Production Subsidy and Countervailing Duties in Vertically Related Markets: The Hog-Pork Case Between Canada and the United States

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ABSTRACT

This paper analyzes U.S. countervailing import duties aimed at offsetting the effects of a Canadian hog production subsidy. Approximate countervailing duty formulae for two alternative objectives are derived, the permissible range of these duties is illustrated, and empirical evidence is provided. To restore equilibrium at the pre-subsidy level in the U.S. hog market, a countervailing duty on hog imports suffices; this duty should be less than the unit hog production subsidy. To restore equilibrium in both the U.S. hog and pork markets, countervailing duties on both hog and pork imports are required. Such duties should be less than the unit subsidy, and the duty on pork should be less than the duty on hogs.

PRODUCTION SUBSIDY AND COUNTERVAILING DUTIES IN VERTICALLY RELATED MARKETS: THE HOG-PORK CASE BETWEEN CANADA AND THE UNITED STATES

To protect domestic industries from international competition judged as "unfair" because of subsidies in foreign countries, it is common for national governments to impose "countervailing duties," a procedure legally sanctioned in the Subsidies Code of the General Agreement on Tariffs and Trade (GATT). Although the trade effects of subsidies are well understood (Bhagwati 1968; Corden 1974), less attention has been paid to a more practical issue arising in the context of countervailing duties, especially those involving domestic production (as opposed to export) subsidies: namely, at what level should these duties be set? GATT rules put a ceiling on the permissible duties by requiring that they not penalize the exporter by more than the subsidy actually received (Hufbauer and Shelton Erb 1984). Beyond that, the rules are rather vague, leaving scope for an economic evaluation.

The purpose of this paper is to analyze the appropriate level of countervailing duties in a case that has attracted considerable attention in recent years—that of exports of hogs and pork from Canada to the United States.[1] Four features of this countervailing duty case should be made explicit. First, the dispute involves Canada's domestic production subsidies; export subsidies are not an issue. Second, virtually all production subsidies identified as countervailable by U.S. authorities were paid to Canadian hog producers, not to pork producers. Third, both hogs and pork are priced in competitive North American markets. Fourth, with the exception of technical regulations involving Canadian hog imports, no significant trade barriers inhibit trade between Canada and the United States in either hogs or pork.

To address the level of countervailing duties, one must be specific about the objectives of such measures because, under competitive conditions, the economic justification for imposing these duties is debatable. Because foreign subsidies on exportable goods improve the terms of trade of the importing country, they also tend to improve its welfare.[2] Hence, under competitive conditions the importing country is not hurt by the subsidies, and the domestic redistributive issue raised by the foreign subsidy could be addressed with nonborder measures if deemed important.[3]

Alternatively, and consistent with the observation that GATT rules are slanted in favor of domestic producers of importables (Baldwin 1980), a plausible objective for setting countervailing duties is to offset the subsidy effects from the perspective of domestic producers of the import-competing product (who are hurt by the foreign subsidy). That is the approach followed here. In particular, we ask whether countervailing duties should be applied to the primary product only (hogs) or to both the primary and processed product (pork), given that domestic production subsidies apply only to the primary product but strong vertical linkages exist between the hog and pork sectors. Our analysis relies on a two-good, two-market equilibrium model. Approximate formulae for countervailing duties are derived, the permissible range of these duties is illustrated, and some empirical evidence is provided.

Canadian Hog Subsidies and the Countervailing Duty Case

Hog production in Canada is subsidized through both federal and provincial programs.[4] In the case brought by the United States against Canadian hog and pork exports in 1984 and against Canadian exports of fresh, chilled, and frozen pork in 1989, numerous government programs were judged countervailable on the basis of the U.S. "specificity test." However, payments under the federal Agricultural Stabilization Act (ASA) and the Quebec Farm Income Stabilization Insurance Program (QFISIP) accounted for 80 percent of the total calculated subsidy in the 1984 investigation. Further, payments from the National Tripartite Stabilization (NTS) program, which replaced the ASA for hogs, and from the QFISIP accounted for nearly 90 percent of the total calculated subsidy in the 1989 investigation.

The main feature of these programs is to provide a (market responsive) floor price to hog producers. For example, under the NTS program a quarterly floor price is calculated equal to the estimated national cash cost of production in that quarter, plus 95 percent of the difference between these cash costs and the national average market price of hogs in the same quarter for the preceding five years. Deficiency payments are made to producers whenever the market price falls below the floor price.

Despite Canada's argument that these programs are "generally available" and hence noncountervailable, the United States imposed a countervailing duty on Canadian hog exports in July 1985 following the National Pork Producers Council petition to the U.S. Department of Commerce filed in November 1984. The U.S. International Trade Commission (USITC) found that, although both the U.S. hog and pork industries were suffering from serious economic difficulties, only the hog industry was materially injured by Canadian hog imports. As a result, a countervailing duty of Canadian $0.0439/cwt liveweight (equal to the measured subsidy) was applied to Canadian exports of hogs and no duty was applied to pork. U.S. hog producers were disappointed by the USITC decision and pushed for a similar duty on pork. Following a new petition filed on January 1989 by the U.S. National Pork Producers Council, a countervailing duty on Canadian pork equal to Canadian $0.036/lb. was levied, beginning in September 1989. However, subsequent rulings by the GATT and the Canada-United States Free-Trade Agreement (CUSTA) panels led to the removal of the countervailing duty on Canadian pork exports in June 1991.[5]

A Market Equilibrium Model for Hogs and Pork

The simplest framework for meeting the objectives of this paper involves a model of two countries trading two goods that are vertically interrelated. We assume that these two markets can be modeled in a semi-partial equilibrium framework separate from the rest of the economy in the two countries. The rest of the world also is ignored, an assumption appropriate for hogs because neither Canada nor the United States trades live hogs with any other country, and justifiable for pork because Canada and the United States are each other's most important trading partner.

Three types of agents are considered: primary producers (farmers), processors, and retailers. These agents act in two vertically related sectors: hogs and pork. In each country, the primary sector produces live hogs that can be delivered domestically to the processing sector or exported to the other country. In each country, the processing sector buys live hogs from the domestic and/or the foreign primary sectors and sells pork to retailers in the home country or in both countries. Retailers in each country reflect demand decisions at the consumption level, but such decisions are represented at the wholesale level in terms of demand for processed pork products (which also can be exported) for domestic consumption. Hence, in each country it is necessary to model hog supply at the farm level, hog demand and pork supply by the processing sector, and pork demand at the wholesale level. These functions are written as

$$S_h^i = S_h(P_h^i, z^i) S_h^i \tag{1}$$

$$D_h^i = D_h^i(p_h^i, p_k^i, z^i) \tag{2}$$

$$S_k^i = S_k^i(p_h^i, p_k^i, z^i) \tag{3}$$

$$D_k^i = D_k^i(p_k^i, z^i) \tag{4}$$

where S is supply, D is demand, p is price, subscript h denotes hogs, subscript k denotes pork, and supercript i denotes the country [later, we let superscript i be an asterisk for Canada (the foreign country) and drop it for the United States (the home country)]. Vector z contains other variables relevant to supply and demand but that are given in the following analysis. For example, in retail demand $D_k^i(.)$, z^i represents income and other prices affecting consumer demand.

The equilibrium conditions for this two-country, two-market model require the exhaustion of spatial arbitrage possibilities. This means that the price difference between Canada and the United States (when expressed in the same currency) must equal the cost of transferring the good from the exporting market to the importing market if trade takes place. Transfer costs include transportation and (possibly) import tariffs or countervailing duties. Hence, assuming that Canada exports both hogs and pork to the United States,[6] and that there are no barriers to trade other than transportation costs, the market equilibrium conditions can be expressed as

$$S_h^*(p_h^*,z^*) + S_h(p_h,z) = D_h^*(p_h^*,p_k^*,z^*) + D_h(p_h,p_k,z) \tag{5}$$

$$S_k^*(p_h^*,p_k^*,z^*) + S_k(p_h,p_k,z) = D_k^*(p_k^*,z^*) + D_k(p_k,z) \tag{6}$$

$$p_h^* = ep_h - T_h \tag{7}$$

$$p_k^* = ep_k - T_k \tag{8}$$

where e is the exchange rate (Canadian dollar per U.S. dollar), and T_h and T_k are unit transportation costs (in Canadian dollars) for hogs and pork, respectively.

Equations (5) through (8) can be solved for the equilibrium market prices, say $\{\bar{p}_h^*,\bar{p}_k^*,\bar{p}_h,\bar{p}_k\}$. Such prices, together with behavioral relations (1) through (4), give equilibrium levels of domestic demand and supply in each country, say $\{\bar{S}_h^*,\bar{S}_k^*,\bar{D}_h^*,\bar{D}_k^*,\bar{S}_h,\bar{S}_k,\bar{D}_h,\bar{D}_k\}$. Equilibrium trade flows are $\bar{X}_h \equiv \bar{S}_h^* - \bar{D}_h^*$ and $\bar{X}_k \equiv \bar{S}_k^* - \bar{D}_k^*$. Note that $\bar{X}_h > 0$ and $\bar{X}_k > 0$ if trade flows from Canada to the United States, the assumption underlying price relations (7) and (8).

Useful simplifications are possible by accounting explicitly for pork production technology. Let Q_h denote the quantity of hogs demanded by the processing sector as an input for the production of a quantity Q_k of pork meat. This production process requires a vector L of other variable inputs (such as labor and energy). Although elements of L may substitute for one another, they clearly cannot substitute for Q_h in the production of Q_k. Moreover, it is legitimate to assume that Q_h is used in fixed proportion to produce Q_k, and without loss of generality we assume this proportion is unity, implying that Q_h and Q_k are measured in the same units (kilograms of carcass weight, say). More precisely, the production function $Q_k = F(Q_h,L)$ can be represented as

$$F(Q_h,L) = \min \{ Q_h, f(L) \} \tag{9}$$

Letting w denote the price vector of other inputs L, it is verified that the cost function dual to this technology can be written as

$$C(Q_k, p_h, w) = p_h Q_k + c(Q_k, w) \tag{10}$$

Applying Shephard's lemma to (10), it is apparent that the conditional factor demand function of hogs is perfectly inelastic, implying that the profit-maximizing supply function for pork and demand function for hogs are identically equal.[7] Moreover, the strongly separable form of the cost function in (10) implies that the pork supply (hog demand) equation is a function of the difference between pork and hog prices $(p_k - p_h)$, the processing margin. Hence, $S_k^i(p_k^i - p_h^i, z^i) \equiv D_h^i(p_k^i - p_h^i, z^i)$.

Countervailing Duty for Hog Producers

Canadian stabilization programs involve government-supported price floors. The price floor skews the farm price distribution to the right and has two main effects. First, it increases the expected price, whether or not the floor is binding. Second, it reduces price variability. In the model that follows, the second effect is ignored, and attention is focused on the mean price effect of subsidy payments, represented by a unit subsidy of amount s. The production subsidy puts a wedge of the same amount between the price that determines production decisions and the price that processors actually pay, and tends to distort market equilibrium. In particular, it tends to put downward pressure on hog prices, and this is what led U.S. hog producers to lobby for countervailing duties.

As discussed earlier, it is crucial to be specific about the objective of levying countervailing duties. Assume first that the U.S. objective is to restore the welfare of U.S. hog producers. Hence, what needs to be restored to the pre-subsidy level is the U.S. hog price. Because this objective entails only one target, it can be achieved with one instrument, a countervailing duty on hog imports. Let t_h be the countervailing duty levied per unit of import (in Canadian dollars) such that the spatial price equilibrium condition consistent with positive Canadian hog exports to the United States can be written as

$$p_h^* = ep_h - T_h - t_h \tag{11}$$

whereas the pork spatial equilibrium condition (8) is unchanged. Then, U.S. equilibrium prices for hogs and pork will solve

$$S_h^*(ep_h - T_h - t_h + s, z^*) + S_h(p_h, z) - D_h^*(ep_h - T_h - t_h, ep_k - T_k, z^*)z - D_h(p_h, p_k, z) = 0 \tag{12}$$

$$S_k^*(ep_h - T_h - t_h, ep_k - T_k, z^*) + S_k(p_h, p_k, z) - D_k^*(ep_k - T_k, z^*) - D_k(p_k, z) = 0 \tag{13}$$

The equilibrium U.S. hog and pork prices will depend on subsidy s and countervailing duty t_h, say $\tilde{p}_h = p_h(.;t_h,s)$ and $\tilde{p}_k = p_k(.;t_k,s)$.

To restore the U.S. hog price to the pre-subsidy level, the countervailing duty t_h must be chosen such that $\tilde{p}_h = \bar{p}_h$. From (12) and (13), it is clear that to choose the appropriate duty one must have detailed knowledge of hog and pork demand and supply conditions. To gain insight into the relevant factors, it is useful to consider an explicit approximate solution for t_h in terms of s. Linearizing $p_h(.;t_h,s)$ around the undistorted equilibrium ($t_h = s = 0$), and recalling that $p_h(.;0,0) = \bar{p}_h$, implies that the duty t_h which keeps p_h at $\bar{p}_h$ given a production subsidy s, satisfies

$$\frac{\partial p_h}{\partial t_h} t_h + \frac{\partial p_h}{\partial s} s = 0 \tag{14}$$

Hence, the countervailing duty that preserves U.S. hog price at the pre-subsidy level can be written as a proportion of the Canadian production subsidy:

$$t_h = \phi_h s \tag{15}$$

where $\phi_h = -(\partial p_h/\partial s)/(\partial p_h/\partial t_h)$ can be interpreted as the specific countervailing duty attributable to one unit of production subsidy s, or as the ad valorem countervailing duty attributable to one unit of ad valorem production subsidy s/p_h^*.[8]

Comparative static effects $(\partial p_h/\partial s)$ and $(\partial p_h/\partial t_h)$ necessary to calculate ϕ_h can be found by differentiating equilibrium conditions (12) and (13). For notational convenience, rewrite (12) as $H(.;t_h,s) = 0$ and (13) as $K(.;t_h,s) = 0$. Hence, for $\partial p_h/\partial s$ one needs to solve

$$\frac{\partial H}{\partial p_h}\frac{\partial p_h}{\partial s} + \frac{\partial H}{\partial p_k}\frac{\partial p_k}{\partial s} + \frac{\partial H}{\partial s} = 0 \tag{16}$$

$$\frac{\partial K}{\partial p_h}\frac{\partial p_h}{\partial s} + \frac{\partial K}{\partial p_k}\frac{\partial p_k}{\partial s} + \frac{\partial K}{\partial s} = 0 \tag{17}$$

whereas for $\partial p_h/\partial t_h$ one needs to solve

$$\frac{\partial H}{\partial p_h}\frac{\partial p_h}{\partial t_h} + \frac{\partial H}{\partial p_k}\frac{\partial p_k}{\partial t_h} + \frac{\partial H}{\partial t_h} = 0 \tag{18}$$

$$\frac{\partial K}{\partial p_h}\frac{\partial p_h}{\partial t_h} + \frac{\partial K}{\partial p_k}\frac{\partial p_k}{\partial t_h} + \frac{\partial K}{\partial t_h} = 0 \tag{19}$$

Solving using Cramer's rule and evaluating the partial derivatives of (12) and (13) at the undistorted equilibrium point gives

$$\phi_h = \frac{-\dfrac{\partial S_h^*}{\partial p_h^*}\left[\dfrac{\partial S_k^*}{\partial p_k^*}e + \dfrac{\partial S_k}{\partial p_k} - \dfrac{\partial D_k^*}{\partial p_k^*}e - \dfrac{\partial D_k}{\partial p_k}\right]}{\left[-\dfrac{\partial S_h^*}{\partial p_h^*} + \dfrac{\partial D_h^*}{\partial p_h^*}\right]\left[\dfrac{\partial S_k^*}{\partial p_k^*}e + \dfrac{\partial S_k}{\partial p_k} - \dfrac{\partial D_k^*}{\partial p_k^*}e - \dfrac{\partial D_k}{\partial p_k}\right] + \dfrac{\partial S_k^*}{\partial p_h^*}\left[-\dfrac{\partial D_h^*}{\partial p_k^*}e - \dfrac{\partial D_h}{\partial p_k}\right]} \tag{20}$$

It is convenient to express (20) in terms of supply and demand elasticities. Let η^i_{hh} denote the hog supply elasticity at the farm, η^i_{kk} the pork supply elasticity at the processing level, η^i_{kh} the elasticity of pork supply with respect to hog price, ϵ^i_{hh} the hog demand elasticity at the processing level, ϵ^i_{hk} the elasticity of hog demand with respect to pork price, and ϵ^i_{kk} the pork demand elasticity at retail. Because, as shown above, pork supply and hog demand are identically equal, $\epsilon^i_{hk} = \eta^i_{kk}$ and $\eta^i_{kh} = \epsilon^i_{hh}$. Moreover, because the (identically equal) hog demand and pork supply are functions of the processing margin $(p_k - p_h)$, hog demand and pork supply elasticities are related by $\epsilon^i_{hh} = -\eta^i_{kk}(p^i_h/p^i_k)$. Using these elasticities, ϕ_h can be expressed as

$$\phi_h = \frac{\eta^*_{hh} S^*_h}{\eta^*_{hh} S^*_h - \epsilon^*_{hh} D^*_h \left(\dfrac{-\epsilon^*_{kk} D^*_k \beta^*_k - \epsilon_{kk} D_k}{\eta^*_{kk} S^*_k \beta^*_k + \eta_{kk} S_k - \epsilon^*_{kk} D^*_k \beta^*_k - \epsilon_{kk} D_k} \right)} \tag{21}$$

where $\beta^*_k = (p^*_k + T_k)/p^*_k$ is a coefficient accounting for the incidence of transportation costs on Canadian pork prices.

Under the weak regularity assumption that supplies are upward sloping ($\eta^i_{hh} \geq 0$ and $\eta^i_{kk} \geq 0$) and demands are downward sloping ($\epsilon^i_{hh} \leq 0$ and $\epsilon^i_{kk} \leq 0$), we can immediately conclude from (21) that $0 \leq \phi_h \leq 1$, or

$$0 \leq t_h \leq s \tag{22}$$

Hence, the unit countervailing duty ought to be lower than the unit production subsidy if the objective is simply to restore the welfare of hog producers to the pre-subsidy level. This result is rather intuitive. Because the subsidy is at the production level, it does not distort processing or consumption decisions in the subsidizing country; hence, the trade effect of the subsidy is reduced as a result of increased domestic consumption. Considerations such as these were ignored when the 1985 countervailing duty on hogs was imposed, essentially by setting $\phi_h = 1$.

In general, the elasticities in (21) are not constants. In particular, they are functions of (z^*,z), so that ϕ_h depends on these variables. Insofar as (z^*,z) are endogenous variables affected by the subsidy cum countervailing duty, this dependence underscores that (21) is only an approximation that neglects some general equilibrium effects. Alternatively, even if (z^*,z) are not affected by the subsidy and countervailing duty, it is clear that the countervailing duty t_h must covary with these variables if the U.S. hog price is to be maintained at the level it would achieve in pre-subsidy conditions. Hence, a countervailing duty is meaningful only in a conditional sense and will not provide a perfect offset to the production subsidy in all possible situations.[9]

Equation (21) gives an operational rule to account for economic considerations in setting the countervailing duty and can shed some light on the relevant factors. Note that ϕ_h does not depend on the U.S. hog supply elasticity. Because ϕ_h is chosen such that the U.S. hog price is restored at the pre-subsidy level, U.S. hog supply also will be restored to the pre-subsidy level, and its price responsiveness is irrelevant. To see when ϕ_h could be set at its limit values of 0 and 1, from equation (21) one finds

$$\begin{aligned}
&\phi_h \to 0 \quad \text{as} \quad \eta^*_{hh} \to 0 \\
&\phi_h \to 1 \quad \text{as} \quad \eta^*_{hh} \to \infty \\
&\phi_h \to 1 \quad \text{as} \quad \epsilon^*_{hh} \to 0 \\
&\phi_h \to 1 \quad \text{as} \quad \epsilon^*_{kk} \to 0 \ \text{and} \ \epsilon_{kk} \to 0
\end{aligned} \tag{23}$$

Hence, setting the U.S. duty at its upper limit of unity is justified only in three special instances: when the Canadian hog supply is infinitely elastic, when the Canadian pork supply is totally inelastic, or when Canadian and U.S. pork demands are both perfectly inelastic. Similarly, setting the duty to its lower bound of zero is admissible only when the Canadian hog supply is totally inelastic (in which case a production subsidy has no production- or trade-distorting effects).

To examine how the unit countervailing duty ϕ_h is affected by the magnitude of the elasticities involved, one can differentiate the expression in (21) [only five independent elasticities are involved because, as noted, $\epsilon_{hh}^{i} = -\eta_{kk}^{i}(p_h^i/p_k^i)$]. Under the assumption that supplies are upward sloping and demands are downward sloping, the following comparative static results (of straightforward interpretation) can be derived: $\partial\phi_h/\partial\eta_{hh}^{*} \geq 0$, $\partial\phi_h/\partial\eta_{kk}^{*} \leq 0$ ($\partial\phi_h/\partial\epsilon_{hh}^{*} \geq 0$), $\partial\phi_h/\partial\eta_{kk} \geq 0$ ($\partial\phi_h/\partial\epsilon_{hh} \leq 0$), $\partial\phi_h/\partial\epsilon_{kk}^{*} \geq 0$, and $\partial\phi_h/\partial\epsilon_{kk} \geq 0$.

Countervailing Duties for Hog Producers and Pork Processors

Neutralizing the effects of a foreign hog production subsidy on domestic hog producers via a countervailing duty on hog imports only, as analyzed in the previous section, neglects the effects of these actions on pork processors' welfare. Specifically, it can be shown that a foreign hog production subsidy without any countervailing duty makes processors better off because the pork price declines less than does the hog price [recall that what matters to processors is the margin $(p_k - p_h)$]. However, given a Canadian hog subsidy s, and a U.S. countervailing duty $t_h = \phi_h s$ that keeps the hog price at the pre-subsidy level, it can be shown that the U.S. pork price decreases. With p_h held constant by the duty and p_k falling, the processor margin shrinks and makes processors worse off.

If the United States deemed the welfare of pork processors as important as that of primary producers, countervailing duties could be formulated to preserve both U.S. hog and pork prices at their pre-subsidy levels. Because this objective entails two targets, it requires at least two instruments, say a countervailing duty t_h on hog imports and a countervailing duty t_k on pork imports. Analytically, it is useful to recognize that both hog and pork prices will be restored at their pre-subsidy level if t_h and t_k result in export flows equal to the pre-subsidy trade flows $\bar{X}_h$ and $\bar{X}_k$. Because no other change has taken place in the United States, these import levels will be consistent with the original U.S. equilibrium solution $\{\bar{p}_h, \bar{p}_k, \bar{S}_h, \bar{S}_k, \bar{D}_h, \bar{D}_k\}$.

If t_h and t_k are levied in Canadian currency, the spatial price equilibrium conditions consistent with positive trade flows from Canada to the United States are given by (11) for hogs, whereas for pork the condition is

$$p_k^* = ep_k - T_k - t_k \tag{24}$$

In this framework, the levels of t_h and t_k that restore equilibrium in the U.S. hog and pork markets will solve

$$S_h^*(e\overline{p_h} - T_h - t_h + s, z^*) - D_h^*(e\overline{p_h} - T_h - t_h, e\overline{p_k} - T_k - t_k, z^*) = \overline{X_h}(z^*, z) \tag{25}$$

$$S_k^*(e\overline{p_h} - T_h - t_h, e\overline{p_k} - T_k - t_k, z^*) - D_k^*(e\overline{p_k} - T_k - t_k, z^*) = \overline{X_k}(z^*, z) \tag{26}$$

Again, useful insights are possible by considering the countervailing duties associated with a small production subsidy. Linearizing (25) and (26) around the undistorted equilibrium ($s = t_h = t_k = 0$) gives

$$\left[\frac{\partial S_h^*}{\partial p_h^*} - \frac{\partial D_h^*}{\partial p_h^*} \right] t_h - \frac{\partial D_h^*}{\partial p_k^*} t_k - \frac{\partial S_h^*}{\partial p_h^*} s = 0 \tag{27}$$

$$\frac{\partial S_k^*}{\partial p_h^*} t_h + \left[\frac{\partial S_k^*}{\partial p_k^*} - \frac{\partial D_k^*}{\partial p_k^*} \right] t_k = 0 \tag{28}$$

where all derivatives are evaluated at the undistorted equilibrium point. These equations can be expressed in terms of elasticities as

$$\left(\eta_{hh}^* S_h^* - \epsilon_{hh}^* D_h^* \right) t_h - \epsilon_{hk}^* D_h^* \frac{p_h^*}{p_k^*} t_k = \eta_{hh}^* S_h^* s \tag{29}$$

$$\eta^{*}_{kh} S^{*}_{k} \frac{p^{*}_{k}}{p^{*}_{h}} t_{h} + \left(\eta^{*}_{kk} S^{*}_{k} - \epsilon^{*}_{kk} D^{*}_{k} \right) t_{k} = 0 \tag{30}$$

Solving by Cramer's rule and using the technological implications $\epsilon^{*}_{hk} = \eta^{*}_{kk}$ and $\eta^{*}_{kh} = \epsilon^{*}_{hh}$, the countervailing duties can be expressed in terms of the unit subsidy on hog production as

$$t_{h} = \theta_{h}\, s \tag{31}$$

$$t_{k} = \theta_{k}\, s \tag{32}$$

where the weights θ_h and θ_k are given by

$$\theta_{h} = \frac{\eta^{*}_{hh} S^{*}_{h}}{\eta^{*}_{hh} S^{*}_{h} - \epsilon^{*}_{hh} D^{*}_{h} \left[\dfrac{-\epsilon^{*}_{kk} D^{*}_{k}}{\eta^{*}_{kk} S^{*}_{k} - \epsilon^{*}_{kk} D^{*}_{k}} \right]} \tag{33}$$

$$\theta_{k} = \frac{\eta^{*}_{hh} S^{*}_{h}}{\eta^{*}_{hh} S^{*}_{h} - \epsilon^{*}_{kk} D^{*}_{k} \left[\dfrac{\eta^{*}_{hh} S^{*}_{h} - \epsilon^{*}_{hh} D^{*}_{h}}{\eta^{*}_{kk} S^{*}_{k}} \right]} \tag{34}$$

Hence, θ_h and θ_k represent specific countervailing duties on hogs and pork, respectively, attributable to one unit of hog production subsidy s.[10] Again, because the elasticities in (33) and (34) are not constants but depend on (z^*,z), θ_h and θ_k also depend on these variables, and the resulting t_h and t_k are effective countervailing duties in a conditional sense only.[11]

Equations (33) and (34) allow the derivation of some interesting bounds on the magnitude of countervailing duties under the weak regularity assumption that hog and pork supplies are not downward sloping ($\eta^{*}_{hh} \geq 0$ and $\eta^{*}_{kk} \geq 0$) and that pork demand is not upward sloping ($\epsilon^{*}_{kk} \leq 0$).

First, note that (33) and (34) imply $\theta_h \leq 1$ and $\theta_k \leq 1$. Moreover, the denominator of (34) is no less than the denominator of (33), and therefore $\theta_k \leq \theta_h$. It follows that

$$0 \leq t_k \leq t_h \leq s \tag{35}$$

Hence, both specific countervailing duties are a fraction of the unit subsidy on hog production. Moreover, the duty required on pork is smaller than that required on hogs. This result is important because the United States has levied countervailing duties by setting $t_h = s$ and $t_k = s$, a procedure that overtaxes Canada if the purpose of these duties is simply to restore equilibrium in the U.S. hog and pork markets to the pre-subsidy level.

Additional insights on the appropriate values for the countervailing duties can be obtained by considering the limit values of θ_h and θ_k as the three independent elasticities in (33) and (34) are made (in turn) arbitrarily small or large. The results can be summarized as:

$$\begin{array}{llll} \theta_h \to 0 & \text{and} \quad \theta_k \to 0 & \text{as} & \eta^*_{hh} \to 0 \\ \theta_h \to 1 & \text{and} \quad \theta_k \to \theta^A & \text{as} & \eta^*_{hh} \to \infty \\ \theta_h \to 1 & \text{and} \quad \theta_k \to 0 & \text{as} & \eta^*_{kk} \to 0 \\ \theta_h \to \theta^B & \text{and} \quad \theta_k \to \theta^B & \text{as} & \eta^*_{kk} \to \infty \\ \theta_h \to 1 & \text{and} \quad \theta_k \to 1 & \text{as} & \epsilon^*_{kk} \to 0 \\ \theta_h \to \theta^C & \text{and} \quad \theta_k \to 0 & \text{as} & \epsilon^*_{kk} \to -\infty \end{array} \tag{36}$$

where $0 \leq \theta^j \leq 1$ ($j = A,B,C$). If the Canadian hog supply is totally inelastic, the countervailing duties for both hogs and pork are zero (with perfectly inelastic supply the hog production subsidy clearly has no trade-distorting implications). Furthermore, when the Canadian processing sector is totally unresponsive to price changes (the demand for hogs and the supply of pork are perfectly inelastic) there is no spill-over of the trade-distorting effects of hog production subsidies onto the pork sector, and the countervailing duty equals the entire production subsidy for the hog sector and zero for the pork sector. Finally, when Canadian pork demand is totally inelastic, the increased hog production spurred by the subsidy must all be exported (as hogs or pork). This case is obviously the most trade-distorting and requires countervailing duties set at their upper bounds, that is, $t_h = t_k = s$. Because recent U.S. policy was equivalent to setting $t_h = t_k = s$, it is clear that this policy requires a fairly stringent condition to be justified on economic grounds.

Similarly, one can discuss the effect on θ_h and θ_k of the three independent elasticities in turn becoming arbitrarily large. A complementary analysis is to consider the comparative statics of countervailing duties. From (33) and (34), and given the regularity assumptions $\eta^*_{hh} \geq 0$, $\eta^*_{kk} \geq 0$, and $\epsilon^*_{kk} \leq 0$, it follows that $\partial\theta_h/\partial\eta^*_{hh} \geq 0$; $\partial\theta_k/\partial\eta^*_{hh} \geq 0$; $\partial\theta_h/\partial\eta^*_{kk} \leq 0$ $(\partial\theta_h/\partial\epsilon^*_{hh} \geq 0)$; $\partial\theta_k/\partial\eta^*_{kk} \geq 0$ $(\partial\theta_k/\partial\epsilon^*_{hh} \leq 0)$; $\partial\theta_h/\partial\epsilon^*_{kk} \geq 0$; and $\partial\theta_k/\partial\epsilon^*_{kk} \geq 0$. As hog supply becomes more elastic, ceteris paribus, both countervailing duties increase; as pork supply becomes more elastic, the duty on hogs decreases and the duty on pork increases [but the inequalities in (35) continue to hold]; and, as final demand for pork becomes more inelastic, both duties increase.

Comparing ϕ_h and θ_h, from (21) and (33) it can be verified that $\phi_h \gtrless \theta_h$ as $[-\epsilon^*_{kk} D^*_k \eta_{kk} S_k] \gtrless [-\epsilon_{kk} D_k \eta^*_{kk} S^*_k]$. Thus, there is no presumption that introducing a duty on pork to preserve pork prices (as well as hog prices) to the pre-subsidy level would reduce the duty required on hogs. Indeed, if elasticities in the two countries were the same ($\epsilon^*_{kk} = \epsilon_{kk}$ and $\eta^*_{kk} = \eta_{kk}$), then $\phi_h < \theta_h$ if Canada is exporting pork to the United States in the undistorted equilibrium (which implies $D^*_k < S^*_k$ and $D_k > S_k$).

Empirical Evidence

For the case in which the U.S. objective is to restore equilibrium to the pre-subsidy level for both hog and pork sectors, some evidence on the appropriate size of the countervailing duties can be obtained by estimating Canadian elasticities of hog supply, pork supply (hog demand), and pork demand. For the specification of hog supply, one must recognize that hog prices are not known with certainty at the time relevant production decisions are made. Here we assume that producers are risk-neutral and ignore the risk implications. The realized price received by Canadian hog producers is affected by government programs, as noted earlier. Although the size of the government subsidy has changed frequently in the past as programs have been modified, the nature of these programs has been to supplement the market price when this price falls below a "floor price," which is itself time-dependent. Hence, we assume that farmers form expectations about the net price they will receive for their hogs from both the market and the government. Moreover, we assume that these expectations are formed adaptively.

Following Nerlove (1956), the assumption of adaptive expectations leads to a dynamic equation for hog supply in which the lagged dependent variable captures the adjustment of expectations.[12] Consistent with this approach, the following parsimonious specification of hog supply is chosen:

$$S_{ht}^{*} = \alpha_{1j} + \beta_1 S_{h,t-1}^{*} + \gamma_1 \left[\frac{p_{h,t-4}^{*} + s_{t-4}}{p_{f,t-4}^{*}} \right] + e_{1t} \tag{37}$$

where S_h^* is hog supply, t denotes time, α_{1j} are quarter-specific intercepts (j = 1,2,3,4), (p_h^* + s) is the net price received by farmers from the market and from the government subsidy, p_f^* is the feed price, e_1 is a random term, and (α,β,γ) are parameters to be estimated. Homogeneity of degree zero in prices of supply is maintained, and a four-quarter lag for the realization of hog production decisions is assumed. Because of this dynamic specification, it is necessary to distinguish between short-run (holding $S_{h,t-1}^*$ constant) and long-run (steady state) supply elasticities.

The specification of the hog demand/pork supply equation follows the structural discussion of equations (9) and (10). A practical problem arises, however, because the correct price for this equation (the price of pork sold at the wholesale level) is not available. What is available is the retail price of pork, P_k. To proceed, it is assumed that the wholesale price is a fraction of the retail price and can be written as λP_k, where λ is a parameter to be estimated. The dynamic specification chosen for this equation is

$$S_{kt}^{*} = \alpha_{2j} + \beta_2 S_{k,t-1}^{*} + \gamma_2 \left[\frac{\lambda P_{kt}^{*} - p_{ht}^{*}}{w_t^{*}} \right] + e_{2t} \tag{38}$$

where S_k^* is the quantity of pork processed, α_{2j} are quarter-specific intercepts, P_k^* is the retail pork price, and w^* is the wage rate for labor in meat packing plants (to capture the effects of other variable input prices on pork supply).[13] Because of the dynamic specification, it is again necessary to distinguish between short-run and long-run elasticities.

The necessary Canadian pork demand equation is that for processed pork (the same type of product that also is exported) at the wholesale level. Because this demand is derived from demand at the consumption level, its properties can be inferred from the latter, which is easier to estimate given the available data. The linear specification adopted explicitly considers the effects of close substitutes (pork and chicken), whereas the effects of all other goods are captured by the Consumer Price Index (CPI). This yields

$$D_{kt}^{*} = \alpha_{3j} + \gamma_3 \frac{P_{kt}^{*}}{CPI_t^{*}} + \delta_{31} \frac{P_{bt}^{*}}{CPI_t^{*}} + \delta_{32} \frac{P_{ct}^{*}}{CPI_t^{*}} + \delta_{33} \frac{Y_t^{*}}{CPI_t^{*}} + e_{3t} \tag{39}$$

where D_k^* is per capita disappearance of pork, α_{3j} are quarter-specific intercepts, P_b^* is the price of beef, Y^* is per capita disposable income, and P_c^* is the price of chicken.[14] This equation does not directly yield an elasticity at the desired wholesale level. However, if wholesale price is a fraction of retail price, say λP_k^* as already assumed for the pork supply equation (38), the elasticity at the wholesale level and at the retail level will be the same for any level of pork consumption (George and King 1971).

The data used are taken largely from the computer database of Agriculture Canada. Quantities of hogs and pork are measured in the same units, namely, millions of kilograms (kg) of dressed cold carcass weight. For the retail demand equation, pork consumption is in kilograms per person. The price of hogs is in Canadian dollars per 100 kilograms. The feed price deflator in the hog supply equation is a weighted average of the Ontario farm price of corn and the prairie barley price (normalized to equal 100 in 1980). The pork price used in retail demand and pork supply equations is in Canadian dollars per 100 kilograms, as are beef and chicken prices in the retail demand equation. These price series were generated from consumer price indices available from Statistics Canada, based on the nominal price computed from food expenditure surveys from 1974 to 1986 (Moschini and Vissa 1991). The price deflator in the pork supply equation is the average wage rate in meat packing plants, in Canadian dollars per week. The income variable in the retail pork demand is per capita personal disposable income (Canadian dollars per person), and the deflator in this equation is the CPI (equal to 100 in 1986). The unit subsidy in the hog supply equation is the value of stabilization payments made to hog producers from federal and provincial programs, minus producers' contributions, expressed in the same units as hog price.

Least squares estimation results for equations (37) through (39), using quarterly data for the period 1980-1 to 1989-4, are reported in Table 1. The price coefficient γ_1 is significantly different from zero at the 5 percent probability level, and so is the coefficient of the lagged dependent variable β_1. In addition, β_1 is quite large, indicating a slow adjustment of supply to innovations. The pork supply equation is nonlinear in the parameters (because λ is not known and needs to be estimated). The results show a very significant price coefficient γ_2 and a faster adjustment of the dynamic structure than that in the primary hog supply sector, as indicated by the lower value of the lagged dependent variable coefficient β_2. The estimated λ coefficient suggests that the relevant wholesale price is about 75 percent of the retail price, which seems consistent with the nature of this price relationship.

The retail pork demand equation shows a significant own-price coefficient γ_3, gross substitutability between pork and beef and chicken, and normality of pork consumption with respect to income. The fit for all three equations is good, especially for the dynamic hog supply and pork supply equations. Also, the Breusch-Godfrey statistic for the test of autocorrelation up to the fourth order (Johnston 1984, 319), labeled BG(4) and distributed as χ^2 with four degrees of freedom, suggests the absence of serial correlation.

Table 1. Estimated Canadian hog and pork equations, 1980-Q1 to 1989-Q4

Parameters	Hog Supply	Hog Demand/ Pork Supply	Pork Demand
α_{i1}	33.502	159.210	6.807
	(15.266)	(26.027)	(1.656)
α_{i2}	13.586	149.850	6.346
	(15.783)	(26.748)	(1.635)
α_{i3}	17.059	148.430	6.315
	(15.091)	(26.327)	(1.679)
α_{i4}	39.006	160.530	6.967
	(14.738)	(25.138)	(1.670)
β_i	0.872	0.318	-
	(0.056)	(0.102)	
γ_i	7.341	164.570	-0.795
	(2.577)	(25.851)	(0.232)
λ	-	0.752	-
		(0.110)	
δ_{i1}	-	-	0.724
			(0.133)
δ_{i2}	-	-	0.109
			(0.277)
δ_{i3}	-	-	0.008
			(0.007)
R^2	0.91	0.93	0.74
BG(4)	5.04	1.51	2.31

Note: Asymptotic standard errors are in parentheses.

Table 2. Elasticities and countervailing duty coefficients at the mean

<table>
<tr><th></th><th>Short-run</th><th>Long-run</th></tr>
<tr><td>Elasticities</td><td></td><td></td></tr>
<tr><td>η^*_{hh}</td><td>0.042
(0.015)</td><td>0.328
(0.155)</td></tr>
<tr><td>ϵ^*_{hh}</td><td>-0.225
(0.035)</td><td>-0.330
(0.027)</td></tr>
<tr><td>η^*_{kk}</td><td>0.338
(0.071)</td><td>0.495
(0.074)</td></tr>
<tr><td>ϵ^*_{kk}</td><td colspan="2">-0.313
(0.091)</td></tr>
<tr><td>Countervailing Duty
Coefficients</td><td></td><td></td></tr>
<tr><td>θ_h</td><td>0.314
(0.088)</td><td>0.756
(0.096)</td></tr>
<tr><td>θ_k</td><td>0.181
(0.069)</td><td>0.502
(0.100)</td></tr>
<tr><td>$\theta_h - \theta_k$</td><td>0.134
(0.033)</td><td>0.253
(0.051)</td></tr>
</table>

Note: Asymptotic standard errors are in parentheses.

The elasticities of interest, computed at the mean of the estimation period, are reported in the first part of Table 2. There is a considerable difference between short-run and long-run elasticities, although all are in the inelastic range. In particular, hog supply is very inelastic in the short run, but is less so in the long run.[15] These estimated elasticities are used to compute countervailing duties for hogs and pork according to (33) and (34), with results reported in the bottom part of Table 2.

Because these duties are nonlinear functions of the elasticities, the standard errors reported in Table 2 are obtained by the linearization method illustrated, for instance, in Moschini (1988).[16]

Countervailing duty coefficients are reported for both the short run and the long run. Short-run estimates of θ_h and θ_k are relevant for a newly introduced subsidy program, whereas long-run estimates of θ_h and θ_k are relevant for a sustained subsidy program (the current situation). In the short run, the countervailing duty is estimated at 31 percent of the hog production subsidy for live hog exports and at 18 percent of this subsidy for pork exports. In the long run, these duties rise to 76 percent of the subsidy for hog exports and to 50 percent of the subsidy for pork exports. All four countervailing duty coefficients are significantly different from zero and significantly different from one at the 5 percent probability level. This shows that, for the purpose of insulating U.S. hog (and pork) producers from the effects of Canadian production subsidies, the required countervailing duties are significantly less than the hog production subsidy. Hence, setting $t_h = t_k = s$, as advocated by the United States, cannot be supported by these results. Finally, the difference (θ_h - θ_k) reported in Table 2 results in a rejection of the hypothesis that $\theta_h = \theta_k$ in both the short and long run. Hence, given the rationale for countervailing duties assumed here, the results suggest that the pork duty should be less than the hog duty.

For the purpose of actually setting countervailing duties for hogs and pork by using the framework of this paper, it would be necessary to measure the relevant production subsidy. As argued in specifying the hog supply function, what is relevant to the producer is the expected net price, which includes the expected subsidy. In this setting, what should be countervailed is the expected subsidy, which in turn depends on the mechanism of (net) price expectation formation. The estimated adaptive expectations model indicates a slow adjustment of expectations, suggesting that a long history of production subsidies is relevant in determining expectations of future subsidies.[17] Consequently, the unconditional expectation of the production subsidy, as measured for example by the average observed subsidy for a reasonably long period, may be a possible estimate of the relevant expected subsidy.[18]

Conclusion

This paper has analyzed countervailing duties aimed at offsetting the effects of a production subsidy, with specific application to the case of hog production subsidies in Canada and countervailing duties on hogs and pork by the United States. Whether only hog imports or both hog and pork imports should be countervailed depends on the objective pursued with countervailing duties. If the objective is to restore the welfare of hog producers only, a duty on hog imports will suffice. On the other hand, if the objective is to offset the effects of the subsidy on both U.S. hog and pork producers, duties on both hog and pork imports are necessary.

The analytic framework developed relies on some simplifying assumptions. Despite its limitations, the analysis may provide greater economic rationale to the process of setting countervailing duties. In particular, the model yields approximate formulae for countervailing duties that account for specific features of the industries involved. These formulae allow some general propositions concerning the appropriate size of countervailing duties, given a specific objective for the importing country. Specifically, it is shown that the duty on both hogs and pork is less than the unit subsidy and that the pork duty is less than the hog duty. The empirical section of the paper uses these formulae to estimate countervailing duty coefficents that restore equilibrium for both the U.S. hog and pork sectors. The estimated countervailing duties are significantly greater than zero and significantly less than the unit production subsidy for both hogs and pork, and the countervailing duty on pork is significantly less than that on hogs.

ENDNOTES

1. Issues that have been studied in this context, and that we do not address here, include whether Canada's production subsidies are countervailable in a legal sense, and whether U.S. hog/pork producers have been materially injured by Canada's domestic production subsidies (Meilke and van Duren 1990; Gilmour and Cluff 1986; van Duren and Martin 1989).

2. In a multimarket context, however, this proposition may be violated (Feenstra 1986).

3. Noncompetitive markets may provide a rationale for countervailing duties (Dixit 1988; Collie 1991; Spencer 1988). In addition, it should be noted that, if the importing country is large enough to affect the international terms of trade, it can find a countervailing duty that improves welfare. In such a situation, however, it is known that the large country could find an "optimal tariff" even if there is no foreign subsidy.

4. A detailed review of Canadian hog subsidy programs and of the legal cases involved is provided in Meilke and Moschini (1990).

5. The 1988 U.S. Omnibus Trade Bill contained provisions that allowed subsidies paid to raw agricultural products to be countervailed at the processed product level without conducting an "upstream subsidy" investigation. After Canada's appeals, however, the GATT and CUSTA panels ruled that the United States must conduct an upstream subsidy investigation before a countervailing duty on pork may be imposed.

6. This is the current situation and the one relevant for the 1980-89 period, the object of the subsequent empirical analysis.

7. If the function $f(L)$ is concave in L, the subcost function $c(Q_k,w)$ is convex in Q_k; this allows the sufficient conditions for profit maximization at the processing level to be satisfied.

8. The expression in (15) is exact if $p_h(.;t_h,s)$ is linear in t_h and s and is otherwise a good approximation for a small subsidy.

9. Only a tax on Canadian hog producers equal to s would do that, a solution obviously not feasible for the foreign country (the United States in this case).

10. For hogs, θ_h also can be interpreted as the ad valorem countervailing duty attributable to a unit of ad valorem production subsidy (s/p_h).

11. It should be emphasized that these countervailing duties restore equilibrium in the U.S. hog and pork markets from the private agent's point of view, but will result in tariff revenue for the United States. Hence, the United States will actually benefit from the combination of a Canadian hog subsidy and these duties. Insofar as this tariff revenue is not rebated to U.S. hog and pork producers, however, this wealth effect can be ignored in determining equilibrium in the hog and pork sectors.

12. Partial adjustment and naive expectations provide an alternative justification for the reduced form in (37) (Nerlove 1958).

13. Because there is no lag in production, current prices are relevant to determine pork production decisions. The lagged dependent variable here is justified by a partial adjustment argument (Nerlove 1958).

14. An alternative mixed demand specification may be desirable here (Moschini and Vissa (1991). For the purpose of estimating the (unconditional) pork demand elasticity, however, this alternative approach gives very similar results.

15. These elasticities are roughly consistent with those reported, among others, by Coleman and Meilke (1988). Because $\epsilon_{hh}^{*} = -\eta_{kk}^{*}(p_h^{*}/p_k^{*})$, as derived earlier, the elasticities reported in Table 2 imply a ratio of the farm price of hogs to the wholesale price of pork of approximately 0.67.

16. Elasticities from separate regressions are treated as independent random variables when computing the standard errors.

17. Given that there is an alternative (partial adjustment) justification for the dynamic specification of supply adopted, interpreting $(1 - \beta_1)$ as the coefficient of expectations may not be wholly appropriate.

18. For the period 1979-89 used here, the average net subsidy (from federal and provincial sources) was measured at 9.1 (Canadian dollars per 100 kilograms); the average hog price for the same period was 155 (Canadian dollars per 100 kilograms) (Meilke and Moschini 1991).

REFERENCES

Baldwin, R.E. 1980. "The Economics of the GATT." In *Issues in International Economics,* Vol. V., P. Oppenheimer, ed. London: Oriel Press.

Bhagwati, J. 1968. *The Theory and Practice of Commercial Policy: Departures from Unified Exchange Rate.* Special Paper in International Economics No. 8. Princeton: Princeton University Press.

Coleman, J.R., and K.D. Meilke. 1988. "The Influence of Exchange Rates on Red Meat Trade between Canada and the United States." *Canadian Journal of Agricultural Economics* 36: 401-24.

Collie, D. 1991. "Anti-Dumping and Countervailing Duties under Oligopoly: A Comment." *European Economic Review* 35: 1185-87.

Corden, W.M. 1974. *Trade Policy and Economic Welfare.* Oxford: Clarendon Press.

Dixit, A. 1988. "Anti-Dumping and Countervailing Duties under Oligopoly." *European Economic Review* 32: 55-68.

Feenstra, R.C. 1986. "Trade Policy with Several Goods and 'Market Linkages'." *Journal of International Economics* 20: 249-67.

George, P.S., and G.A. King. 1971. *Consumer Demand for Food Commodities in the United States with Projections for 1980.* Giannini Foundation Monograph 26, University of California.

Gilmour, B., and M. Cluff. 1986. "Canadian Stabilization Initiatives and their Effects on the Welfare of American Pork Producers." *Canadian Farm Economics* 20: 9-18.

Hufbauer, G.C., and J. Shelton Erb. 1984. *Subsidies in International Trade.* Washington, DC: Institute for International Economics.

Johnston, J. 1984. *Econometric Methods,* Third edition. New-York: McGraw-Hill.

Meilke, K.D., and G. Moschini. 1992. "A Chronicle of Canadian Hog Stabilization Programs and U.S. Countervailing Duties on Hogs and Pork." Department of Economics, Iowa State University, Ames.

Meilke, K.D., and E. van Duren. 1990. "Economic Issues in the U.S. Countervail Case Against Canadian Hogs and Pork." In *Canadian Agricultural Trade: Disputes, Actions, Prospects,* G. Lermer and K.K. Klein, eds. Calgary: University of Calgary Press.

Moschini, G. 1988. "The Cost Structure of Ontario Dairy Farms: A Microeconometric Analysis." *Canadian Journal of Agricultural Economics* 36: 187-206.

Moschini, G., and A. Vissa. 1991. "Flexible Specification of Mixed Demand Systems." Paper presented at the American Agricultural Economics Association meeting, Manhattan, KS, August.

Nerlove, M. 1956. "Estimates of Supply of Selected Agricultural Commodities." *Journal of Farm Economy* 38: 496-509.

Nerlove, M. 1958. *The Dynamics of Supply: Estimation of Farmers Response to Price.* Baltimore, MD: Johns Hopkins University Press.

Spencer, B.J. 1988. "Capital Subsidies and Countervailing Duties in Oligopolistic Industries." *Journal of International Economics* 25: 45-69.

van Duren, E., and L. Martin. 1989. "The Role of Economic Analysis in Countervailing Duty Disputes: Cases Involving Agriculture." *Canadian Public Policy* XV: 163-74.