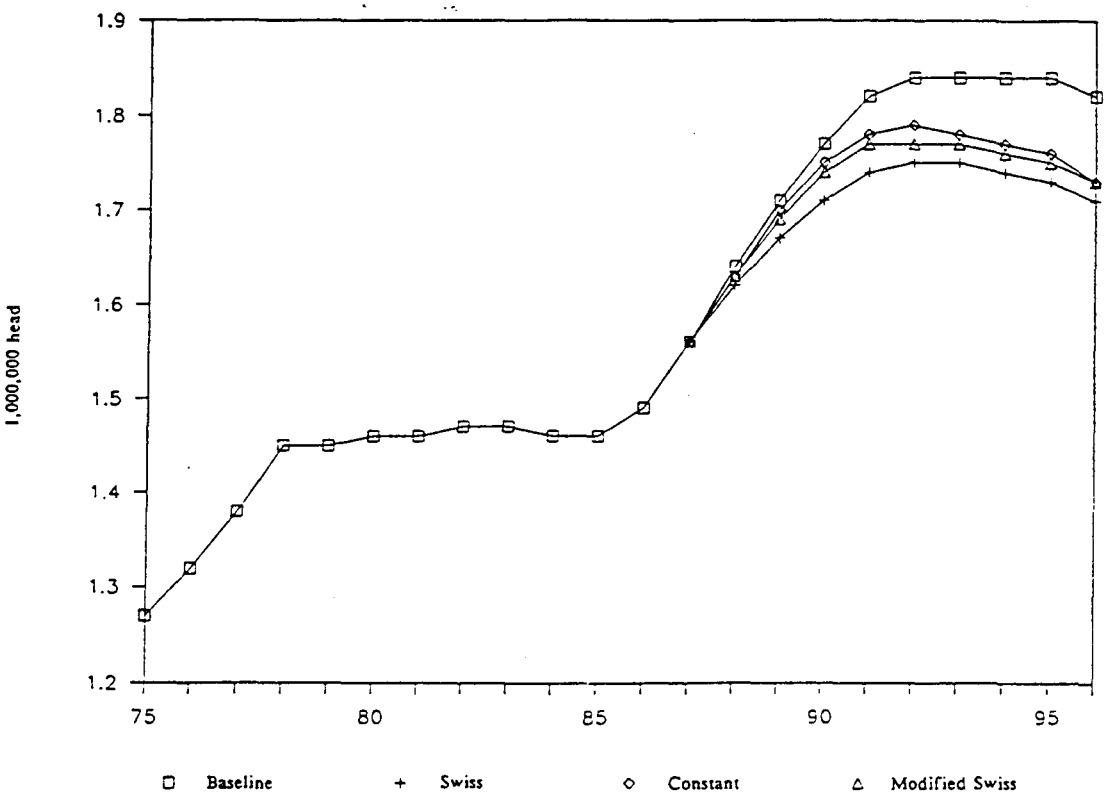


Figure 9 : Dairy Steer Carcass Price.

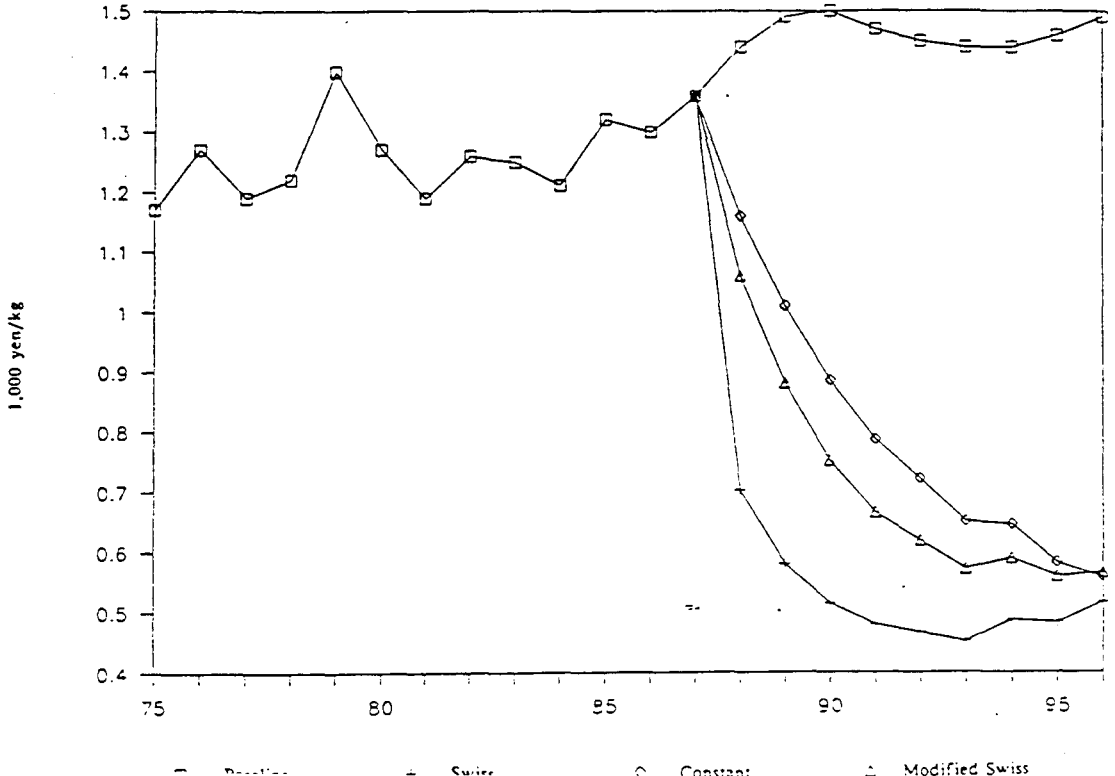


Figure 10 : Import-Quality Beef Consumption.

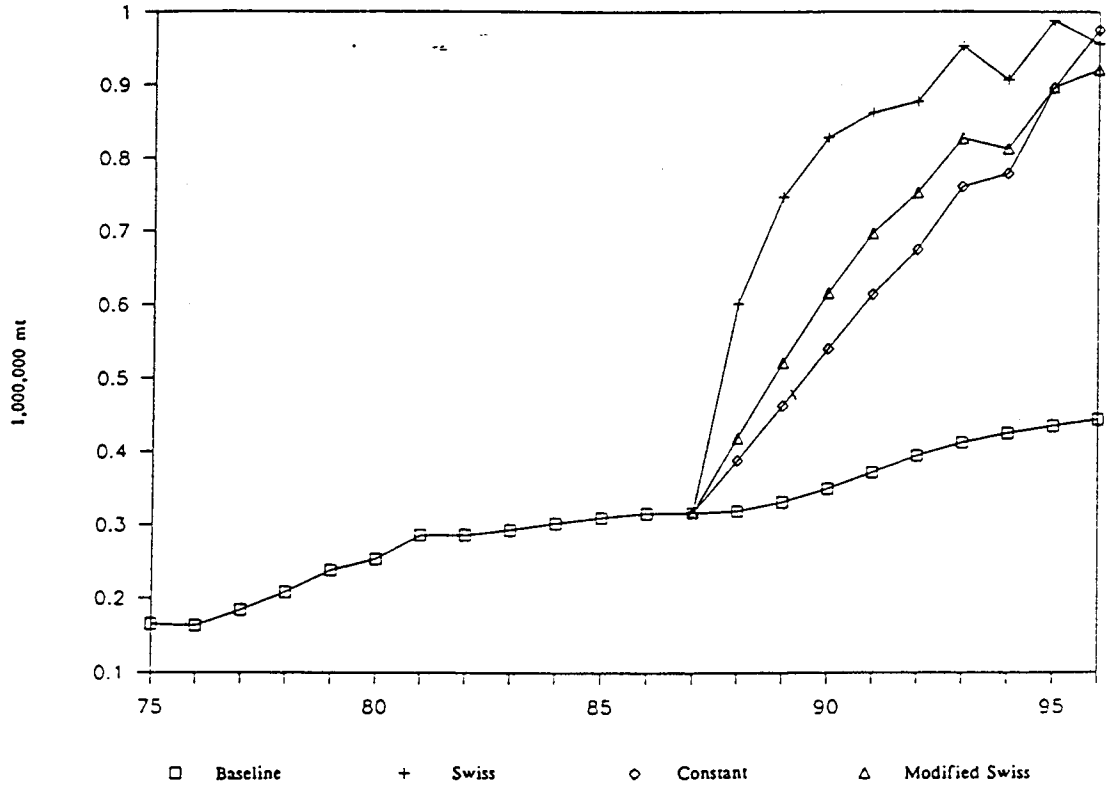


Figure 11 : Japanese Beef Imports.

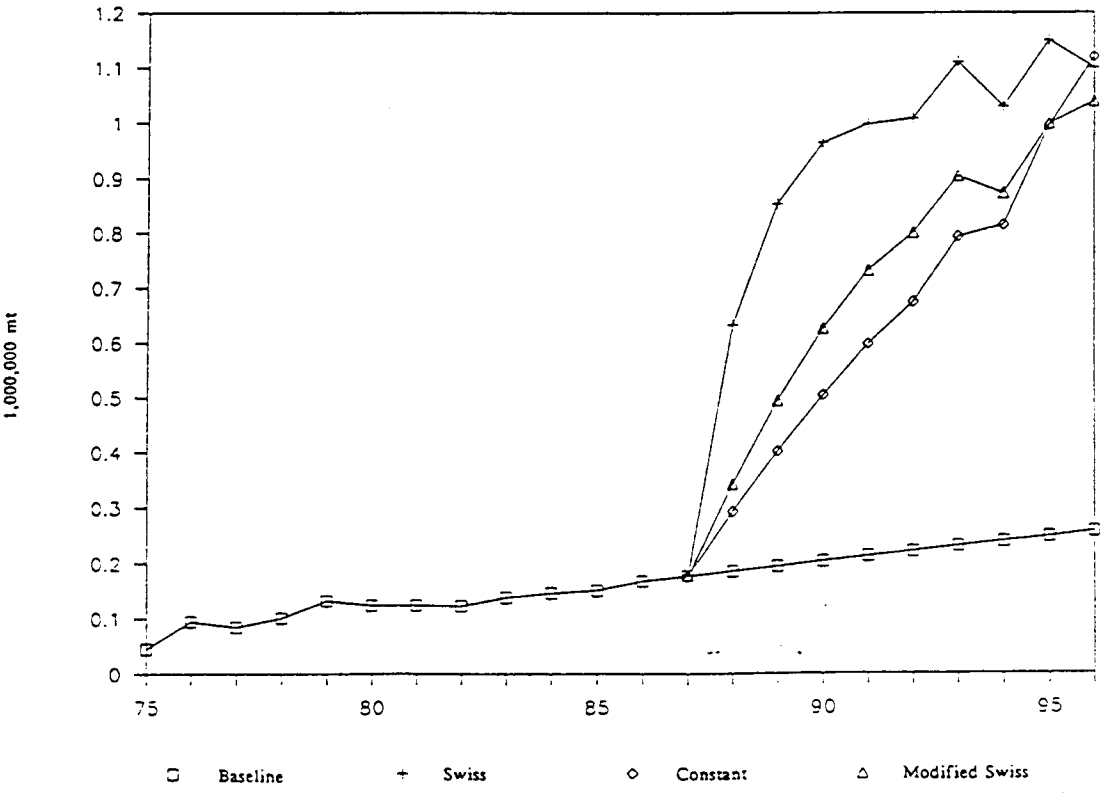


Figure 12 : Wagyu Steer Carcass Price.

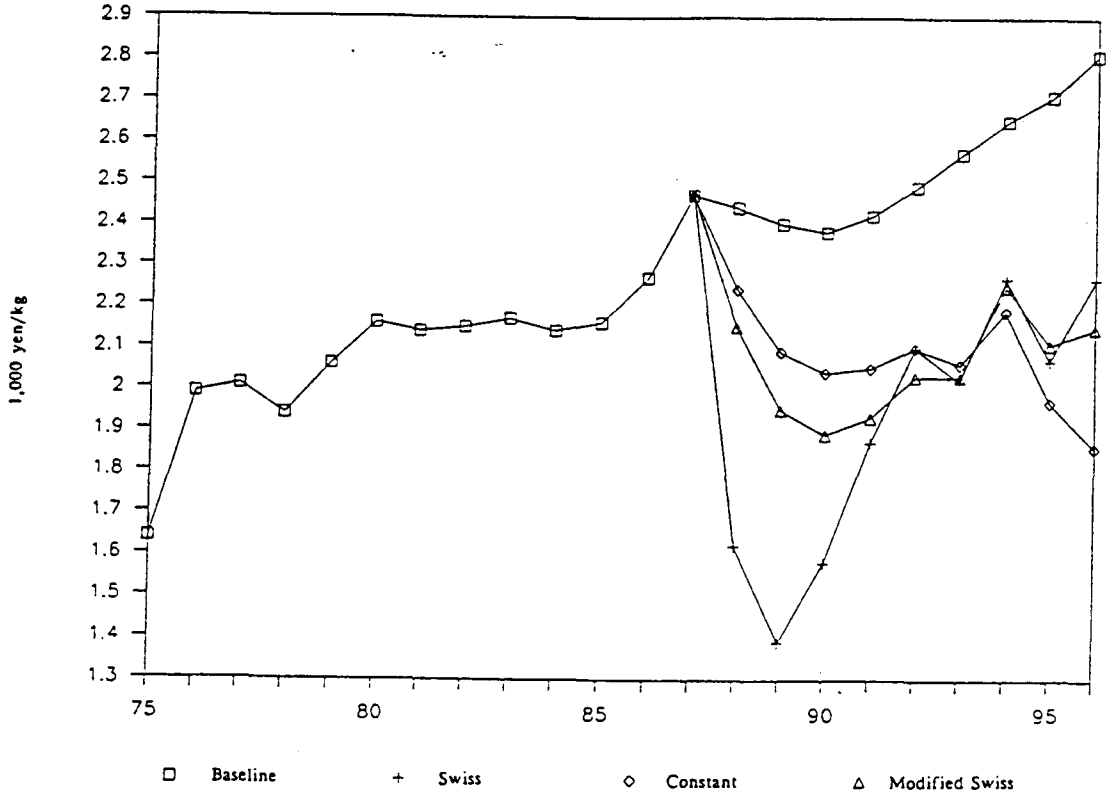


Figure 13 : Wagyu Cattle Breeding Herd Ending Inventory.

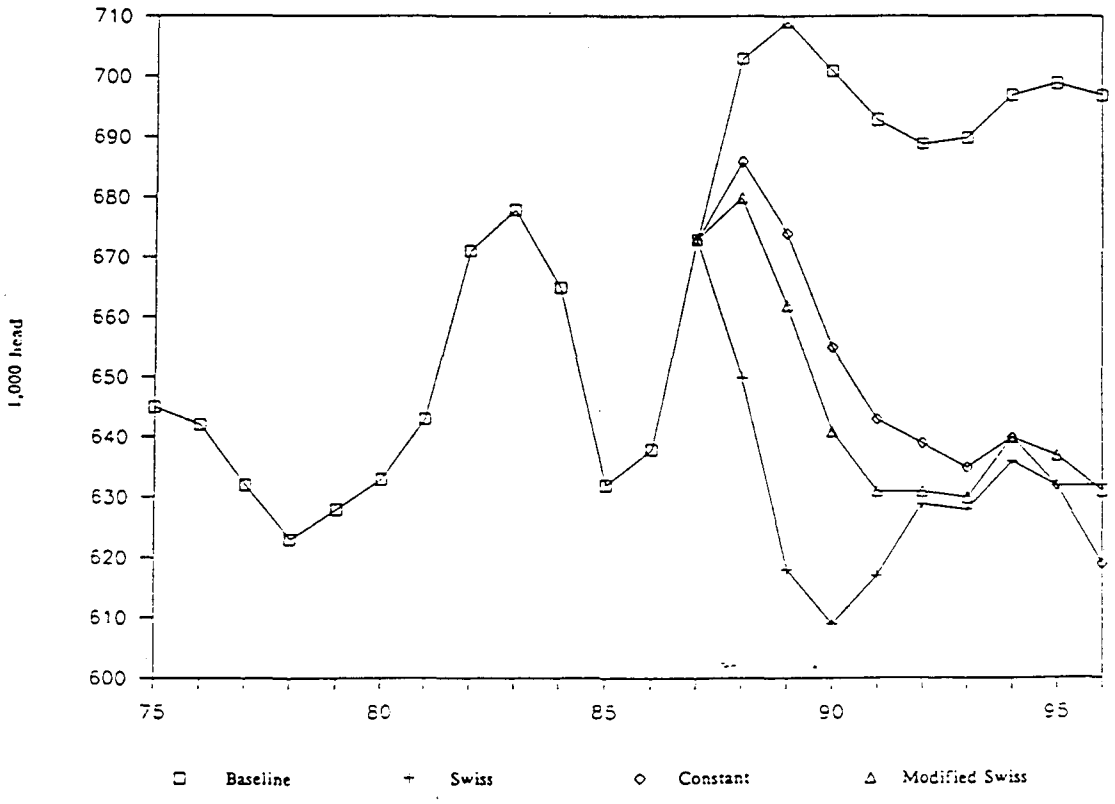


Figure 14 : Native Quality Beef Consumption.

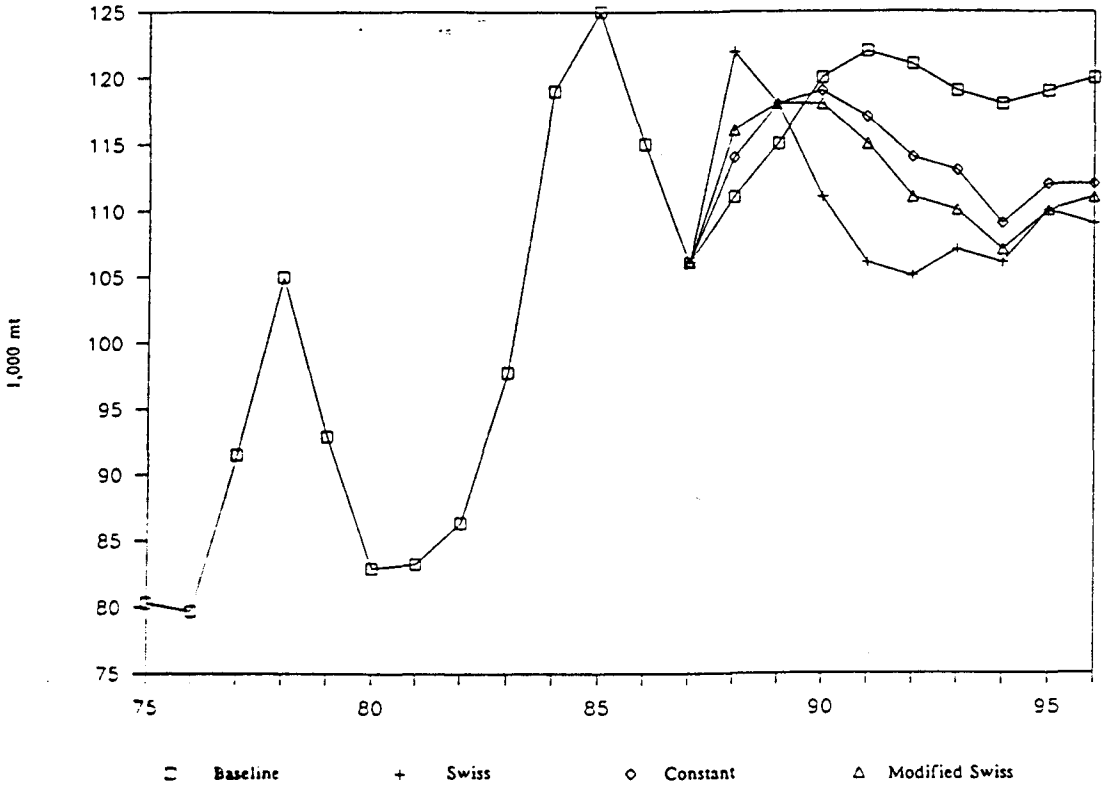
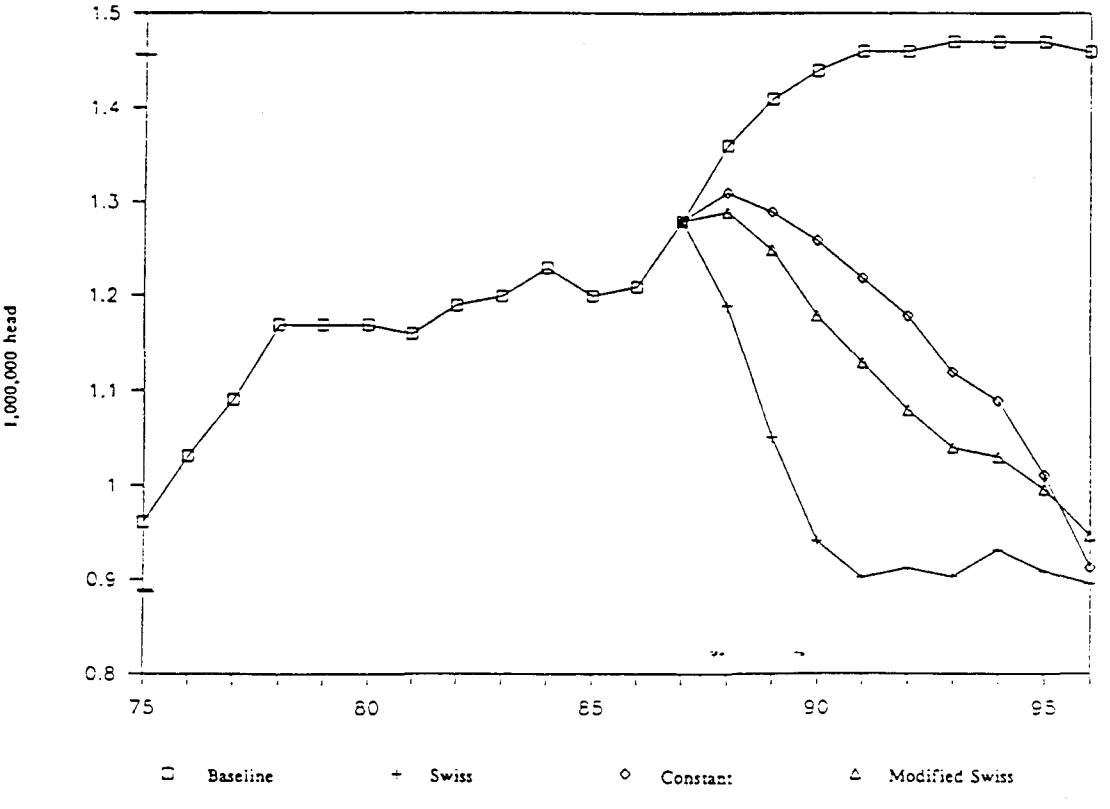


Figure 15 : Hog Breeding Herd Ending Inventory.



current and projected declines in world feedgrain prices are expected to give a further boost to the real profitability of milk production in Japan. The reduction in the dairy beef price over the forecast period is dramatic, reflecting a relatively high level of protection to beef producers before the implementation of the PSE reduction (figure 9). Nevertheless, the dairy breeding herd and dairy beef output continue to increase although at a 2% to 3% lower rate than in the baseline. This occurs despite the assumption of maximum responsiveness of dairy beef producers to beef price changes in the price expectations formulation. In essence, the model assumes that Japanese dairy beef producers know at the time of the PSE reduction agreement that beef prices will decline in the future. Consequently, dairy steer fatteners would bear the burden of the reduction in the price of beef. Because 90% of the revenues of dairy calf producers comes from milk production, however, the predicted increase in the profitability of milk production dominates the reduction in profitability of dairy steer fattening.

Beef Imports and Consumption of Import-Quality Beef

The simulated increase in the consumption of import-quality beef is large under all PSE reduction schemes as expected given the large estimated own-price elasticity of demand for beef as discussed earlier (figure 10). By the end of the PSE reduction period, the consumption of import-quality beef is more than twice the level of the baseline projection. Although imports tend to replace domestic production of import-quality beef to some extent, the tradeoff is much smaller than might be expected. Consequently, the additional consumption of import-quality beef above the baseline is about equal to the increase in imports.

The biggest effect of the simulated PSE reductions is on beef imports (figure 11). Beef imports would likely grow, rapidly with the Swiss formula and more slowly with the other two formulas, to about 1.1 million tons by 1996, more than 400% above the baseline and more than 600% above the 1986 level. Imports from the U.S. grow over the forecast period about in line with imports from Australia as a result of the PSE reductions, with the U.S. gaining slightly in import share. The simulated increase in beef imports could be viewed as the increase in the beef import quota that would be necessary in order to meet PSE reduction targets as specified in the three formulas used. That is, a beef import quota of about 1.1 million tons would reduce domestic dairy beef prices to the beef import price level.

The additional imports would not likely displace feedgrain imports to a large extent inasmuch as the domestic beef industry would be relatively unaffected by the PSE reduction. This would be the case as long as the Japanese milk PSE remains unaffected. As a corollary, a reduction in the very high Japanese milk PSE would likely do more to reduce domestic production of beef than a reduction of the beef PSE.

The Wagyu Beef Sector

The beef PSE reduction affects the Wagyu industry in the model only through the estimated cross-price elasticity between dairy and Wagyu beef. Because this elasticity is relatively large (0.57), the simulated decline in the dairy steer carcass price as a result of the PSE reductions has a significant impact on the Wagyu industry. Using the Swiss PSE reduction formula, the Wagyu steer carcass price is over 40% lower in 1989 than otherwise would have been the case, inducing a decline in the Wagyu breeding herd to about 13% below the baseline forecast by 1990 (figures 12 and 13). The reductions in the Wagyu carcass price and, hence, in the Wagyu breeding herd are more modest using the Constant Absolute or the Modified Swiss formulas. Wagyu beef output initially increases as farmers reduce the size of their breeding

herds, placing further downward pressure on Wagyu prices. After the initial declines, both the Wagyu breeding herd and the carcass price tend to rebound to some extent regardless of the formula used. A continuing consumer preference for native-quality beef combined with declining supplies puts some upward pressure on prices and arrests the decline in Wagyu inventories and beef output (figure 14). By the end of the forecast period, the formulas tend to converge so that the final effect is to reduce the Wagyu breeding herd by about 9% and Wagyu prices by about 15% to 20% below what otherwise would have been the case.

Other Livestock Sectors

The effects of the PSE reduction on the hog and chicken sectors is significant. Sow inventories, for example, drop to 38% below the baseline by the end of the forecast period (figure 15). This occurs because pork prices are 25% below the baseline at the end of the period. The simulated drop in the pork price is large enough to reduce the profitability of pork production despite the sharp expected decline in world feedgrain prices. This implies that Japanese pork producers could be as (if not more) affected by the reduction in the protection of beef producers than domestic producers of import-quality beef might be. This is one of the more interesting and significant results of the analysis. Pork output drops by a greater percentage as a result of the reduction in the beef PSE than beef output.

Summary and Implications for Current Negotiations

This paper utilizes dynamic simulation analysis to consider the likely consequences of a reduction in the level of government assistance to Japanese beef producers through a negotiated, progressive reduction in the beef Producer Subsidy Equivalent (PSE). Using a simultaneous model of Japanese livestock markets, a forecast baseline through 1996 was first established assuming that the import quota continues to increase by 9,000 mt per year as in the 1984 agreement. Three formulas for reduction of the beef PSE over ten years were selected from among the many available (the Swiss formula, a constant absolute reduction of one-tenth per year, and a modified Swiss formula). The three formulas were alternatively imposed on the model over the forecast period. The simulated changes in the values of the model variables from their baseline values in each case are the measured effects of the alternative PSE reduction schemes. The analytical results lead to a number of conclusions and implications for current negotiations.

First, larger own-price elasticities for all meats in Japan than in the United States imply that a reduction of protection to beef producers in Japan would result in a significant increase in per capita meat consumption in Japan.

Second, because the income elasticities of demand for both dairy and Wagyu beef in Japan are also relatively high, expected increases in Japanese real incomes will put upward pressure on beef prices unless the present rate of increase in the beef import quota is increased. In other words, the current rate of increase in beef imports may not be sufficient in coming years to keep beef prices from increasing significantly in Japan.

Third, Wagyu and dairy beef are not perfect substitutes in Japan. Treating them as such will lead to over estimates of the impact of any reduction of beef producer price support on the Japanese beef industry. At the same time, however, there is a significant and growing degree of substitutability between the two types of beef in Japan. Considering them as completely unrelated commodities would lead to the erroneous conclusion that beef import

liberalization would have no impact on the Wagyu industry. In fact, because of the high level of support provided to milk producers in Japan, beef import liberalization would tend to reduce Wagyu beef output by more than dairy beef output. Wagyu beef production would likely be about 20% lower at the end of the PSE reduction period than would otherwise be the case.

Fourth, a reduction of assistance to Japanese beef producers could increase beef imports into Japan by more than 600% over the 1986 level by the end of a 10-year period of adjustment. This would require an annual increase in the beef import quota of almost 100,000 mt per year, over ten times the current annual rate of increase, to meet a typical progressive PSE reduction target. Beef consumption would increase by almost the full amount of the increase in imports because of the relatively small decline in domestic beef production.

Fifth, Japanese dairy feeder calf producers are much more responsive to changes in the prices of milk and feedgrains than they are to changes in the prices of dairy beef. The projections of low world feedgrain prices and an increasing level of milk support in Japan would likely lead to an increase in dairy beef production even under a PSE reduction scheme that reduces dairy beef prices significantly. An agreement to liberalize the Japanese milk market through a reduction in the extremely high milk PSE in Japan would likely have a greater impact on Japanese beef production than would an agreement to simply reduce support for beef producers. As a corollary, a trade liberalization agreement that allows the Japanese to retain their dairy support programs would lead to a more immediate and even perhaps a greater increase in beef imports besides being more politically acceptable in Japan. This is because a reduction in the milk PSE would throw significant amounts of import-quality of beef onto the market, reducing the need for imports to meet consumer beef demand.

Sixth, the increase in milk cow numbers in the baseline forecast may result in an worsening milk oversupply problem in Japan by the early 1990s. Surprisingly, a negotiated reduction in support to beef producers in Japan would not help reduce the oversupply by much.

Seventh, one major result of a reduction in the Japanese beef PSE could likely be the impact on hog and chicken sectors. Pork production, for example, is 40% lower than the baseline forecast by 1996 as a result of the simulated beef PSE reductions. Consequently, negotiators deliberating a reduction in the Japanese beef PSE would need to consider the entire livestock industry as an interrelated system in order to correctly project the outcomes of the reduction:

Eighth, the elasticity of native beef demand with respect to pork is greater than that for imported beef. The implication is that the Japanese government might be more successful in supporting native beef producers by restricting pork imports than by restricting beef imports.

Ninth, the specification of the adjustment path deserves serious consideration in trade negotiations. The rapid reductions in tariffs agreed to during previous multilateral trade talks are unlikely to be politically acceptable in agriculture. This is because the adjustment costs that would likely occur as a result of trade liberalization are greater in agriculture than in the non-agricultural markets liberalized in previous agreements. Any measure of protectionism that is based on the difference between world and domestic prices will increase if world prices fall, rendering the agreed-upon adjustment path more difficult to achieve as a result of volatile world prices, despite the best efforts of the country. To avoid this problem, the formula used to project a PSE adjustment path should automatically adjust the target to changes in the level of world prices.

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