Evaluating the Impacts of the U.S. Department of Commerce's Preliminary Imposition of Tariffs on U.S. Imports of Canadian Live Cattle

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Research Discussion Paper No. 34
August 1999

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Introduction

In January 1999, the U.S. International Trade Commission (ITC) ruled that U.S. cattle producers may have been materially injured by Canadian live cattle imports. The ruling was in response to a petition filed by the Ranchers-Cattlemen Action Legal Fund (R-CALF). On June 30, 1999, the U.S. Department of Commerce's Import Administration of the International Trade Administration issued a preliminary ruling instructing the U.S. Customs Service to require cash deposits or bonds totaling 4.73 percent (and subsequently increased to 5.57 percent) of the value of imported live Canadian cattle. The ruling was based on a preliminary conclusion that Canadian feedlot managers had sold live cattle to U.S. purchasers below the "normal value" of those cattle in Canada. The Department of Commerce is expected to issue a final ruling on this petition in the Fall of 1999.

The purpose of this article is to evaluate the potential effects of a 5.57 percent tariff on imported live cattle from Canada. We consider the impacts on import quantities of Canadian live cattle, U.S. and Canadian slaughter and feeder cattle prices, and Montana and Washington feeder cattle prices.

General Implications of Imposing a Tariff

Trade in live cattle and beef between the United States and Canada is highly integrated (Young and Marsh). In 1998, U.S. beef packers imported 3–4 percent of all cattle processed in U.S. plants from Canada. Approximately 75 percent of those imports were fed steers and heifers with the remainder being cull cows and bulls (National Cattlemen's Beef Association). In addition, the U.S. imports beef carcasses and boxed beef from Canada. However, Canada is the third largest market for U.S. beef exports. In addition, the United States exported a small number

of live cattle to Canada in 1998—the majority being feeder cattle from Montana and Washington. This section presents a theoretical model of the potential effects on U.S. and Canadian cattle markets of an *ad valorem* tariff on U.S. imports of Canadian live cattle.

The Canadian and U.S. markets for Canadian-produced live cattle are represented in Figure 1. The Canadian domestic market is represented in Figure 1(a) where S_D^C and D_D^C represent the domestic supply and demand functions for Canadian live cattle. In the absence of trade, the Canadian domestic equilibrium price is P_0 with traded quantity Q_0. At prices above P_0, there is a surplus or excess supply of Canadian live cattle available for export to the United States which is Canada's only viable market for live cattle exports.

Assuming that there are no tariffs, the excess supply of Canadian cattle exports is shown as ES^C in Figure 1(b). This function, which has its origin at the Canadian domestic equilibrium price P_0, is constructed as the horizontal difference between Canadian domestic quantity supplied and quantity demanded at prices above P_0. In Figure 1(b), D_{US}^C represents the import demand for Canadian fed cattle by U.S. packers.

Under free trade, the U.S. market for Canadian fed cattle imports will be in equilibrium at the market price P_1 with imports equal to M_1. For simplicity of exposition, assume that transportation costs are zero. The free trade equilibrium price in the Canadian market is P_1 with domestic production Q_1^P, domestic consumption Q_1^C, and exports M_1 which equal (by construction) U.S. imports of Canadian live cattle.

An *ad valorem* (proportional) tariff *'t'* imposed by the United States increases the after-tariff import cost of fed cattle to $(1+t)P^C$, where P^C is the pre-tariff price received by Canadian

exporters. The proportional tariff shifts the after-tariff excess supply curve to ES_T^C in Figure 1(b).[1] The tariff raises the U.S. purchase price of Canadian fed cattle imports to P_2^{US}, reduces U.S. imports to M_2, and results in a dollar denominated tariff of 'T' which is equal to (tP_2^C). In the Canadian domestic market, Figure 1(a) indicates that the U.S. tariff reduces the Canadian price to P_2^C, reduces Canadian domestic live cattle production to Q_2^P, increases domestic consumption to Q_2^C, and reduces Canadian exports to the United States to M_2.

Decreases in Canadian live cattle prices and domestic production resulting from a tariff have implications for the Canadian feeder cattle market. Likewise, associated increases in the price of Canadian live cattle imports in the United States and the reduction in import volume also have consequences for the U.S. feeder cattle market. These effects are illustrated in Figure 2. Figure 2(a) represents the Canadian feeder cattle market. The pre-tariff domestic demand curve for feeder cattle is D_0^{CF} and the total supply of feeder cattle from both Canada and the United States is S_{TOT}^C. The pre-tariff equilibrium price and traded quantity in the Canadian feeder cattle market are P_0^{CF} and Q_0^{CF}. A U.S. import tariff reduces prices received by Canadian feedlots for any given quantity of cattle exports and decreases Canadian demand for feeder cattle to D_1^{CF}. Thus, the Canadian domestic feeder cattle price is reduced to P_1^{CF} and Canadian purchases of feeder cattle decline to Q_1^{CF}.

Figure 2(b) illustrates the U.S. feeder cattle market with initial domestic supply and demand curves for feeder cattle represented by S^{USF} and D_0^{USF}. The pre-tariff equilibrium price is P_0^{USF} and the traded quantity is Q_0^{USF}. As illustrated in Figure 1, an import tariff increases the price of Canadian fed cattle to U.S. packers and increases the demand for U.S. live cattle. Resulting

[1]Note that the vertical intercept of the new excess supply curve is at $(1+t)P_0$ and that the slope of the new excess supply curve (ES_T^C) is steeper than the initial excess supply curve (ES^C). This is the consequence of an *ad valorem* tariff. A fixed or specific tariff would simply result in a vertical parallel shift of the excess supply curve.

increases in U.S. live cattle prices (at any given output level) will increase the U.S. demand for feeder cattle which is illustrated by a shift in the U.S. feeder cattle demand curve to D_1^{USF} in Figure 2(b).[2] The consequence is an increase in the price of U.S. feeder cattle to P_1^{USF} and in U.S. feeder cattle production to Q_1^{USF}.

The above analysis focuses on short-run adjustments. In addition, the analysis treats the U.S. feeder cattle market as a single integrated market. However, the effects of the tariff on the demand for feeder cattle in different regions of the United States may be somewhat different, depending on whether or not, prior to the tariff, those regions could deliver feeder cattle to Canadian feedlots (as could Montana and Washington). Hence, reductions in the demand for feeder cattle in Canada will reduce Canadian bid prices of Montana and Washington feeder cattle and partially offset price increases caused by reduced U.S. imports of Canadian live cattle.

Model Development

The U.S. beef packing industry has been characterized by excess capacity in recent years (Lesser; Ward). With retail beef demand declining since the late 1970s and technological change increasing livestock weights, resulting declines in real slaughter cattle prices have reduced U.S. cattle inventories (Marsh 1999). Consequently, excess beef packing capacity has emerged in the U.S. beef processing industry relative to the 1970s (when larger inventories caused packers to expand capacity). U.S. beef packers, particularly in the northern tier regions of the United States (Washington, Utah, and Colorado), have had difficulties maintaining livestock slaughter numbers and plant efficiencies due to declining U.S. cattle inventories and relocation of feedlots to the Southern Plains. Thus, imports of Canadian slaughter cattle have been necessary to better utilize

[2] A secondary effect of an import tariff is an increase in the supply of feeder cattle to U.S. feedlots as fewer numbers of feeder cattle are exported to Canadian feedlots from Montana and Washington. Because Montana and Washington exported fewer than 100,000 head of feeder cattle to Canada in 1998, the effect is assumed to be small enough to be ignored in the analysis presented in this section.

slaughter and fabrication capacities and to meet expanding export demands for table cut beef. Canadian feedlots and meat packers, on the other hand, rely upon the U.S. market for select-to-choice grades of live cattle and carcasses because Canadian domestic beef production exceeds Canadian consumer demands (Young and Marsh). Transportation and market distances also make it more economical for Western Canadian cattle to be processed in the United States and for Midwest U.S. packers to sell beef into Eastern Canada (Hayes, Hayenga, and Melton).

U.S. beef packers have an excess demand for live cattle while Canada has an excess supply of live cattle. Our empirical model focuses on the U.S. quantity demanded of imported Canadian live cattle and on cattle price changes resulting from the imposition of the import tariff described above. The theoretical construct of import demand is based upon firms maximizing expected utility of profits (Hooper and Kohlhagen). In the case of a meat packer purchasing a raw commodity (cattle) to be transformed into an edible retail product (steaks, roasts, ground beef), import demand is considered a derived demand (Hooper and Kohlhagen; Tomek and Robinson). With certain modifications, an import demand specification parallels the domestic derived demand for live cattle (Brester and Marsh; Marsh 1992; Wohlgenant).

The following represents a quarterly model of the U.S. market for Canadian live cattle:

(1) $QM_t^d = f_1(PSCA_t, PBXUS_t, PBPUS_t, FMKUS_{t-1}, DTF, S_i, QM_{t-1}^d)$ (U.S. import demand)

(2) $QM_t^s = f_2(PSCA_t, PSUS_t, Z_t, S_i, QM_{t-1}^s)$ (Canada export supply)

(3) $QM_t^d = QM_t^s = QM_t$ (market clearing)

In the U.S. import demand equation, QM_t^d is U.S. import demand for Canadian fed and nonfed live cattle (thousand head); $PSCA_t$ is the real demand price of Canadian slaughter steers (the price of Alberta A1 slaughter steers converted to U.S. dollars/cwt are used as a proxy for the

price of Canadian live cattle); $PBXUS_t$ is the real U.S. boxed beef cutout value of Choice 1–3, 550–700 pound carcasses (dollars/cwt); $PBPUS_t$ is the real U.S. price of beef by-products, hide and offal (cents/lb); $FMKUS_{t-1}$ is a one-quarter lag in U.S. 7-State fed cattle marketings from feedlots possessing 1,000 head or larger capacities (thousand head); DTF is a binary variable representing U.S. tariffs on imported slaughter cattle (1 if tariff exists, 0 if tariff does not exist); and S_i represents three seasonal binary variables (i=quarters 2, 3, and 4). In the Canadian export supply equation, QM_t^s is Canadian fed and nonfed live cattle exports to the United States (thousand head); $PSUS_t$ is the price of Choice, U.S. slaughter steers; and Z_t represents a vector of export supply shifters.

Equation (1) indicates that the U.S. import demand for Canadian live cattle depends upon the real price (packer input cost) of Canadian live cattle (measured in U.S. dollars by adjusting the Canadian dollar price of slaughter steers by the Canadian/U.S. exchange rate), the real output price of U.S. boxed beef products sold to retailers, the real value of U.S. by-products (joint products) in slaughtering and processing, lagged U.S. fed cattle marketings which approximate domestic supplies available to satisfy packer capacity requirements, U.S. trade restrictions (tariffs) on Canadian live cattle imports, and seasonal intercept shifts. Because import demand is based upon quarterly observations, the specification of equation (1) includes a Koyck partial adjustment process, i.e., a first-order difference equation implying geometric distributed lags (Pindyck and Rubinfeld, pp 230–236). Partial adjustment models proxy dynamic behavior which occurs because of biological, institutional, and expectational constraints (Marsh 1988). Therefore, by including a lagged dependent variable (QM_{t-1}^d) in equation (1), a tariff shock is recognized to cause both short- and long-run adjustments in quantity demanded of imports and subsequent U.S. slaughter and feeder cattle prices.

Equation (2) indicates that Canadian live cattle exports to the United States are dependent upon the price of cattle in the United States, the price of cattle in Canada, seasonality, and other (unspecified) supply shifters. Supply shifters could include Canadian feed costs, cattle inventories, interest rates, etc. Market clearing conditions are assumed (equation (3)).

The U.S. Live Cattle Import Demand Function

We quantify the general functions noted in Figure 1 by linearizing demand and supply functions around 1998 average quarterly prices and quantities using elasticity estimates. An estimate of the import demand price elasticity is required to quantify the impacts of a tariff imposed on U.S. imports of Canadian live cattle. The import demand function (equation (1)) expressed in double log form is:

$$(4) \qquad ln(QM_t) = \beta_0 + \beta_1\, ln(PSCA_t) + \beta_2\, ln(PBXUS_t) + \beta_3\, ln(PBPUS_t) + \beta_4\, ln(FMKUS_{t-1}) + \beta_5\, DTF + \beta_6\, S2 + \beta_7\, S3 + \beta_8\, S4 + \lambda_m\, ln(QM_{t-1}) + \mu_\tau,$$

where S2, S3, S4 are binary variables for the second, third, and fourth quarters, respectively, the β_i's are parameters to be estimated, and μ_τ is a white noise error term.

The Canadian Live Cattle Export Supply Function

Estimating the Canadian export supply function, equation (2), is problematic because of data limitations regarding supply shifters, and because the export supply function is probably more variable than the import demand function. Hence, econometric estimation of equation (2) is hampered by identification problems. Therefore, we use an excess supply model to estimate the export supply price elasticity.

Canadian live cattle exports can be represented by an excess supply function:

(5) $E(P) = S(P) - D(P)$,

where E is the quantity of Canadian live cattle exports, P is the price of Canadian live cattle, S is Canadian domestic live cattle output, and D is the Canadian domestic (derived) demand for live cattle (Brester). The response of cattle exports to a change in the price of cattle is found by differentiating equation (5) with respect to P:

(6) $dE/dP = dS/dP - dD/dP$.

Multiplying equation (6) by P/E converts the function to an elasticity form:

(7) $(dE/dP)(P/E) = (dS/dP)(P/E) - (dD/dP)(P/E)$,

or;

(8) $\epsilon_E = (dS/dP)(P/E) - (dD/dP)(P/E)$,

where ϵ_E is the own-price elasticity of excess supply of Canadian cattle with respect to the Canadian price of cattle. To express ϵ_E in its share form, the first term on the right-hand side of equation (8) is multiplied by P/S and its reciprocal. Likewise, the second term on the right-hand side of equation (8) is multiplied by P/D and its reciprocal. Combining these two steps yields:

(9) $\epsilon_E = (dS/dP)(P/S)(P/E)(S/P) - (dD/dP)(P/D)(P/E)(D/P)$,

Solving equation (5) for D and substituting the result into the second term on the right-hand side of equation (9) yields:

(10) $\epsilon_E = (1/s)\epsilon_C - [(1-s)/s]\eta_C$,

where *s* is the share of Canadian cattle production that is exported (i.e., *s* = E/S), ϵ_C is Canadian cattle producers' own-price elasticity of supply of cattle, and η_C is Canadian packing plants' own-price elasticity of (derived) demand for cattle.

Tariff Impacts on U.S. and Canadian Slaughter and Feeder Cattle Prices

Linearizing the import demand and excess supply elasticities (and normalizing using 1998 average quarterly price and quantities) allows for the calculation of price and quantity impacts on the Canadian and U.S. cattle industries. Thus, the elasticities are used to calculate the resulting equilibrium subsequent to the provisional import tariff. The tariff will reduce U.S. live cattle imports from Canada, and thus, increase U.S. slaughter cattle price. The change in U.S. slaughter cattle price can be estimated as follows:

$$\Delta(PSUS_t) = \left(\frac{\Delta QM_t}{QUS_t} \right) E_f^u \ (PSUS_t) \ , \tag{11}$$

where Δ represents "change", $PSUS_t$ is the price of U.S. slaughter cattle, QM_t is quarterly live cattle imports from Canada, QUS_t is quarterly U.S. fed and nonfed cattle slaughter, and E_f^u is the price flexibility of U.S. slaughter cattle prices with respect to quantity of U.S. cattle slaughtered. In equation (11), the change in U.S. slaughter price caused by a change in import quantities is obtained by multiplying the change in market share of Canadian imports of U.S. slaughter by the price flexibility (E_f^u) and the price of U.S. slaughter cattle.

An increase in U.S. slaughter cattle prices is expected to increase U.S. feeder cattle prices. The dollar/cwt impact on U.S. feeder cattle prices resulting from the 5.57 percent import tariff change is estimated as:

$$(12) \qquad \Delta(\mathrm{PFUS}_t) = \left(\frac{\partial PFUS_t}{\partial PSUS_t}\right) \Delta(\mathrm{PSUS}_t),$$

where PFUS_t is the price of feeder cattle in the United States In equation (12), the change in U.S. feeder prices ($\Delta(\mathrm{PFUS}_t)$) is estimated by multiplying the change in U.S. slaughter cattle prices ($\Delta(\mathrm{PSUS}_t)$ obtained from equation (11)) by the price transmission between U.S. slaughter and feeder cattle. The price transmission between U.S. slaughter and feeder cattle prices is estimated as:

$$(13) \qquad \mathrm{PFUS}_t = \gamma_0 + \gamma_1 \mathrm{PSUS}_t + \gamma_2 \mathrm{PCUS}_t + \gamma_3 S2 + \gamma_4 S3 + \gamma_4 S4 + \lambda_p \mathrm{PFUS}_{t-1} + \psi_t$$

where PCUS_t is the price of corn in the United States, γ_i's are parameters to be estimated, and ψ_t is a white noise error term.

As noted above, the imposition of an import tariff will, *ceteris paribus*, reduce U.S. live cattle imports and increase average U.S. slaughter cattle prices. But the tariff will also reduce slaughter cattle prices in Canada, and subsequently reduce Canadian derived demand for feeder cattle. This implies that Canadian feedlot managers will lower bid prices for feeder cattle from all sources (including Montana and Washington—the two U.S. States which export feeder cattle to Canada under the Northwest Pilot Project).

The impact on Canadian bid prices for feeder cattle (in U.S. dollars/cwt) is estimated as:

$$(14) \qquad \Delta(\mathrm{PFCA}_t) = \left(\frac{\partial PFCA_t}{\partial PSCA_t}\right) \Delta(\mathrm{PSCA}_t),$$

where PFCA_t is the price of feeder cattle in Canada. In equation (14), the change in Canadian

feeder price ($\Delta(PFCA_t)$) is estimated by multiplying the price transmission between Canadian slaughter cattle and feeder cattle by the change in Canadian slaughter cattle prices (Figure 1). The price transmission between Canadian slaughter and feeder cattle prices is estimated as:

$$(15) \qquad PFCA_t = \delta_0 + \delta_1 PSCA_t + \delta_2 PBCA_t + \delta_3 S2 + \delta_4 S3 + \delta_4 S4 + \lambda_c PFCA_{t-1} + \zeta_t$$

where $PBCA_t$ is the price of barley in Canada, δ_i's are parameters to be estimated, and ζ_t is a white noise error term.

Finally, reductions in bid prices for feeder cattle in Canada will reduce feeder cattle prices in Montana and Washington. The impact is calculated as follows:

$$(16) \qquad \Delta(PFMW_t) = \left(\frac{\Delta QEMW_t}{QMW_t} \right) \Delta(PFCA_t) \ ,$$

where $PFMW_t$ is the price of feeder cattle in Montana and Washington, QEMW is the quantity of feeder cattle exported to Canada from Montana and Washington, and QMW is the total quantity of calves produced in Montana and Washington (previous year calf crop). Equation (16) indicates the "change" in Montana and Washington feeder prices ($\Delta(PFMW_t)$) is estimated by multiplying the export market share of Montana and Washington feeder cattle with respect to the sum of calf crops in the two states by the change (reduction) in feeder cattle bid prices in Canada. The "total" impact on Montana and Washington feeder cattle prices is the sum of the increase in U.S. feeder cattle prices as a result of the tariff (equation (12)) and the decrease in Canadian derived demand for Montana/Washington feeder cattle (equation (16)).

Data and Estimation Technique

Quarterly data from 1988 to 1998 are used to estimate equations (4), (13), and (15). Table 1 presents variable names and definitions. All U.S. price and quantity data were obtained from the USDA's *Red Meat Yearbook*, the USDA's *Livestock, Dairy, and Poultry Situation and Outlook* reports, and the Livestock Marketing Information Center. All U.S. prices were deflated by the Consumer Price Index (CPI, 1982-84=100) obtained from the *Economic Report of the President*. Canadian livestock price data were obtained from CANFAX, a division of the Canadian Cattlemen's Association, and feed price data were obtained from the Alberta Grain Commission. All Canadian prices are deflated by the Canadian CPI (1990=100), and converted to U.S. dollars using the Canadian/U.S. exchange rate. Canadian CPI and exchange rate data were obtained from *International Financial Statistics* of the International Monetary Fund. According to the Canadian Market and Industry Services Branch's *Livestock Market Review*, U.S. tariffs on imported Canadian live cattle existed from 1988:1 through 1991:4.

Each equation is estimated using Ordinary Least Squares (OLS) with allowance for first-order autoregressive errors using the Cochrane-Orcutt procedure (Pindyck and Rubinfeld, pp 163–64). Correlation tests on cross-equation residuals failed to show a significant nondiagonal covariance error structure. In addition, the Canadian steer price variable in equation (4) was subjected to a Hausman specification test which failed to reject the null hypothesis of an exogenous regressor. The Augmented Dickey-Fuller Unit Root (ADF) test indicated several model variables contained unit roots (Pindyck and Rubinfeld, pp 507–510); however, applying the ADF test to the equation residuals rejected the null hypothesis of unit roots in the errors. These results indicate the equations are cointegrated and can be estimated in data-level form (Johnston and DiNardo, pp 259–269).

Empirical Results

U.S. Import Demand Elasticity for Canadian Live Cattle

The estimated regression model for U.S. import demand for Canadian live cattle (equation (4)) is:

$$
\begin{aligned}
(17)\quad ln(QM_t) = {} & -2.90 - 1.79\ ln(PSCA_t) + 1.52\ ln(PBXUS_t) + 0.09\ ln(PBPUS_t) \\
& \quad (-0.55)\ (-2.20) \qquad\qquad (1.93) \qquad\qquad (0.30) \\
& - 0.13\ ln(FMKUS_{t-1}) - 0.12\ DTF - 0.09\ S2 - 0.31\ S3 - 0.19\ S4 \\
& \quad (-1.81) \qquad\qquad (-1.58) \quad (-0.86) \quad (-3.86) \quad (-1.80) \\
& + 0.70\ ln(QM_{t-1}) - 0.44\ \rho_{t-1} \\
& \quad (7.54) \qquad (-2.55)
\end{aligned}
$$

$\overline{R}^2 = 0.800$ S.E. = 0.156 $\overline{Y} = 12.45$ Dh = -0.25

$t^* = 1.697$ at α=0.10 $t^* = 2.042$ at α=0.05,

where $\overline{R}^2$ is the adjusted R-squared, S.E. is the Standard Error of Estimate, $\overline{Y}$ is the log mean of the dependent variable, and Dh is the Durbin *h* statistic. The critical t-values (t^*) are provided for α=0.10 and α=0.05 significance levels (32 degrees of freedom).

Coefficient signs in equation (17) are consistent with theoretical reasoning; that is, a negative Canadian slaughter price effect (U.S. packer input costs), a positive U.S. boxed price effect (packer output price), a negative effect of lagged U.S. fed marketings (larger domestic supplies that satisfy capacity reduces demand for slaughter imports), and a negative tariff effect (restrictions/costs are higher during tariff periods which reduces import demand). The short-run import demand price elasticity (-1.79) is relatively elastic. As expected, it is considerably more elastic than the U.S. slaughter demand price elasticity which has been estimated by other researchers [e.g., -0.65 (Marsh 1992) and -0.76 (Wohlgenant]. The larger import demand elasticity is consistent with Canada's small market share of U.S. cattle supplies.

Canadian Excess Supply Elasticity

Equation (10) is used to calculate the Canadian excess supply elasticity. The share 's' of Canadian cattle production that was exported in 1998 was 0.396. Recent Canadian supply and demand elasticity estimates for fed cattle are not available. Given that the Canadian and U.S. markets are highly integrated (Young and Marsh), U.S. estimates are used as proxies for the Canadian supply and demand responses. Marsh (1994) has estimated the short-run U.S. own-price elasticity of supply for fed cattle (ϵ_C) as 0.12. A simple average (-0.71) of Marsh's (1992) (-0.65) and Wohlgenant's (-0.76) estimates is used for the own-price elasticity of derived demand for cattle (η_C). Therefore, the Canadian excess supply elasticity is calculated to be 1.39.

U.S. and Canadian Price Transmission Estimates

The OLS parameter estimates of equation (13) used to obtain the price transmission effects of U.S. slaughter to feeder cattle prices are as follows:

(18) $$PFUS_t = \underset{(1.18)}{4.90} + \underset{(4.21)}{0.57}\, PSUS_t - \underset{(-2.05)}{3.47}\, PCUS_t - \underset{(-0.76)}{1.15}\, S2 - \underset{(-1.94)}{3.15}\, S3 - \underset{(-3.73)}{5.42}\, S4 + \underset{(6.40)}{0.60}\, PFUS_{t-1}$$

$\overline{R}^2 = 0.927$ S.E. = 3.30 $\overline{Y} = 62.55$ Dh = 1.47

$t^* = 1.697$ at α=0.10 t^*=2.042 at α=0.05.

Equation (18) is estimated in levels permitting the use of a dollar/cwt estimate of price transmission effects. Thus, $\overline{Y}$ is the sample mean value of real U.S. feeder cattle price over the sample period. The model indicates a $1/cwt increase in real (quarterly) U.S. slaughter prices increase real (quarterly) U.S. feeder prices by $0.57/cwt. The long-term price transmission is

$1.43/cwt ($0.57/(1-0.60)), where 0.60 is the estimated coefficient of the lagged dependent variable.

An estimate of the price transmission elasticity of Canadian slaughter cattle price to Canadian feeder cattle prices as specified in equation (15) is obtained from the following estimated Canadian price transmission model:

$$(19)\quad PFCA_t = \underset{}{0.24} + \underset{(1.60)}{0.41}\, PSCA_t - \underset{(2.29)}{0.15}\, PBCA_t - \underset{(-3.49)}{0.01}\, S2 - \underset{(-0.35)}{0.01}\, S3 - \underset{(-0.14)}{0.05}\, S4 + \underset{(7.29)}{0.61}\, PFCA_{t-1}$$

$\overline{R}^2 = 0.855$ S.E. = 0.059 $\overline{Y} = 1.03$ Dh = 0.96

$t^* = 1.697$ at α=.010 $t^* = 2.042$ at α=0.05

The estimated price transmission in equation (19) is used in equation (14). The specification of equation (19) parallels that of the U.S. price transmission (equation (13)) except that the price of barley, the dominant feed grain in Canada, is used in place of the price of corn. Results indicate that a one dollar increase in Canadian slaughter price increases Canadian feeder price by $0.41/cwt in the short-run, and by $1.05/cwt in the long-run.

The Effects of Imposing a 5.57 Percent Import Tariff

Assuming No Changes in U.S. Imports of Canadian Beef Carcasses and Boxed Beef

Price and quantity impacts calculated in this section assume that U.S. imports of Canadian beef carcasses and boxed beef do not increase as the result of imposing a tariff on Canadian live cattle. The import demand and export supply elasticity estimates are used to develop linear demand and supply functions normalized around average (quarterly) 1998 slaughter cattle prices and live cattle imports. Table 2 presents estimated short- and long-run

effects for import quantities and U.S. and Canadian slaughter and feeder cattle prices. The analysis of the tariff effect is conditioned upon holding the value of other exogenous variables in the Canadian and U.S. livestock-meat sectors constant.

The overall effects of the tariff are not large, which might be expected since Canadian live cattle exports constitute a relatively small portion of total U.S. cattle slaughter (an annual average of 3.1 percent over the period 1988–1998). We estimate the following short term (one quarter) effects: (1) a decline in Canadian live cattle exports of 13,338 head (or 3.97 percent of 1998 average quarterly imports of 335,869 head); (2) an increase in U.S. slaughter cattle prices of $0.13/cwt and U.S. feeder cattle prices of $0.07/cwt; (3) a decline in Canadian slaughter cattle prices of $1.77/cwt; (4) a decrease in Canadian feeder cattle prices of $0.73/cwt; and (5) a decline in the Canadian derived demand for feeder cattle which results in Montana and Washington feeder cattle prices increasing by a net of $0.05/cwt (a smaller increase relative to the rest of the United States).

The long-term effects of the tariff will be larger because biological and institutional rigidities are more easily circumvented over time. The parameter estimates in equation (17) indicate that the long-run equilibrium will be reached after 2 years. The empirical results show that the longer term price effects, though larger than those of the short term, remain relatively small for the United States However, the long-term effects are relatively large in Canada. Table 2 indicates that the imposition of a 5.57 percent tariff would cause the following quarterly impacts in the long run: (1) U.S. quarterly live cattle imports from Canada would decline by 31,542 head (a 9.39 percent decrease); (2) U.S. slaughter cattle prices would increase by $0.31/cwt; (3) U.S. feeder cattle prices would increase by $0.44/cwt; (4) Montana and Washington feeder cattle

prices would increase by a net of $0.40/cwt; (5) Canadian slaughter cattle prices would decline by $2.17/cwt; and (6) Canadian feeder cattle prices would decline by $2.28/cwt.

Assuming Increases in U.S. Imports of Canadian Beef Carcasses and Boxed Beef

The proposed tariff on imports of Canadian live cattle does not apply to U.S. imports of Canadian beef carcasses or boxed beef. It is likely that U.S. beef packers will increase imports of Canadian carcasses as a replacement for the loss of live cattle imports in order to maintain fabrication line efficiencies. In addition, beef carcasses are more likely to be imported than boxed beef because imported carcasses are eligible to receive USDA grades while boxed beef is not (Hayes, Hayenga, and Melton). If increases in carcasses and/or boxed beef imports offset reductions in live cattle imports, then U.S. and Canadian slaughter and feeder cattle prices will be affected only to the extent that increased costs are imposed on the processing sector. These costs may be borne by beef processors, consumers, producers, or some combination of the three. Hence, over the longer term, U.S. cattle prices could actually decline by a small amount as a result of the tariff.

Summary

U.S. imports of Canadian live cattle represent approximately 3–4 percent of total U.S. live cattle slaughter. If carcass or boxed beef imports do not increase in response to the proposed tariff on U.S. imports of Canadian live cattle, the tariff will generate very small positive impacts on U.S. slaughter and feeder cattle prices. Conversely, an import tariff on Canadian live cattle will likely cause relatively larger (negative) impacts on Canadian slaughter and feeder cattle prices because Canada exports approximately 40 percent of its live cattle production to the United States

The ultimate impacts of the proposed tariff on U.S. live cattle imports from Canada hinge critically upon the actions of the beef processing sector. If beef processors increase imports of Canadian carcass or boxed beef, then much of the small positive effects on U.S. cattle prices of reduced live cattle imports could be offset. In addition, increased imports of Canadian carcass or boxed beef may reduce cattle slaughtering efficiencies which has the potential to increase retail prices and/or reduce cattle prices and processor profitability.

Finally, several other general aspects of this recent trade action are worthy of consideration. For example, the legal and bureaucratic costs associated with this trade dispute have been relatively large for U.S. and Canadian livestock producers and their respective governments. These costs are likely to increase substantially over time as this trade action is challenged under NAFTA and WTO provisions. In addition, the imposition of an import tariff is likely to hamper efforts to expand access and reduce tariff-rate quotas in U.S. beef export markets during the upcoming WTO negotiations. Finally, such trade actions may encourage retaliatory trade actions (for example, Mexico's proposed tariffs on imported U.S. beef, variety meats, and by-products) that could limit U.S. beef exports.

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Figure 1. Canadian and U.S. Markets for Canadian Live Cattle

Figure 1(a). The Canadian Domestic Market for Live Cattle

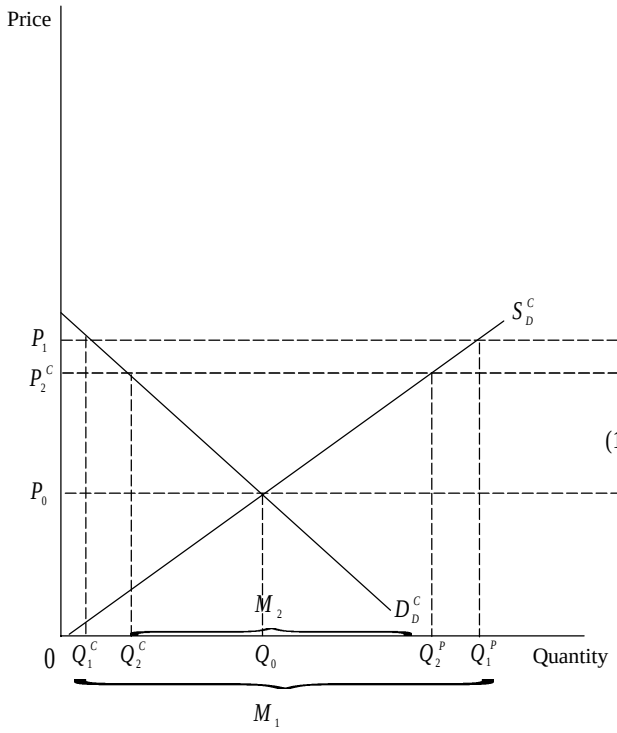

Figure 1(b). The U.S. Market for Canadian Live Cattle

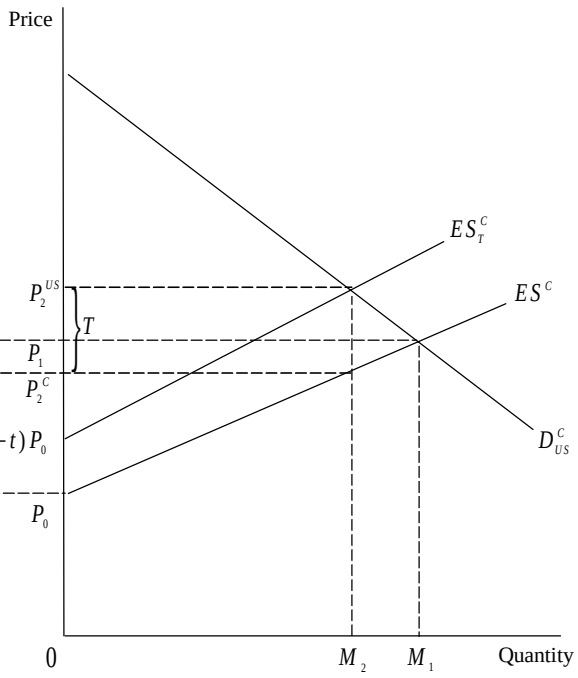

Figure 2. The Canadian and U.S. Feeder Cattle Markets

Figure 2(a). The Canadian Market for Feeder Cattle

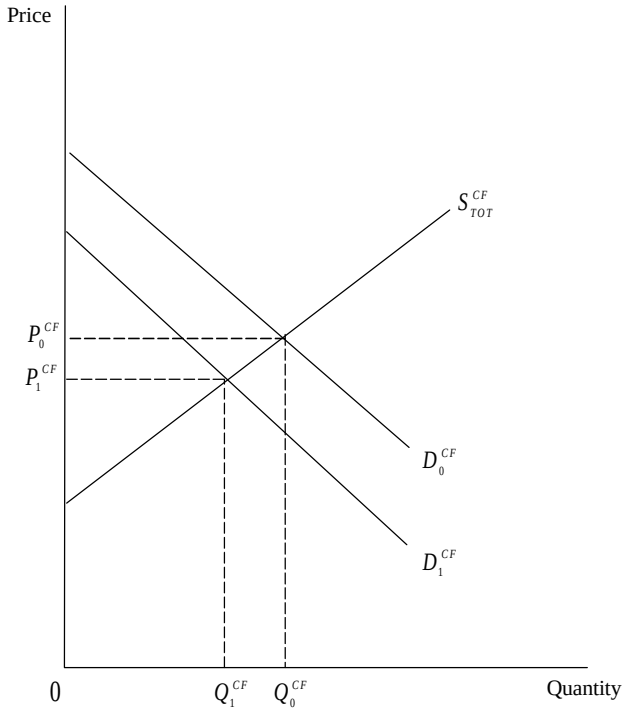

Figure 2(b). The U.S. Market for Feeder Cattle

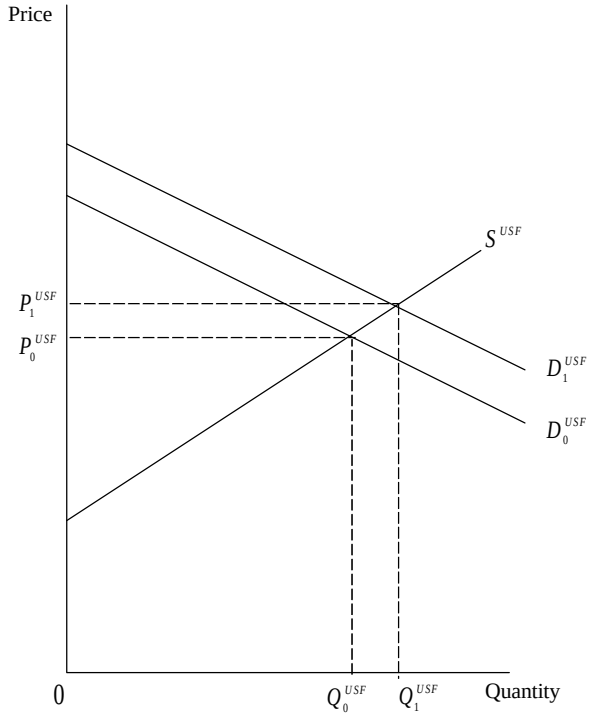

Table 1. Variable Descriptions Used in the Import Demand Model.

Variables	Definition
QM	U.S. imports of Canadian live cattle (thousands of head)
PSCA	Price of Canadian slaughter cattle (Alberta A1 slaughter steers, in U.S. dollars/cwt)
PBXUS	U.S. boxed beef cutout value of Choice 1–3, 550–700 pound carcasses (dollars/cwt)
PBPUS	U.S. price of beef by-products, hide and offal (cents/lb)
FMKUS	U.S. 7-State fed cattle marketings, feedlots with 1,000 head or larger capacities (thousand head)
DTF	A binary variable representing U.S. quarterly tariffs on imported live cattle (1 if tariff exists, 0 if tariff does not exist)
S2, S3, S4	Seasonal binary variables for the second, third, and fourth quarters, respectively (the first quarter is omitted)
PSUS	Price of U.S. slaughter steers, Choice 1–3, Nebraska direct (dollars/cwt)
QUS	Quantity of U.S. cattle slaughtered (thousands of head)
PFUS	Price of U.S. feeder steers, medium nno. 1, 500–550 pounds, Oklahoma City (dollars/cwt)
PCUS	Price of U.S. #2 yellow corn, Central Illinois (dollars/bushel)
PBCA	Price of Canadian feed barley, Alberta (U.S. dollars/cwt)
PFCA	Price of Canadian feeder steers, 500–600 pounds, Edmonton (U.S. dollars/cwt)

Table 2. Impacts of a 5.57% Tariff on U.S. Imports of Canadian Live Cattle and Farm-Level Prices, Assuming No Increases in U.S. Imports of Canadian Beef Carcasses or Boxed Beef.

	Short Run		Long Run	
Changes In:	Price/Quantity Changes	Percentage Changes	Price/Quantity Changes	Percentage Changes
U.S. Imports of Canadian Live Cattle (quarterly)	-13,338 head	-3.97%	-31,542 head	-9.39%
U.S. Slaughter Cattle Price	+$0.13/cwt	+0.21%	+$0.31/cwt	+0.50%
U.S. Feeder Cattle Price	+$0.07/cwt	+0.08%	+$0.44/cwt	+0.53%
Canadian Bids For MT & WA Feeder Cattle	-$0.02/cwt	-0.02%	-$0.04/cwt	-0.05%
Net Price of MT & WA Feeder Cattle	+$0.05/cwt	+0.06%	+$0.40/cwt	+0.48%
Canadian Slaughter Cattle Price (in U.S. Dollars)	-$1.77/cwt	-2.88%	-$2.17/cwt	-3.53%
Canadian Feeder Cattle Price (in U.S. Dollars)	-$0.73/cwt	-0.91%	-$2.28/cwt	-2.85%

Notes: The short-run refers to a single quarter and the long-run refers to cumulative impacts over two or more years. Calculations are based on discussion in text. Long-run calculations involve relevant slope coefficients divided by $(1- \lambda_i)$, where λ_i is the appropriate coefficient of the lagged dependent variable. Mean nominal U.S. slaughter steer price and mean nominal U.S. feeder steer price for 1998 are $61.48/cwt and $83.77/cwt, respectively. Quarterly imports of Canadian cattle for 1998 averaged 335,869 head. Canadian feeder cattle price averaged $79.88/cwt in 1998 (in U.S. dollars).