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Effects of Japanese Import Demand on U.S. Livestock Prices: Comment

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A recent study by Miljkovic, Marsh, and Brester estimates that reductions in the Japanese tariff-rate quota between 1993 and 2001 increased U.S. beef prices by $1.03 per cwt and yen depreciation between 1995 and 1998 reduced U.S. hog prices by $0.99 per cwt. Relaxing the assumption that U.S. beef and hog supplies are fixed cuts the total elasticities underlying these estimates by 50% or more. The upshot is that shocks in the Japanese market have little effect on U.S. beef and pork prices. Hence, producers may be better off focusing on domestic issues such as dietary concerns over red meat consumption.

Key Words: elasticities, exchange rates, import demand, income, supply response, tariffs

JEL Classifications: Q17, F14, C32

The purpose of this comment is to extend Miljkovic, Marsh, and Brester's (MMB's) analysis of Japanese import demand for U.S. red meat to take into account supply response. Specifically, MMB's "total" elasticity estimates of U.S. livestock prices with respect to Japanese import demand variables implicitly assume that U.S. beef and pork supplies are fixed. In reality, these supplies are not fixed, especially when the forecast interval extends beyond 1 year, as is the case in MMB's analysis (see their Table 4). Since the price effects of demand shocks are moderated when supplies are permitted to adjust, it follows that MMB's projections are overstated. At issue is the degree of overstatement. The issue is addressed by first developing a model to compute the long-run elasticities that is consistent with MMB's working assumptions. The model is then implemented using supply elasticity estimates from the literature.

A secondary purpose of this comment is to highlight theoretical restrictions that apply to MMB's import demand equation. These restrictions are important because they imply *inter alia* that the exchange-rate variable in the model is redundant, which may have biased the estimated own-price effects. The paper's main contribution is to show that events in Japan have little impact on U.S. meat prices when supplies are permitted to adjust to changes in price.

Analytical Framework

MMB's total elasticities are based on two estimated equations. The first equation is a Japanese import demand function of the following form:

$$(1)\quad \ln Q_{MJ} = \alpha - \eta_J \ln P_J - \eta_R \ln R - \eta_T \ln T + \iota \ln Y - \delta \ln S + \text{other shift variables},$$

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where Q_{MJ} is Japan's imports of beef (pork) from the United States, P_J is the import price in yen, R is the real exchange rate (yen/US$), T is the tariff rate, Y is the real Japanese GDP, and S is the producer subsidy equivalent enjoyed by Japanese beef (pork) producers. The remaining shift variables are suppressed, since they are insignificant or irrelevant to the computation of total elasticities. Signs are attached to coefficients in Equation (1) so that elasticities can be interpreted as absolute values.

The second estimated equation is an inverse demand function of the following form:

$$\text{(2)} \quad \ln P_{US} = \alpha - (1/\eta_F)\ln Q_S + \text{shift variables},$$

where P_{US} is the U.S. farm price of beef (pork) expressed in U.S. dollars, Q_S is the total U.S. supply of beef (pork) (assumed to be predetermined), and η_F is the farm-level demand elasticity for beef (pork). The shift variables in Equation (2), which relate to U.S. supply/demand factors, are suppressed.

To show how Equations (1) and (2) are related and to endogenize Q_S, consider the following simple structural model of the U.S. beef (pork) market:

$$\text{(3)} \quad Q_D = D(P_{US}) \quad \text{(U.S. demand)}$$

$$\text{(4)} \quad Q_S = S(P_{US}) \quad \text{(U.S. supply)}$$

$$\text{(5)} \quad Q_{XJ} = X(P_J, S, Y) \quad \text{(U.S. exports to Japan)}$$

$$\text{(6)} \quad Q_{XR} = X(P_{US}) \quad \text{(U.S. exports to rest of world)}$$

$$\text{(7)} \quad P_J = P_{US}\cdot R\cdot T' \quad \text{(Japanese import price in Yen)}$$

$$\text{(8)} \quad Q_S = Q_D + Q_{XJ} + Q_{XR} \quad \text{(U.S. market clearing)},$$

where $T' = 1 + T$, and the remaining variable definitions are obvious from the context. In this model, supply and demand shifters other than those pertaining to the Japanese market are suppressed. In addition, all equations pertain to the farm level. Thus, Equation (3) is interpreted as a (domestic) derived demand equation for beef (pork), and Equation (4) is interpreted as a primary supply relation. In keeping with MMB's analysis, beef and pork are assumed to be homogenous goods at the farm level.[1] In addition, international markets are assumed to be integrated such that the law of one price holds after taking into account tariffs and transportation costs. With these assumptions, Q_{XJ} and Q_{XR} may be interpreted as *net* exports, i.e., the difference between U.S. exports and imports from the respective regions. Note that P_J in Equation (5) is defined as the *tariff-inclusive* price expressed in yen. Thus, R and T do not appear in Equation (5), since the price term already takes into account the exchange rate and tariff.

The first task is to develop expressions that can be used to interpret Equations (1) and (2). For this purpose, first express Equations (3)–(8) in percent changes:

$$\text{(3}'\text{)} \quad Q_D^* = -\eta_{US}P_{US}^*$$

$$\text{(4}'\text{)} \quad Q_S^* = \epsilon_{US}P_{US}^*$$

$$\text{(5}'\text{)} \quad Q_{XJ}^* = -\eta_J P_J^* - \delta S^* + \iota Y^*$$

$$\text{(6}'\text{)} \quad Q_{XR}^* = -\eta_R P_{US}^*$$

$$\text{(7}'\text{)} \quad P_J^* = P_{US}^* + R^* + T'^*$$

$$\text{(8}'\text{)} \quad Q_S^* = \kappa_{US}Q_D^* + \kappa_J Q_{XJ}^* + \kappa_R Q_{XR}^*,$$

where the asterisked variables refer to relative changes (e.g., $P_{US}^* = dP_{US}/P_{US}$); η_{US} and ϵ_{US} are domestic (United States) demand and supply elasticities, η_R is the export demand elasticity with respect to rest of world (ROW); κ_{US} $(=Q_D/Q_S)$ is the domestic quantity share; κ_J $(=Q_{XJ}/Q_S)$ is Japan's share of domestic supply; and κ_R $(=Q_{XR}/Q_S)$ is ROW's share. As

[1] There is some confusion on this point. For example, Equation (1) includes the wholesale price of beef from Australia as a shift variable, which implies differentiated goods. However, in discussing the estimation of Equation (1), MMB state (p. 504) "... [it is assumed that] an exclusive change in Japanese demand for U.S. beef or pork does not influence the world price of meats." This statement implies homogenous goods, as does the description of the model used to calculate the "total" elasticities (MMB, p. 505, fn. 1). In any event, the cross-price effects specified in Equation (1) were insignificant, which is consistent with the homogenous-good (isolated market) assumption.

before, signs are attached to coefficients so that elasticities can be interpreted as absolute values.

Substituting Equation (7′) into Equation (5′) yields the following:

$$(5'') \quad Q^*_{XJ} = -\eta_J(P^*_{US} + R^* + T'^*) - \delta S^* + \iota Y^*,$$

which is Japan's import demand equation for U.S. beef (pork) implied by the model. Noting that $Q_{XJ} = Q_{MJ}$, three observations can be made. First, the R variable in Equation (1) is redundant, since all financial variables are expressed in yen.[2] This result may explain why MMB's estimates of $-\eta_J$ are problematic (positive and insignificant in the case of pork and very small (-0.25) in the case of beef). Second, when the price variable in Equation (1) is expressed in U.S. dollars, as would be appropriate if R were included, then $\eta_J = \eta_R$ when exchange-rate pass-through is complete, a testable proposition.[3] Third, this restriction can be extended to include η_T, provided that T in Equation (1) is replaced with T' (and the price variable P_J is measured *exclusive* of the tariff).[4] Indeed, MMB's estimates are consistent with this latter restriction. Specifically, for the beef equation $\eta_R = 0.91$ and $\eta_T = 0.95$ and for the pork equation $\eta_R = 2.22$ and $\eta_T = 2.06$. In addition to serving as a test for the pass-through (or no money illusion) hypothesis, these restrictions might have improved the precision of the estimates of the remaining parameters in the model.

Rewriting Equation (5″) as

$$Q^*_{XJ} = -\eta_J P^*_{US} - \eta_R R^* - \eta_T T'^* - \delta S^* + \iota Y^*$$

and substituting this expression along with Equations (3′) and (6′) into Equation (8′) yields:

$$(9) \quad Q^*_S = -\eta_F P^*_{US} - \kappa_J \eta_R R^* - \kappa_J \eta_T T'^* - \kappa_J \delta S^* + \kappa_J \iota Y^*,$$

where $\eta_F = \kappa_{US}\eta_{US} + \kappa_J\eta_J + \kappa_R\eta_R$ is the farm-level demand elasticity corresponding to Equation (2). Writing Equation (9) in inverse form gives:

$$(9') \quad P^*_{US} = -(1/\eta_F)Q^*_S - (\kappa_J\eta_R/\eta_F)R^* - (\kappa_J\eta_T/\eta_F)T'^* - (\kappa_J\delta/\eta_F)S^* + (\kappa_J\iota/\eta_F)Y^*,$$

which is the model used by MMB to compute total elasticities. In particular, MMB estimated Equation (2) to obtain $1/\eta_F = 1.699$ for beef and $1/\eta_F = 1.610$ for pork. These estimates were then combined with the estimates of η_R, η_T, δ, and ι from Equation (1) and empirically observed values for κ_J to compute total elasticities using formulas that correspond to the coefficients in Equation (9′). (These elasticities are reported in MMB's Table 3.)

Clearly, the total elasticities based on Equation (9′) assume that U.S. supply is fixed. To relax this assumption, we substitute Equation (4′) into Equation (9′) and combine terms to yield the following:

$$(10) \quad P^*_{US} = -(\kappa_J\eta_R/\Lambda)R^* - (\kappa_J\eta_T/\Lambda)T'^* - (\kappa_J\delta/\Lambda)S^* + (\kappa_J\iota/\Lambda)Y^*,$$

where $\Lambda = \eta_F + \epsilon_{US}$. Comparing the coefficients of Equations (9′) and (10), it is apparent that ignoring supply response causes the total elasticities to be overstated. The reason, of course, is that fixing supply magnifies the effect of demand shocks on price. The task now is to determine the extent to which the total

[2] For a good discussion of specification of exchange rates in import demand models, see Dutton and Grennes, pp. 108–14. A key point in that discussion is that if financial variables are expressed in a single currency (either exporter's or importer's), exchange-rate variables are redundant by the homogeneity condition of demand. In these instances, a "significant" exchange-rate variable probably represents specification error (e.g., due to omitted variables).

[3] As emphasized by Chambers and Just (1979, pp. 252f), the restriction rests on the assumption that cross-price effects are zero, as appears to be true for U.S. beef and pork exports to Japan based on MMB's Table 2. If cross-price effects are not zero, imposing the restriction could bias results. Thus, the restriction should be *tested* and not simply imposed.

[4] Since import demand functions are homogenous of degree zero in prices and income, the restriction can be extended further to include the income effect, i.e., $\eta_J = \eta_T = \eta_R = -\iota_J$, *provided all goods are traded* (Chambers and Just, 1979, p. 252).

Table 1. Total Elasticities for U.S. Slaughter Cattle and Hog Prices with Respect to Japanese Import Demand Variables

	Demand Variable			
Price Variable/Time Horizon	Japanese Income	Tariff	Exchange Rate	Subsidy
Beef:				
Immediate run (ϵ_{US} = 0)	0.013	−0.048	−0.046	−0.030
One year (ϵ_{US} = 0.15)	0.010	−0.039	−0.037	−0.024
Five years (ϵ_{US} = 0.60)	0.006	−0.024	−0.023	−0.015
Long run (ϵ_{US} = 3.24)	0.002	−0.007	−0.007	−0.005
Pork:				
Immediate run (ϵ_{US} = 0)	0.020	−0.050	−0.054	−0.047
One year (ϵ_{US} = 0.40)	0.012	−0.030	−0.033	−0.029
Five years (ϵ_{US} = 1.80)	0.005	−0.013	−0.014	−0.012
Long run (ϵ_{US} = ∞)	0.000	−0.000	−0.000	−0.000

Note: Elasticities are based on Equation (10). See text for details.

elasticities based on Equation (9′) overstate the actual price effects.

Revised Elasticity Estimates

The answer is provided in Table 1. These elasticities were computed using Equation (10) and alternative values for ϵ_{US} gleaned from the literature. For beef, Marsh estimated elasticities of −0.17, 0.60, and 3.24 for 1-month, 18-month, and infinite lags; Buhr and Kim report values of 0.36 and 0.61 at one quarter and six quarters; and Sarmiento and Allen report estimates of −0.44 and 0.33 for 1-month and long-run responses, respectively. On the basis of these estimates, 0.15, 0.60, and 3.24 were selected to represent short-run (1 year), intermediate-run (5 years), and long-run responses. These lengths of run are the same as those used by Lemieux and Wohlgenant in their analysis of supply response in the U.S. hog industry. Although the numerical values assigned to the short- and intermediate-run periods are subjective, they suffice to indicate the sensitivity of total elasticities to supply response, this paper's main objective.

There are far fewer empirical studies of supply response for pork. The most recent is a 1992 study by Holt and Moschini that focuses on sow farrowings. That study puts the one-quarter elasticity at between 0.168 and 0.172 and the long-run elasticity at between 1.93 and 1.98. For pork *per se,* Lemieux and Wohlgenant's paper is the most recent, which estimates the supply elasticity to be 0.4 in the short run, 1.8 in the intermediate run, and infinite in the long run. The perfectly elastic long-run response was deemed plausible, since "hog production requires such little land" (Lemieux and Wohlgenant, p. 909). In the absence of more recent estimates, Lemieux and Wohlgenant's estimates were used in this study.

Results indicate that supply response significantly reduces the total elasticities. Focusing on the 5-year (intermediate-run) responses, the total elasticities for beef are cut by half and, for pork, by one fourth (Table 1). If the time horizon is extended beyond 5 years, the reduction is more dramatic, i.e., one sixth for beef and infinite for pork. (With U.S. hog supply perfectly elastic in the long run, demand shocks have no lasting effect on farm price.) These results suggest that supply response does indeed matter in estimating the effects of foreign demand shocks on U.S. livestock prices. In particular, the estimated price effects presented in MMB's Table 4 are overstated by a factor of at least two in the case of exchange rate and tariff and by a factor of at least six in the case of Japanese income.

Concluding Comments

The most striking aspect of the total elasticities in Table 1 is their small size (less than 0.06 in absolute value).[5] This result suggests that trade liberalization, monetary policies, economic growth, and other factors that lead to increased Japanese demand for U.S. red meat will have little effect on domestic producer welfare. This is especially true in the long run, where most of the initial price rise is dissipated by increased industry output. As an example, the 22% GATT-mandated reduction in Japan's tariff quota on beef that occurred between 1993 and 2001 would cause U.S. beef prices to rise by between 0.2% and 0.4% based on the elasticities in Table 1. At current prices, this rise represents a nominal price increase of between 15¢ and 31¢ per cwt, which is substantially less than MMB's estimate of $1.03 per cwt. In light of this finding, the U.S. red meat industries may be better off focusing on product redesign to address consumer health concerns (Kinnucan et al.) or research to lower production costs (Wohlgenant).

A caveat in interpreting the total elasticities in Table 1 is that they are computed using supply elasticities taken from the literature. In addition, the supply elasticity values corresponding to the different time horizons in Table 1 are based in part on judgment. To the extent that this judgment is faulty or that the supply elasticity estimates are invalid, the total elasticities must be interpreted with caution. Still, these caveats do not alter the basic conclusion that events in Japan have little effect on U.S. red meat prices.

[5] This is in contrast to corresponding elasticities for grains, which range from −0.79 for wheat to −2.16 for soybeans according to Chambers and Just's estimates (1981, table 4). The basic reason for the differences is that export markets absorb a large share of U.S. grain production but only a tiny share of U.S. meat production. For example, Japan, the largest export market for U.S. beef and pork, absorbed only 3% of U.S. beef supplies and 1.5% of U.S. pork supplies according to the data used in MMB's study. The tiny export shares account for the minute elasticities in Table 1 (see Equation (10)).

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