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Technical Annex

An Economic Assessment of the BSE Crisis in Canada: Impact of Border Closure and BSE Recovery Programs

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This document is the technical annex to the full paper "An Economic Assessment of the BSE Crisis in Canada: Impact of Border Closure and BSE Recovery Programs" which is available separately.

The empirical model captures the essence of the cattle and beef sector while abstracting from the cattle cycle. We take this approach because we want to focus attention on the medium-run consequences of various policy alternatives. It is quite possible that well-intentioned short-run policies have undesirable longer-run consequences. In addition, we want a model that is simple and transparent enough to be easily understood. To explain the short-run effects of policies in the cattle and beef sector, complex dynamic models are required. Not only are these models difficult to construct and to explain, they make the calculation of producer welfare almost

impossible. In addition, regardless of the short-run dynamics, the cattle and beef sector will eventually reflect the fact that the breeding herd will adjust to the profitability in the sector and a breeding herd of a given size will generate a relatively fixed group of animals that must either be slaughtered or exported. Border measures will largely determine the amount of domestic production (cattle and beef) that is processed or consumed at home and how much is exported. It is this medium-run outcome we want to capture, and this also makes the calculation of producer surplus relatively straightforward.

Equation (1) characterizes the critical linkage in the model among cattle inventories, cattle prices, and input prices.

(1) $I = a_1 + a_2 P_o + a_3 P_i; where \;\; P_o = w_y (P_{yc} + sub_{yc}) + w_o (P_{oc} + sub_{oc})$

In equation (1), I is the breeding inventory of cattle, P_o is the average output price, and P_i represents all other input prices. The parameter a_2 in equation (1) shows the medium-run change in the breeding inventory resulting from a unit change in the returns from selling both young and old cattle. The weights w_y and w_o show the average proportions of the total numbers of animals slaughtered that are young and old. *P* denotes price and is expressed in dollars per head, and *sub* denotes the per head subsidy, if any. Subscripts denote the type of product: *yc* refers to young cattle and *oc* refers to old cattle. Production costs, other than the cost of live animals, are treated as constant across all scenarios and are captured in the inventory equations intercept term ($a_0 = a_1 + a_3 P_i$).[1] A constant proportion of the breeding inventory (offspring and cull animals) is slaughtered as young and old cattle. The supply functions for young and old cattle are illustrated in the top two panels of figure 2 in the accompanying article and are described by equations (2) and (3):

(2) $S_{yc} = \lambda_{yc} * I$ supply of young cattle for slaughter;

(3) $S_{oc} = \lambda_{oc} * I$ supply of old cattle for slaughter;

where λ_{yc} is the average proportion of the breeding inventory that is slaughtered as young cattle and λ_{oc} is the average proportion slaughtered as old cattle. The demand for young cattle by processors is a function of the packers' gross margin – the difference between the price of a unit of beef minus the cost of the cattle required to produce the beef.

Equations (4) and (5) characterize the slaughter demands for young and old cattle:

(4) $D_{yc} = c_{yc} + d_{yc}(P_{yb} - \Phi_{yc} \cdot P_{yc})$ slaughter demand for young cattle;

(5) $D_{oc} = Min\{(c_{oc} + d_{oc}(P_{ob} - \Phi_{oc} \cdot P_{oc})), \;\; \overline{D}_{oc}\}$ slaughter demand for old cattle;

where $\overline{D}_{oc}$ is the maximum slaughtering capacity. The constant Φ shows the quantity of cattle required to produce one unit of beef (Moschini and Meilke, 1992). The demand for old cattle by packers uses the same specification as that for young cattle, except that a capacity constraint in processing old beef is incorporated into equation (5) by kinking the demand curve and making it completely price inelastic at the capacity constraint. Equations (4) and (5) are the cattle demand functions shown in the top two panels of figure 2.

The supply of beef is a constant proportion of the cattle slaughtered:

(6) $S_{yb} = cf_{yc} * D_{yc}$ supply of young beef;

(7) $S_{ob} = cf_{oc} * D_{oc}$ supply of old beef;

where *cf* is the cold carcass weight, subscript *yb* denotes young beef, and subscript *ob* denotes old beef.

In the empirical model consumers treat young and old beef as substitutes, and the final demands for both products are functions of both prices (equations 8 and 9). The demand functions for old and young beef are illustrated in the bottom two panels of figure 2; these functions, together with the supply of domestic beef (calculated from the number of cattle slaughtered), determine domestic beef prices under autarky, or the quantity of beef traded under free trade.

(8) $D_{yb} = f_{yb} - g_{yb}P_{yb} + h_{yb}P_{ob}$ demand for young beef

(9) $D_{ob} = f_{ob} + g_{ob}P_{yb} - h_{ob}P_{ob}$ demand for old beef

Direct government expenditures on subsidy programs are calculated as

(10) $GE = sub_{yc} * S_{yc} + sub_{oc} * S_{oc}$

The appropriate market-clearing conditions depend on the assumptions made with respect to the trading regime. These applicable market-clearing conditions are shown below for free trade, autarky, trade in young beef only (baseline), and trade in young beef and cattle only.

For free trade: Equations (11), (12), (13), and (14) impose the small-country assumption, where *x* is the C$/US$ exchange rate and *T* represents the basis between the relevant U.S. cash market and the Canadian cash market when free trade prevails. For all four products it is assumed that Canada is an exporter.

(11) $P_{yc} = P_{yc}^{us} \cdot x - T_{yc}$

(12) $P_{oc} = P_{oc}^{us} \cdot x - T_{oc}$

(13) $P_{yb} = P_{yb}^{us} \cdot x - T_{yb}$

(14) $P_{ob} = P_{ob}^{us} \cdot x - T_{ob}$

For autarky: Canadian supply is equated to Canadian demand to generate market-clearing prices.

(11') $S_{yc} = D_{yc}$

(12') $S_{oc} = D_{oc}$

(13') $S_{yb} = D_{yb}$

(14') $S_{ob} = D_{ob}$

For trade in young beef only (baseline): The market-clearing conditions are shown below.

(11'') $S_{yc} = D_{yc}$

(12'') $S_{oc} = D_{oc}$

(13'') $P_{yb} = P_{yb}^{us} \cdot x - T_{yb}$

(14'') $S_{ob} = D_{ob}$

For trade in young beef and young cattle only: The market-clearing conditions are shown below.

(11''') $P_{yc} = P_{yc}^{us} \cdot x - T_{yc}$

(12''') $S_{oc} = D_{oc}$

(13''') $P_{yb} = P_{yb}^{us} \cdot x - T_{yb}$

(14''') $S_{ob} = D_{ob}$

In all cases, Canada's net exports (E) of cattle and beef are calculated from the identities shown below.[2]

(15) $E_{oc} = S_{oc} - D_{oc}$

(16) $E_{yc} = S_{yc} - D_{yc}$

(17) $E_{ob} = S_{ob} - D_{ob}$

(18) $E_{yb} = S_{yb} - D_{yb}$

The gross revenue of cattle producers is calculated using equation (19).

(19) $TR = S_{oc} \cdot (P_{oc} + sub_{oc}) + S_{yc} \cdot (P_{yc} + sub_{yc})$

This static, medium-run model contains 20 endogenous variables ($D_{yc,}$ $D_{oc,}$ $D_{yb,}$ $D_{ob,}$ $S_{yc,}$ $S_{oc,}$ $S_{yb,}$ $S_{ob,}$ $E_{yc,}$ $E_{oc,}$, $E_{yb,}$ $E_{ob,}$ $GE,$ $I,$ $P_{yc,}$ $P_{oc,}$ $P_{yb,}$ $P_{ob,}$ $P_{o,}$ TR); 13 exogenous variables ($\overline{D}_{oc}, P_{yc}^{us}, P_{oc}^{us}, P_{ob}^{us}, P_{yb}^{us}, sub_{oc}, sub_{yc}, x, T_{yc}, T_{oc}, T_{yb}, T_{ob}, P_i$); 8 technical coefficients ($cf_{yc,}$ $cf_{oc,}$ $\Phi_{yc,}$ $\Phi_{oc,}$ $\lambda_{yc,}$ $\lambda_{oc,}$ $w_{y,}$ w_o); and 12 parameters (a_0, a_2, $c_{yc,}$ $d_{yc,}$ $c_{oc,}$ d_{oc}, $f_{yb,}$ $g_{yb,}$ h_{yb}, $f_{ob,}$ $g_{ob,}$ and h_{ob}).

When the policy shocks are introduced they are handled in the following ways:

i. Slaughter capacity expansion: increase the intercept of the old cattle demand function (equation 5) and capacity limit by 10 percent.
ii. Destruction of a part of the cattle herd: shift the breeding herd inventory function to the left by 10 percent (equation 1).
iii. Subsidy on slaughter of old cattle: create a wedge between the price producers receive and the price packers pay (sub_{oc}) by an amount equivalent to the per head payment (equation 1).

Data and Parameters

The model is calibrated using 2004 data. Hence, the baseline data represent the situation where the border is open to trade in young beef but not to trade in live animals or old beef. The data maintained by Agriculture and Agri-Food Canada (AAFC, 2003) and utilized in its Food and Agriculture Regional Model (FARM) are the main data source. Where FARM data are insufficient they are augmented with data from CANSIM (Statistics Canada) and other AAFC sources (AAFC (annual), 2004a, 2004b). Steers, heifers, and calves are considered young animals while bulls and cows are considered old animals.

Cattle market

The number of animals slaughtered and the breeding inventory are measured in thousands of head. Cattle slaughter is delineated by the type of animal: steers (2,001.46), heifers (1,383.73), bulls (52.67), and cows (465.73). The number of calves slaughtered is 353 (Statistics Canada). The total number of old and young animals slaughtered are 518.40 and 3,738.19 thousand head, respectively. The total number of animals slaughtered in 2004 is 4,256.59 thousand head. Therefore, 12.18 percent and 87.82 percent of total slaughter consisted of old and young animals, respectively, and these percentages are the weights used for the old (w_o) animal price and young (w_y) animal price in the inventory equation (equation 1).

These animals originated from a breeding inventory that contained 239.7 thousand head of bulls, 1,065.3 thousand head of dairy cows, and 4,752.1 thousand head of beef cows.[3] The total breeding inventory is 6,057.10 thousand head, from which 8.56 percent were slaughtered as old cattle (culls) and 61.72 percent were slaughtered as young cattle (offspring). Therefore, 8.56 percent and 61.72 percent are used as the technical coefficients (λ_{oc} and λ_{yc}) in the old and young cattle supply equations (equations 3 and 2).

Beef market

Beef production, exports, imports, and consumption are measured in thousands of metric tonnes. The number of animals slaughtered is multiplied by the respective cold carcass weight to obtain old and young beef production of 162.84 and 1,280.31 thousand tonnes, respectively (table 1). All exports of beef in 2004 are young beef, and net exports are 466.37 thousand tonnes.[4] Beef consumption levels are obtained by adjusting beef production for net exports. Accordingly, young beef consumption is 813.94 thousand tonnes.[5] Old beef consumption in 2004 is 162.84 thousand tonnes.

Table 1 Data for Carcass Weights, Cattle Slaughter, and Beef Production

Type of animal	Number slaughtered ('000 head)	Dressing percentage (percent)	Cold carcass weight (kg)	Beef production ('000 tonnes)
steers	2001.46	58.5	375.39	751.33
heifers	1383.73	57.0	350.79	485.40
bulls	52.67	48-58	460.34	24.25
cows	465.73	40-50 for dairy 50-60 for beef	297.59	138.60
calves	353.05	50.0	123.46	43.59

Source: Calculated by authors using secondary data.

Prices

The Canadian cow price ($23.36 per 100 pounds (cwt) in live weight) and steer price ($77.89 per cwt live weight) are indicative of the domestic prices of old and young cattle in 2004. The price per head is obtained by multiplying the price by cold carcass weight and dividing by the respective dressing percentage (table 1). The dressing percentages for bulls, dairy cows, and beef cows are in the ranges of 48 to 58, 40 to 50, and 50 to 60, respectively. For steers, heifers, and calves, the dressing percentages are 58.5 percent, 57 percent, and 50 percent, respectively. The weighted-average dressing percentages for old and young cattle are 50.30 percent and 57.14 percent, respectively. The average cold carcass weight of an old animal is 692.53 pounds (the weighted average of bulls and cows obtained as 0.11*1014.87+0.89*656.07, where 0.11 and 0.89 are the shares of bulls and cows in old cattle, and 1,014.87 and 656.07 are their cold carcass weights, respectively). The average cold carcass weight of a young animal is 805.42 lbs (the weighted average of steers and heifers obtained as

0.59*827.59+0.41*773.35, where 0.59 and 0.41 are the shares of steers and heifers in young cattle, and 827.59 and 773.35 are their cold carcass weights, respectively). The resulting old and young cattle live weights are 1,376.63 and 1,409.51 pounds, respectively, and the prices per head are $321.45 and $1097.87 per head, respectively.

Cattle prices in the United States for boning utility cows and choice steers are treated as old and young cattle prices. However, the closed border in 2004 distorted these prices. When we model partial or complete border opening we want to capture the normal relationship between Canadian and U.S. prices. To do this we calculate the cash market basis (U.S. cash market price minus the Canadian cash market price) between Canada and the United States in 2002 (the year prior to the discovery of BSE). The price of old cattle in 2002 in Canada was $58.51/cwt live weight, and the U.S. price after adjusting for the exchange rate (1.57 in 2002) was $61.64/cwt live weight. Prices per head of old cattle in Canada and in the United States in 2002 were $805.49 and $848.55, respectively. Hence, the old cattle basis in 2002 was $43.06/head. The 2002 price of young cattle in Canada was $98.74/cwt live weight, and the U.S. price after adjusting for the exchange rate was $105.25/cwt live weight; hence, the 2002 basis for young cattle was $91.80/head.

According to AAFC, the price of beef sides in Canada, which is used as the young beef price, was $4.96/kg ($4,960/tonne) in 2004. The U.S. equivalent price for young beef is assumed to equal the Canadian price, adjusted for exchange rates, since young beef was freely traded in 2004.[6]

The prices for low-quality beef in Canada in 2004 and 2002 were $113 and $129.3/cwt ($2,506.66 and $2,851.24/tonne), respectively. The U.S. price of low-quality beef reported in the FARM database is taken to represent the price for old beef in the United States (AAFC, 2003). It was US$64.17/cwt ($100.74/cwt or $2,221.09/tonne) in 2002. Hence, the basis in 2002 was –$630.10 per tonne.[7]

The cold carcass weight of cattle is used in determining the production of beef. The cold carcass weight of a young animal is 805.42 lbs (0.365 tonnes). This number implies that one young animal is used to produce 0.365 tonnes of beef, or 2.737 young animals are required to produce one tonne of young beef. Therefore, the constant term (Φ_{yc}) in the young cattle demand function (equation 4) is 2.737. For old animals, the cold carcass weight is 0.314 tonnes, implying 3.183 old animals are required to produce one tonne of old beef. The constant term (Φ_{oc}) in the old cattle demand function (equation 5) is 3.183.

Elasticity Estimates

Elasticity of the Breeding Inventory with Respect to Price

This medium-run inventory elasticity is assumed to equal 0.33, and it determines the own- and cross-price elasticities of the young and old and cattle supply functions in the following manner. Combining equations (1), (2), and (3), the cattle supply functions can be written as follows:

$$(2') \quad S_{yc} = \lambda_{yc} \cdot (a_1 + a_2 (w_y (P_{yc} + sub_{yc}) + w_o (P_{oc} + sub_{oc})))$$
$$(3') \quad S_{oc} = \lambda_{oc} \cdot (a_1 + a_2 (w_y (P_{yc} + sub_{yc}) + w_o (P_{oc} + sub_{oc})))$$

Simplifying the above equations gives

$$(2'') \quad S_{yc} = a_{yc} + b_{yc} (P_{yc} + sub_{yc}) + c_{yc} (P_{oc} + sub_{oc})$$
$$(3'') \quad S_{oc} = a_{oc} + b_{oc} (P_{yc} + sub_{yc}) + c_{oc} (P_{oc} + sub_{oc})$$

The relationships among different parameters are

$b_{yc} = \lambda_{yc} a_2 w_y$

$c_{yc} = \lambda_{yc} a_2 w_o$

$b_{oc} = \lambda_{oc} a_2 w_y$

$c_{oc} = \lambda_{oc} a_2 w_o$

As the inventory elasticity with respect to price is 0.33, the values obtained for the above parameters are b_{yc} = 1.090; c_{yc}=b_{oc}=0.151; and c_{oc}=0.021, implying that the own-price effect (b_{yc}) is higher than the cross-price effect (c_{yc}) in the supply function for young cattle, but the own-price effect (c_{oc}) is smaller than the cross-price effect (b_{oc}) in the supply function for old cattle.

Elasticity of Cattle Demand with Respect to Beef Price

The elasticity of cattle demand (processors' demand) with respect to the beef price is 0.66, taken from FARM (AAFC, 2003). Using this elasticity, the demand function for young cattle can be calibrated (demand is expressed as a function of the gross margin). The old and young capacity constraints were considered as 110 percent and 200 percent (effectively non-binding) of the 2004 actual slaughter level.

Own- and Cross-price Elasticities of the Young and Old Beef Demand Functions

Both the own- and the cross-price elasticities of demand are required to calibrate the consumer demand functions; they were obtained from FARM (table 2). The direct price elasticity in both the young and the old demand functions is assumed to be -0.69,

the cross-price elasticity for old beef is assumed to be 1.00, and the cross-price elasticity for young beef is set at 0.043 (AAFC, 2003). The implication of these elasticities is that changes in the price of young beef have a relatively large impact on consumption of old beef, while changes in the price of old beef have a relatively small impact on the demand for young beef.

Table 2 Elasticity Assumptions for Baseline Model[a]

Elasticity	Estimate
Inventory elasticity	0.33
Young cattle demand with respect to young cattle price	-0.40
Old cattle demand with respect to old cattle price	-0.27
Cattle demand with respect to beef price	0.66
Young beef demand with respect to own price	-0.69
Old beef demand with respect to own price	-0.69
Old beef demand with respect to young beef price	1.00
Young beef demand with respect to old beef price	0.04

[a] The elasticities are based on estimates in FARM, a search of the literature, and the judgment of the authors (AAFC, 2003).

Results

Table 3 shows the results from the model for cattle and beef supply, cattle and beef demand, cattle and beef prices, gross producer revenue, and producer surplus under four trade regimes: 1) baseline, trade in young beef only; 2) autarky; 3) partial trade liberalization (trade in young beef and cattle only); and 4) free trade. Table 4 contains the results of applying the three alternative policies (increased slaughter capacity, mass cull, and a subsidy for the slaughter of old cattle) in the baseline border situation. Table 5 shows the impact of each of the policy scenarios under each of the potential border situations. These results are discussed in detail in the main article.

Table 3 Cattle and Beef Demand, Supply, Prices, and Surplus Measures under Different Trade Regimes[a]

Variable		Baseline: trade in young beef only	Regime 1: autarky	Regime 2: partial trade liberalization – trade in young beef and cattle	Regime 3: free trade
Cattle supply ('000 head)	old	518.48	424.55 (-18.12)	569.58 (9.85)	585.48 (12.92)
	young	3,738.42	3,061.10 (-18.12)	4,106.83 (9.85)	4,221.51 (12.92)
Cattle demand ('000 head)	old	518.48	424.55 (-18.18)	569.58 (9.85)	185.16 (-64.29)
	young	3,738.42	3,061.11 (-18.11)	2,483.69 (-33.56)	2,483.69 (-33.56)
Cattle prices ($ per head)	old	321.45	156.84 (-51.21)	139.88 (-56.48)	898.65 (179.56)
	young	1,097.87	499.10 (-54.54)	1,461.13 (33.08)	1461.13 (33.08)
Beef supply ('000 tonnes)	old	162.84	133.34 (-18.12)	178.89 (9.85)	58.15 (-64.29)
	young	1,280.31	1,048.34 (-18.12)	850.88 (-33.56)	850.59 (-33.56)
Beef demand ('000 tonnes)	old	162.84	133.43 (-18.12)	178.89 (9.85)	145.18 (-10.84)
	young	813.94	1,048.34 (28.80)	808.96 (-0.61)	819.42 (0.67)
Beef prices ($ per tonne)	old	2,506.66	1,575.48 (-37.14)	2,150.22 (-14.22)	2,898.88 (15.64)
	young	4,960.00	2,784.46 (-43.86)	4,960.00 (0.00)	4,960.00 (0.00)
Gross revenue ($ million)		4,270.99	1,594.93 (-62.67)	6,080.31 (42.36)	6,694.33 (56.74)
Producer surplus ($ million)	old	165.58	66.33 (-59.94)	79.47 (-52.01)	517.68 (212.63)
	young	3,447.63	1,392.09 (-59.62)	4,837.48 (40.31)	5,005.02 (45.17)
	Total	3,613.22	1,458.42 (-59.64)	4,916.94 (36.08)	5,522.71 (52.84)

[a] Percentage changes from the baseline values are shown in parentheses under the values of the variables.

Table 4 Cattle and Beef Demand, Supply, Prices, and Surplus Measures under Different Policy Scenarios with Trade in Young Beef Only (Baseline)[a]

Variable		Baseline: trade in young beef only	Policy 1: increased slaughter capacity	Policy 2: mass cull	Policy 3: slaughter subsidy
Cattle supply ('000 head)	old	518.48	520.03 (0.30)	480.11 (-7.40)	520.06 (0.30)
	young	3,738.42	3,749.58 (0.30)	3,461.72 (-7.40)	3,749.75 (0.30)
Cattle demand ('000 head)	old	518.48	520.03 (0.30)	480.11 (-7.40)	520.06 (0.30)
	young	3,738.42	3,749.58 (0.30)	3,461.71 (-7.40)	3,749.75 (0.30)
Cattle prices ($ per head)	old	321.45	481.38 (30.15)	457.83 (42.43)	315.88 (-1.73)
	young	1,097.87	1,094.65 (-0.29)	1,177.98 (7.30)	1,094.60 (-0.29)
Beef supply ('000 tonnes)	old	162.84	163.32 (0.30)	150.79 (-7.40)	163.33 (0.30)
	young	1,280.31	1,284.50 (0.30)	1,185.54 (-7.40)	1,284.18 (0.30)
Beef demand ('000 tonnes)	old	162.84	163.32 (0.30)	150.79 (-7.40)	163.33 (0.30)
	young	813.94	813.79 (-0.02)	817.68 (0.46)	813.79 (-0.02)
Beef prices ($ per tonne)	old	2,506.66	2,495.88 (-0.43)	2,774.40 (10.68)	2,495.72 (-0.44)
	young	4,960.00	4,960.00 (0.00)	4,960.00 (0.00)	4,960.00 (0.00)
Gross revenue ($ million)		4,270.99	4,322.03 (1.19)	4,297.66 (0.62)	4,322.82 (1.21)
Producer surplus ($ million)	old	165.58	215.74 (30.29)	217.84 (31.55)	216.51 (30.76)
	young	3,447.63	3,451.62 (0.12)	3,397.42 (-1.46)	3,451.68 (0.12)
	Total	3,613.22	3,667.36 (1.50)	3,615.26 (0.06)	3,668.19 (1.52)

[a] Percentage changes from the baseline values are shown in parentheses under the values of the variables.

Table 5 Cattle Supply, Prices, and Surplus Measures under Different Policy Scenarios and Three Different Trade Regimes[a]

Variable		Trade regime[b]	Equilibrium values	Policy 1: increased slaughter capacity	Policy 2: mass cull	Policy 3: slaughter subsidy
Cattle supply ('000 head)	old	autarky	424.55	425.08	408.77	425.31
		partial lib.	569.58	571.35	516.20	570.33
		free trade	585.48	585.48	526.94	587.66
	young	autarky	3,061.11	3,064.95	2,947.32	3,066.57
		partial lib.	4,106.83	4,119.65	3,721.95	4,112.28
		free trade	4,221.51	4,221.51	3,799.35	4,237.23
Cattle prices ($ per head)	old	autarky	156.84	225.01	302.57	149.85
		partial lib.	139.88	224.73	329.58	71.95
		free trade	898.65	898.65	898.65	898.65
	young	autarky	499.10	493.17	674.99	490.66
		partial lib.	1,461.13	1,461.13	1,461.13	1,461.13
		free trade	1,461.13	1,461.34	1,461.13	1,461.13
Gross revenue ($ million)		autarky	1,594.40	1,607.19	2,113.10	1,612.61
		partial lib.	6,080.33	6,147.78	5,608.40	6,108.95
		free trade	6,694.33	6,694.33	6,024.90	6,780.37
Producer surplus ($ million)	old	autarky	66.33	95.12	122.82	107.29
		partial lib.	79.47	127.87	169.10	100.03
		free trade	517.68	517.68	465.91	578.69
	young	autarky	1,392.09	1,379.03	1,766.01	1,373.48
		partial lib.	4,837.48	4,856.21	4,391.43	4,845.44
		free trade	5,005.02	5,005.02	4,504.52	5,027.99
	Total	autarky	1,458.42	1,474.15	1,888.83	1,480.77
		partial lib.	4,916.94	4,984.09	4,560.53	4,945.46
		free trade	5,522.70	5,522.07	4,970.44	5,606.68
Government expenditure ($ million)		autarky	0.00	0.00	0.00	44.23
		partial lib.	0.00	0.00	0.00	59.31
		free trade	0.00	0.00	0.00	61.12

[a] Percentage changes from the baseline values are shown in parentheses under the values of the variables.
[b] The partial trade liberalization regime allows trade in young cattle and beef.

Endnotes

1. An unfortunate and inescapable consequence of using a price-inelastic, linear supply curve is that it cuts the price axis at a negative value.
2. Under the assumption of autarky, exports are obviously zero.
3. The static nature of the model forced a difficult decision. Most of the young animals slaughtered in 2004 were the offspring of cows on farms in 2003 while most of the culls would have been taken from the 2004 herd. We made the decision to assume that both young and old slaughter animals in 2004 could be related to the size of the 2003 herd.
4. Old beef could not be exported in 2004.
5. In 2004 Canada was a small net exporter (16 thousand tonnes) of beef to countries other than the United States. This trade is ignored in our analysis.
6. We were unable to find comparable beef price data for the United States, and as a result we ignored the basis between the two markets.
7. Since Canada was a net exporter of low-quality beef to the United States, the fact that measured U.S. prices are lower than those in Canada is troubling. We feel this is a problem of not being able to compare comparable products, and using the traditional basis in our analysis does not create any serious problems in the policy analysis.