Integration to Fragmentation: Post-BSE Canadian Cattle Markets, Processing Capacity, and Cattle Prices

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This paper examines the potential impacts of expansions to Canadian cattle slaughter capacity with varying assumptions about the ability to export live cattle to the United States. A synthetic model is calibrated to historic data and then used to gauge the impacts of changing slaughter capacity, commercial grade beef import competition, and export potential for lower quality cuts on the Canadian cattle and beef sector. Expanded slaughter capacity improves fed cattle prices, but cull prices remain below pre-BSE levels. Reduced ability to export lower quality beef and increased import competition from commercial grade beef also further depress cattle prices.

Le présent article examine les répercussions potentielles d'une augmentation de la capacité d'abattage au Canada à l'aide de diverses hypothèses sur la capacité d'exporter des bovins vivants aux États-Unis. Un modèle synthétique est calibré selon les données historiques et utilisé pour évaluer les répercussions qu'une modification de la capacité d'abattage, de la concurrence quant à l'importation de bœuf de qualité commerciale et de l'exportation éventuelle de coupes de viande de qualité inférieure aurait sur le secteur canadien du bœuf. Une capacité d'abattage accrue améliore les prix des bovins finis, mais les prix des animaux de réforme demeurent inférieurs aux niveaux de prix observés avant la découverte de l'ESB. La diminution de la capacité d'exporter du bœuf de qualité inférieure et l'augmentation de la concurrence pour l'importation de bœuf de qualité commerciale contribuent également à faire baisser davantage les prix des bovins.

INTRODUCTION

The May 2003 discovery of bovine spongiform encephalopathy (BSE) in an Alberta cow resulted in the immediate closure of international markets to both live Canadian cattle and beef products. Unable to export their products into traditional markets, Canadian beef packers reduced slaughter numbers to a fraction of their pre-BSE levels. In the weeks immediately following the discovery, prices of both fed and cull animals dropped precipitously.

Almost immediately, industry attention focused on the need for additional domestic slaughter capacity to replace lost access to U.S. packing houses. Several existing Canadian beef packers planned expansions, and several new initiatives were proposed. Four months after being closed, the U.S. border reopened to shipments of boneless beef derived from animals under the age of 30 months, relieving some of the downward pressure on fed cattle prices as Canadian packers, again able to participate in the North American market, raised kill numbers to near-record levels. In July 2005, the American embargo on live Canadian cattle shipments ended, but new regulatory measures were put in place governing the movement of live animals across the border. These measures included age verification as well as disease and pregnancy tests to be carried out by accredited veterinarians (CFIA 2006).

This paper has three main purposes. The first is to determine the impact of border disruptions on Canadian cattle and beef production and prices. This question is critical because of the uncertainty regarding whether the U.S. border will remain open to Canadian cattle and beef products in the long term. A second purpose is to measure the degree to which adding domestic slaughter capacity is effective in offsetting price declines that result from a border closure. This issue is relevant given planned expansions in the industry and uncertainty regarding the viability and sustainability of some of these initiatives. The third purpose is to examine how prices are affected by the ability to sell low quality beef into international markets. If this beef cannot be marketed, there are significant implications for low quality beef prices, slaughter demand, and both fed and cull prices.

Price and production impacts given the four scenarios are simulated using a small synthetic model of Canadian cattle and beef markets. This dynamic annual model is simulated over a sufficiently long period to allow markets to adjust given the projected expansion to slaughter capacity. In the first scenario, the U.S. border remains closed to live exports over the entire simulation period. The second allows under 30-month cattle to be exported beginning in the third year of the simulation. The third and fourth scenarios, carried out as sensitivity analyses, see projected slaughter capacity reduced and assumptions about exports of low quality beef relaxed, respectively.

Results show that under a closed border scenario, expansions to domestic slaughter capacity are able to reduce downward pressure on prices over time. It is also clear that access to U.S. markets for high and low quality beef by Canadian packers is critical to maintaining prices even if the border is closed to trade in live cattle. Live fed and cull cattle prices are at their highest when trade in cattle and beef products between the two countries is unfettered, but failing that, price pressure can be relieved if certain conditions are met.

CANADIAN SLAUGHTER CAPACITY

Prior to the closure of the U.S. border, Canadian cattle feeders were heavily dependent upon the United States as a market for their slaughter cattle. Live exports of fed cattle were 594,636 head out of 3.5 million head total marketings (17%) in 2002, while 429,742 cull slaughter animals out of 990,860 head total marketings (44%) were exported that year (Canfax 2004). Canada is also a major exporter—and importer—of beef products, and the United States is the largest market for those products. Total exports of beef into the United States from Canada were slightly over 363,453 tonnes in 2002, representing approximately 40% of total beef production; an additional 9% was exported to other destinations (AAFC 2005a).[1]

Table 1. Largest Canadian beef packing plants, current & planned capacities

Company	Plant location	Category	Daily kill	
			Current	Planned
Cargill Foods	High River, AB	Fed cattle	4,100	5,000
Lakeside Packers	Brooks, AB	Fed cattle	4,000	5,000
Better Beef Ltd. (owned by Cargill)	Guelph, ON	Fed cattle	1,900	1,900
XL Beef	Calgary, AB	Mixture	1,000	1,000
XL Beef	Moose Jaw, SK	Fed cattle	900	1,200
Colbex/Levinoff	St. Cyrille, QC	Cull cows	720	1,040
Ranchers Beef	Balzac AB	Fed cattle	NA	800

Note: In some cases numbers have been converted from weekly to daily. A five-day kill week was assumed.
Sources: Canfax (2004), Farm Business Communications (2005) and MacArthur, Briere, and Bell (2005).

Historically, the slaughter sector expanded fairly steadily from a kill of around 1 million head in the 1920s to a peak of 4.5 million head in 1976. After that, there were nearly two decades of decline in slaughter numbers, with the annual kill reaching 2.7 million head in 1993 (Statistics Canada 2005). This was due to a rationalization of the industry as the previous generation of facilities became obsolete, and exports of fed cattle and culls to larger scale facilities in the United States grew. Since the mid 1990s, Canadian slaughter capacity has trended upward again as new facilities have come online, mainly in Alberta. That province has become one of North America's most prominent cattle-feeding regions, and is now home to over three-quarters of Canada's fed cattle slaughter capacity (AAFC 2005a).

Canada's post-BSE cattle slaughter industry is in a state of rapid expansion. Several new processing facilities and expansions of existing plants have been announced since May 2003. Table 1 shows a selection of Canadian beef slaughter facilities with current or planned capacities of greater than 1,000 head per day, as well as the category of cattle slaughtered at the plants.[2] Cargill Foods in High River and Lakeside Packers in Brooks are Canada's largest packers, with planned processing capacities of 5,000 head per day in the near future (MacArthur, Briere, and Bell 2005). Prior to May 2003, the Lakeside plant reportedly killed culls on one line at the end of the second shift each day. For a period between 2003 and 2006, Lakeside limited its slaughter activities to fed cattle, but apparently has returned to killing cull animals. Table 2 provides an aggregate picture of all sizes and types of Canadian slaughter facilities[3] and separates out capacities for fed (under 30 month) and non-fed (cull) cattle as well as providing weekly and annual capacities.

Existing under 30 month facilities are reluctant to add capacity for animals over 30 months to their existing operations not only because of the inability to export meat from these animals, but also because of capacity problems associated with the historical seasonality of cull cattle supply. There is also the potential that the border may re-open to exports of live older animals which would reduce the availability of culls. Cows are usually

Table 2. Canadian weekly cattle slaughter, federal & provincial inspection

Class	2003	2004	2005	2006[p]	2009[f]
Federally inspected					
Fed cattle	61,220	71,270	76,910	81,410	88,397
Non-fed	11,920	10,020	15,720	15,470	16,798
Annual total	3,657,000	4,064,500	4,631,500	4,844,000	5,259,741
Provincially inspected					
Fed cattle	2,763	3,500	3,500	3,500	3,500
Non-fed	943	1,500	1,500	1,500	1,500
Annual total	185,300	250,000	250,000	250,000	250,000
Total slaughter					
Weekly total	76,846	86,290	97,630	101,880	110,195
Annual total	3,842,300	4,314,500	4,881,500	5,094,000	5,509,741

Note: slaughter numbers are end-of-year.
Source: Personal correspondence with AAFC and Canfax.
[p] Projection by AAFC.
[f] Forecast by the authors.

culled from the herd in the spring and fall, and as a result there is a lack of consistent supply of cattle aged over 30 months in Canada (Grier 2005). The Colbex Abattoir in Quebec is able to take advantage of a fairly steady supply of cull dairy cattle to maintain a consistent kill rate of over 700 head per day.

Even though the border is now open to exports of live fed cattle and boxed beef, cull animals and beef from older animals cannot be exported to the United States. The problems facing the Canadian cattle industry are not only the limited facilities to slaughter cattle but also the challenge of selling beef. One purpose of this paper is to assess how these problems affect the price of cattle. A suitable approach to determine the impact on prices is with an empirical model that addresses the supply and demand for cattle and beef and the vertical relations between these markets. Although they address different research questions, cattle/beef models by Coleman and Meilke (1988), McGivern and Kerr (1994), and Cranfield and Goddard (1999) capture these basic relationships in Canadian cattle and beef markets and these studies form the basis of the approach used in this study. This empirical model is discussed next.

EMPIRICAL MODEL

The vertical structure of the Canadian cattle and beef production and processing industry is quite complex and consists of cow-calf operations, backgrounding and feeder production, slaughter cattle production, cattle slaughter and meat processing, and wholesale and retail distribution. The small synthetic model employed here compresses several of these activities into input demands and output supplies that are linked by prices.

The structural model consists of 24 equations and 24 endogenous variables. Seventeen of these equations are behavioral consisting of supply, demand, and price linkage equations. The remaining seven equations are identities. Four of the identities are market clearing conditions for steer/heifer, cow/bull, and low and quality beef markets. The remaining identities convert live animals to meat and per capita demand to total demand. The model is synthetic with linear equations. Table 3 presents the major equations of the model and Table 4 defines and describes (1995–2001 mean and standard deviation) the major variables.

Supply Response for Cattle

This study uses a cow and bull breeding inventory as the major driving force behind the supply response for cattle. The breeding inventory is an identity made up of the beginning inventory plus investment in breeding heifers less marketings of cull animals. This is consistent with Jarvis' (1974) description of cattle as being simultaneously capital (heifer investment) and consumption (cull marketings) goods. Following Mbaga and Coyle (2003), investment in heifers is a function of current and two lagged prices of feeder cattle, deflated by the price of barley, and a lagged dependent variable.

The decision to market (salvage) breeding animals depends on the relative size of the cow price (salvage value) to the imputed value of breeding animals as a capital good (the expected price of feeder calves), and the maturity of the animal relative to the prime age of culling (Rucker, Burt and LaFrance 1984). This study specifies the supply of cull breeding animals as function of the ratio of cow prices to feeder calves prices, the stock of cows and bulls and a lagged dependent variable. The inclusion of the stock variable identifies the culling rate.[4] The supply function for the marketing of cull animals is a dynamic equation with adaptive expectations where the lagged dependent variable captures the adjustment of expectations.

The market for feeder cattle is not considered explicitly in this study (feeder cattle are implicitly included in the supply equation for the marketing of fed animals), but the price of feeder animals is determined by the price of fed animals at slaughter. The relationship between the feeder price and the price of fed animals is taken from Marsh, Brester and Smith (2005).

The specification of marketings for fed steers and heifers should account for biological growth, producer decision alternatives and technical constraints. This model employs Marsh's (1994) parameter estimates to calibrate a supply equation for the marketings of steers and heifers that is a function of the price of fed cattle and the price of feeder cattle, each normalized by the price of feed grains, and a 70% share of the inventory of cows and bulls lagged two periods.[5] The coefficient on cattle prices in this equation are calibrated to elasticities for an 18 month lag (Marsh 1994) so each price variable is constructed as a weighted average of current and one year lagged prices which represent the expected prices in this supply function.

Slaughter Demand for Cattle

Traditionally, the derived demand for cattle has assumed a fixed proportions technology, so the input demand has been modeled by subtracting fixed per unit marketing costs for a price dependent retail demand (Tomek and Robinson 2003). This approach has given way to a more general input demand function where the demand for cattle is function of the price beef, the price of cattle, and measure of processing costs (Wohlgenant 1989; Marsh 1991, 2003).[6] This approach is conceptually the same as deriving an input demand equation from a profit function where input and output prices determine the profitability of additional slaughter.

Table 3. Equation structure of the model

Cow and bull market	Fed cattle market
Investment in heifers: $I_t^{heifers} = \alpha_0 + \alpha_0(p^{feeders}/p^{cg})_t + \alpha_1(p^{feeders}/p^{cg})_{t-1} + \alpha_2(p^{feeders}/p^{cg})_{t-2} + \alpha_3\, I_{t-1}^{heifers}$	Feeder price linkage: $p_t^{feeders} = \pi_0 + \pi_1 \cdot p_t^{steers}$
Cow/bull inventory identity: $Stock_t^{cows/bulls} \equiv Stock_{t-1}^{cows/bulls} + I_t^{heifers} - mkt_t^{cows/bulls}$	
Supply of cull animals: $mkt_t^{cows/bulls} = \beta_0 + \beta_1 \cdot p_t^{cows}/p_t^{feeders} + \beta_2 \cdot mkt_{t-1}^{cows/bulls} + \beta_3 \cdot Stock_t^{cows/bulls}$	Supply of fed animals: $mkt_t^{steers/heifers} = \lambda_0 + \lambda_1(0.4 \cdot p_t^{steers}/p_t^{cg} + 0.6 \cdot p_{t-1}^{steers}/p_{t-1}^{cg})$ $\lambda_2(0.4 \cdot p_t^{feeders}/p_t^{cg} + 0.6 \cdot p_{t-1}^{feeders}/p_{t-1}^{cg}) + \lambda_3 \cdot Stock_{t-2}^{cows/bulls}$
Market clearing identity: $mkt_t^{cows/bulls} \equiv \min[D_{capacity}^{cow\ slaughter}, D_t^{cow\ slaughter}] + net\ exports_t^{cows/bulls}$	Market clearing identity: $mkt_t^{steer/heifers} \equiv \min[D_{capacity}^{steer\ slaughter}, D_t^{steer\ slaughter}] + net\ exports_t^{steer/heifers}$
Slaughter demand: $D_t^{cow\ slaughter} = \delta_0 + \delta_1 \cdot p_t^{cows}/wage + \delta_2 \cdot p_t^{cow\ carcass}/wage + \delta_3 \cdot D_{t-1}^{cow\ slaughter}$ $p_t^{cow\ carcass} \equiv 0.115 \cdot p_t^{lqb} + 0.885 \cdot p_t^{hqb}$	Slaughter demand: $D_t^{steer\ slaughter} = \theta_0 + \theta_1 \cdot p_t^{steer}/wage + \theta_2 \cdot p_t^{steer\ carcass}/wage + \theta_3 \cdot D_{t-1}^{steer\ slaughter}$ $p_t^{steer\ carcass} \equiv 0.57 \cdot p_t^{lqb} + 0.43 \cdot p_t^{hqb}$
Low quality beef market	**High quality beef market**
Supply of low quality beef: $S_t^{lqb} \equiv \sum_{type=cow,steer} Shr_{type}^{lqb} \cdot CF_{type} \cdot \min[\bar{D}_{capacity}^{slaughter}, D_{type}^{slaughter}]$	Supply of low quality beef: $S_t^{hqb} \equiv \sum_{type=cow,steer} Shr_{type}^{hqb} \cdot CF_{type} \cdot \min[\bar{D}_{capacity}^{slaughter}, D_{type}^{slaughter}]$
Market clearing identity: $S_t^{lqb} \equiv D_t^{lqb} + \Delta \bar{S}tk^{lqb} - \bar{M}_t^{lqb} + X_t^{lqb}$	Market clearing identity: $S_t^{hqb} \equiv D_t^{hqb} + \Delta \bar{S}tk_t^{hqb} - net\ exports^{hqb}$
Demand for low quality beef: $D_t^{lqb} = \gamma_0 + \gamma_1(p^{lqb}/CPI) + \gamma_2(p_t^{hqb}/CPI)$	Demand for low quality beef: $D_t^{hqb} = \phi_0 + \phi_1(p^{hqb}/CPI) + \phi_2(p_t^{lqb}/CPI)$
Exports of low quality beef: $X_t^{lbf} = Shr_{steer}^{lbf} \cdot CF_{steer} \cdot D_{steer}^{slaughter}$	

Table 4. Variable definitions and descriptions

Label	Definition	Quantity	Mean	St Dev
$I^{heifers}$	Investment breeding Heifers	000 head	914	68
$Stock^{cows/bulls}$	Stock of cows & bulls	000 head	4695	114
$mkt^{cows/bulls}$	Marketing of slaughter bulls & cows	000 head	870	116
$D^{cow\ slaughter}$	Total inspected slaughter bulls & cows	000 head	582	66
P^{cows}	Weighted avg. cow, Canada (D1-D2)	\$/cwt lw	54	7
$P^{feeders}$	Alberta feeder steers 5–600 lbs	\$/cwt lw	121	29
P^{steers}	Steer price (Alberta)	\$/cwt lw	88	8
$S^{l\ bf}$	Production low quality beef	000 tonnes	539	58
$Shr^{l\ qb}{}_{steer}$	Share of low quality beef in fed cattle	%	43%	0
$Shr^{l\ qb}{}_{cow}$	Share of low quality beef in cull cattle	%	88.50%	0
$Shr^{h\ qb}{}_{steer}$	Share of high quality beef in fed cattle	%	57%	0
$Shr^{h\ qb}{}_{cow}$	Share of high quality beef in cull cattle	%	11.50%	0
CF_{steer}	Average cold carcass weight of steer/heifer	kg	351	15
CF_{cow}	Average cold carcass weight of cow/bull	kg	288	18
$D^{l\ qb}$	Disappearance low quality beef	000 tonnes	565	6
$M^{l\ qb}$	Imports low quality beef	000 tonnes	199	26
$X^{l\ qb}$	Exports low quality beef	000 tonnes	173	73
$\Delta Stk^{l\ qb}$	Change in stocks low quality beef	000 tonnes	0	6
$P^{l\ qb}$	Wholesale price of low quality beef	\$/cwt	111	10
$mkt^{steers/heifers}$	Marketings of slaughter steers & heifers	000 head	3329	220
$D^{steer\ slaughter}$	Total inspected slaughter steers & heifers	000 head	2633	294
$S^{h\ bf}$	Production high quality beef	000 tonnes	531	77
$D^{h\ qb}$	Disappearance high quality beef	000 tonnes	355	26
$\Delta\ Stk^{h\ qb}$	Change in stocks high quality beef	000 tonnes	−1	4
$net\ export^{h\ qb}$	Net export high quality beef	000 tonnes	176	59
$P^{h\ qb}$	Retail price of high quality beef	\$/kg	11	1
$P^{cow\ carcass}$	Wholesale price D1 cow carcass	\$/cwt	122	11
$P^{steer\ carcass}$	Wholesale price (A) steer carcass	\$/cwt	167	17
p^{cg}	Price of coarse grains	\$/tonne	134	18

Source: AAFC Farmbank Data Base (2005b).

The slaughter demand for cull cows and bulls is function of the input price (live price of D1 and D2 cows), the selling price for beef products (the wholesale price of a D1 cow carcass), and the wage rate in packing plants. The prices of live cattle and beef are normalized by wages to impose homogeneity of degree zero on the input demand function. The carcass price of cows is the weighted average of the wholesale price of high (11%) and low (89%) quality beef. These wholesale prices are then linked to retail prices and this then links the derived slaughter demand to retail demands for low and high quality beef. The model must also account for the possibility that cull cow slaughter demand may exceed slaughter capacity. A condition is added that the number of cows and bulls slaughtered does not exceed the predetermined capacity constraint.

The slaughter demand for fed steers and heifers is derived in a similar manner to the demand for cull animals. The input price is the Alberta steer price and the output price is the wholesale price of 225–325 kg steer carcasses. The carcass price of fed animals is the weighted average of the wholesale price of high (57%) and low (43%) quality beef. The wholesale prices of these products are in turn linked to consumer prices. So the slaughter demand equation is a function of the input and output prices, each normalized by wages, and a lagged dependent variable. Again, a condition is imposed to ensure that slaughter demand does not exceed a predetermined capacity constraint.

Supply and Demand for Low and High Quality Beef

Low quality beef comes from both cull cows and bulls (89% of the dressed carcass; the remaining 11% is high quality beef from rib and loin cuts) as well as from fed animals (43% of the carcass; 57% is high quality).[7] The supply of low quality beef is sum of the share of low quality beef in cows and bulls times the average cold carcass weight times the number of animals slaughtered (slaughter demand for culls) plus the share low quality beef in fed steers and heifers times the cold carcass weight of these animals times the number of steers and heifers slaughtered (slaughter demand for fed animals). The demand for low quality beef is a function of price of low quality beef, the price of high quality beef, the price of other substitutes, and the level of income. In this application, income and the price of other substitutes are assumed constant and so these variables become part of the intercept. The supply of and demand for high quality beef is determined in an analogous way to that for low quality.

Market Clearing Identities

There are four identities that specify the equilibrium conditions for the cull animal, fed cattle, low quality, and high quality beef markets. The first market clearing identity equates the marketing of cows and bulls less net exports to the lesser of slaughter demand or the capacity constraint. The price of culls adjusts so that this identity exactly holds and therefore the price of culls is exclusively determined within the Canadian market. The second market clearing identity equates the marketing of fed steers and heifers less net exports to the lesser of slaughter demand or the capacity constraint. The price of fed animals adjusts so that the identity holds exactly and the market clears.[8]

In the third market clearing identity, the low quality beef market clears by equating exports of low quality beef to domestic production less domestic demand plus net inventories less imports. Net inventories and imports of low quality beef are held constant. The price that clears this market clearing identity is the wholesale price of low quality beef in Ontario.[9] The consumer price of low quality beef[10] is linked with a mark-up equation to the wholesale price of low quality beef; likewise the wholesale price of D1 cow carcasses is linked to this wholesale price. The fourth market clearing identity equates exports of high quality beef with domestic production of high quality beef less domestic demand plus net inventories less imports. In the case of high quality beef, Canadian prices are determined by U.S. prices, so net exports of high quality beef adjust to clear the market.

Modeling Procedures and Assumptions

To determine the impact of additional Canadian slaughter capacity on Canadian cattle prices, scenarios accounting for the impacts of the border disruptions, for the effects of binding slaughter capacity constraints, and for the implications of marketing low quality beef are considered. These scenarios are analyzed with a structural model that is synthetic[11] with linear behavioral equations. The slopes of the linear behavioral equations

Table 5. Elasticity estimates and sources

Definition	Elasticity estimate		
Cattle supply			
Heifer investment w.r.t. feeder price[a]	0.4 (t-1)	0.07 (t-2)	0.04 (t-3)
Steer marketing w.r.t. steer price[b]		0.6 [18 month]	
Steer marketing w.r.t. feeder price[b]		−0.7 [18 months]	
Cow marketing w.r.t. steer/feeder price[c]	0.6 [SR]		1.4 [LR]
Cow marketing w.r.t breeding stock[c]	0.4 [SR]		1 [LR]
Cattle demand			
Steer slaughter w.r.t. steer price[d]	−0.6 [SR]		−5.3 [LR]
Steer slaughter w.r.t. beef price[d]	0.6 [SR]		5.2 [LR]
Cow slaughter w.r.t. cow price[e]	−0.9 [SR]		−3.1 [LR]
Cow slaughter w.r.t. beef price[e]	0.8 [SR]		2.7 [LR]
Beef demand			
High quality beef w.r.t price high quality[f]			−0.5
High quality beef w.r.t price low quality[f]			0.04
Low quality beef w.r.t price low quality[f]			−0.7
Low quality beef w.r.t price high quality[f]			0.05
Other			
Feeder price w.r.t. steer price[g]			1.3

Sources:

[a] Mbaga and Coyle (2003).

[b] Marsh (1994).

[c] Estimated (1980–2002).

$$Mkt^{cow} = \underset{(-1.1)}{-532.2} + \underset{(2.6)}{997.8} \cdot p^{cow}/p^{feeder} + \underset{(1.8)}{0.1} \cdot Stock^{cow/bulls} + \underset{(2.9)}{0.6} \cdot Mkt^{cow}{}_{t-1} \quad (t\text{-}stat) \quad R^2 = 0.4$$

[d] (1980–2002) *Estimated.*

$$D^{slaughter\ steer} = \underset{(0.8)}{217.1} - \underset{(-2.2)}{7696} \cdot p^{steer}/wage + \underset{(2.6)}{707.1} \cdot p^{whsl.\ steer\ carcass}/wage + \underset{(11.5)}{0.89} \cdot D^{slaughter\ steer}{}_{t-1} \quad (t\text{-}stat) \quad R^2 = 0.92$$

[e] Estimated (1980–2002)

$$D^{slaughter\ cow} = \underset{(1.7)}{299.3} - \underset{(-2.1)}{5553.6} \cdot p^{cow}/wage + \underset{(1.7)}{375.9} \cdot p^{whsl.\ cow\ carcass}/wage + \underset{(5.6)}{0.7} \cdot D^{slaughter\ cow}{}_{t-1} \quad (t\text{-}stat) \quad R^2 = 0.79$$

[f] AAFC Food and Agriculture Regional Model (2005b).

[g] Marsh, Brester, and Smith (2005).

are obtained from existing estimates of elasticities (Table 5). The calibration method converts elasticities to linear slope coefficients by multiplying the elasticity by the ratio of the average (1995–2001) dependent variable to average independent variable. The next step in the calibration process is to determine the intercept terms on all the behavioral equations by subtracting the sum of the product of the independent variables in each equation and the appropriate slope coefficients from the dependent variable. Intercepts are calculated for each year of the simulation so that the calibrated model exactly reproduces the baseline data set for the entire simulation period. Given this perfectly calibrated model, it is then possible to conduct policy analysis.

Although it is common practice to do policy analysis against a forward looking baseline, in this case it is more expedient to do the comparative analysis against a historic baseline for the period 1995–2001. This is a time period that pre-dates BSE and is sufficiently long to allow the model to fully adjust after the initial shock of closing the border to live cattle trade. The data used were obtained from the AAFC (2005b) Farmbank database.[12]

All of the scenarios considered below require a common set of modeling assumptions. The first two years of the simulation assume that the U.S. border is closed to exports of live animals and beef derived from cattle that are over 30 months in age. Exports of high quality boxed beef are allowed to continue uninterrupted for the entire simulation period. As well, the model is adjusted so that in the first two years, the marketing of culls is artificially reduced by approximately 300 thousand animals each year to account for the fact that cull cows have been held back and bred for an additional year (Schroeder and Coffey 2005).

Slaughter demand is determined endogenously in the model; however, this demand may not exceed available capacity in existing facilities. Therefore it is necessary to make assumptions as what these capacity constraints would be over the simulation period. The starting point is Table 2 which was obtained from discussions with AAFC officials who have made judgments about the feasibility of all announced expansion plans. This projection was only made to 2006 so it is necessary to extend the projection for the rest of the simulation period. A growth rate of 8%, based on discussions with industry officials, was applied to federally inspected slaughter.

Imports of beef are treated exogenously. Canada's tariff rate quota (TRQ) for offshore beef is 76,409 tonnes each year, however, historically each year there were supplemental quotas for tariff-free imports (CCA 2004). In 2004, imports of low quality beef were just over 96,000 tonnes (AAFC 2005a); it is therefore assumed that imports of low quality beef will be held constant at this level.

It is necessary to make an assumption as to how much low quality will be exported to the United States. Low quality beef from animals over 30 months cannot be exported to the United States or most other markets. However, low quality cuts (chuck, brisket, shank, plate and flank) and trimmings from fed steers and heifers are also considered low quality beef, and these products from young animals can still be exported. Roughly 70% of low quality beef is derived from animals aged under 30 months. Grier (2005) observes that 40% of the trimmings, 50% of the chucks, and 10% of thin meats (flank, skirt, brisket) are consumed in Canada. Therefore it is assumed that 60% of lower quality beef cuts, from young animals are exported, so 42% of the total low quality beef is exported. Rather than specifying an export demand equation, the historic share of exports to low quality beef production is used to determine the volume of exports to the United States. This assumption is adjusted in the sensitivity analysis discussed below.

The remaining assumptions are scenario specific. The first scenario assumes that exports of under than 30 month cattle are discontinued for the entire simulation period. The second scenario reopens the U.S. border to exports of younger cattle in the third year of the simulation. This requires a change in how the model is closed. An equation is added that determines the Canadian price of fed animals by adjusting the U.S. price by the exchange rate and subtracts a $5 per cwt border fee[13] for pregnancy testing for heifers and age and brand verification. Exports of steers and heifers become an endogenous variable and this variable is determined by the market clearing condition for young animals. Scenarios three and four are introduced for sensitivity analysis. The third scenario reduces the slaughter capacity constraint for cows and bulls by 20% below the projected growth rate and assumes a closed border for all live animal trade.[14] The path of cattle prices is affected not only by slaughter capacity but also by the downstream market for beef. The fourth scenario considers the reduced potential to export low quality beef and increased import competition from lower quality offshore beef.

RESULTS

Scenario 1: Closed Border with Projected Capacity Constraints

The results of the impact of the border closure on all major endogenous variables are shown in Table 6 (columns 3–8). This table shows the impact relative to a baseline with an open border and no BSE, and the impacts are shown as both absolute and percentage changes from the baseline. The results are shown for the first and last years of the seven year simulation period, and averages over the period are also given.

The closure of the U.S. border to exports of live Canadian cattle required that cattle previously slaughtered in the United States had to compete for spots in Canadian plants with cattle that were normally slaughtered in Canada. The excess supply of cattle relative to the limited slaughter capacity allowed beef packers to dramatically reduce their bid prices.[15] Columns 3 and 4 of Table 6 show the immediate impact on cattle prices, with cull prices 53% below the baseline, steer prices down by 35%, and the price of feeders reduced by 40%.

The price of high quality beef is still determined in the U.S. market (these prices are assumed not to change from the baseline) so beef packers' margins increase and the slaughter of fed animals increases by 32% in the first year. Given the increased slaughter of fed steers and heifers, the production of high and low quality beef increases proportionally.[16] With the closure of the border, the price of low quality beef is determined in Canada and as a result of increased production, prices decline by 9% in the first year.

In the initial year the marketing of cows and bulls declines by 46% because of substantially lower prices, resulting in an 8% increase in the stock of cows and bulls. At this time the slaughter of cows and bulls declines by 20% because the cull rate declines as producers withhold their culls from market and because Lakeside halted their cull kill. The increased breeding inventory has subsequent ramifications as future marketings of fed animals increase because the stock of breeding animals increased. As a result, fed marketings increase over the entire period despite reduced fed prices. However, over time slaughter demand for fed animals increases, because of favorable packer margins and as a result the price of steers gradually recovers towards baseline levels by the end of the simulation period (see Figure 1).

After an initial 53% decline in cull prices and only a 9% decline in low quality beef prices, packer margins increase. For the second and third years, cull slaughter demand exceeds available capacity and as cull marketings increase, cull prices decrease in the third year. The price of culls does recover somewhat over the simulation period, as slaughter increases, but the price gap relative to baseline remains at least $15/cwt (see Figure 2).

Table 6. Impact of BSE border arrangements with projected processing capacity

		Closed border to cattle under 30 months						Open border to cattle under 30 months					
		First year		Final year		Average		Third year		Final year		Average	
Primary	Units	Unit Δ	% Δ	Unit Δ	% Δ	Unit Δ	% Δ	Unit Δ	% Δ	Unit Δ	% Δ	Unit Δ	% Δ
Cow and bull inventory	000 head	363	8%	−99	−2%	298	6%	691	15%	295	6%	481	10%
Cow/bull marketing	000 head	−363	−46%	−82	−10%	−154	−16%	−130	−13%	−19	−2%	−126	−13%
Steer/heifer marketing	000 head	−30	−1%	134	4%	193	6%	328	10%	317	9%	273	8%
Price of cows	$/cwt lw	−27	−53%	−16	−25%	−20	−37%	−17	−33%	−14	−22%	−17	−31%
Price of steers	$/cwt lw	−30	−35%	−8	−8%	−15	−17%	−1	−1%	−2	−2%	−7	−9%
Price of feeders	$/cwt lw	−39	−40%	−11	−7%	−19	−18%	−2	−1%	−3	−2%	−10	−10%
Cow/bull slaughter	000 head	−110	−20%	241	46%	154	28%	215	33%	304	58%	181	33%
Steer/heifer slaughter	000 head	697	32%	822	29%	873	33%	708	28%	336	12%	538	21%
Processed beef													
Production low quality	000 tonnes	66	15%	196	33%	170	30%	154	30%	141	24%	129	23%
Production high quality	000 tonnes	123	30%	174	29%	172	33%	135	28%	79	13%	108	21%
Wholesale price low quality	$/cwt	−10	−9%	−25	−19%	−27	−24%	−6	−5%	−10	−8%	−14	−12%
Disappearance low quality	000 tonnes	13	2%	30	5%	34	6%	7	2%	12	2%	17	3%
Disappearance high quality	000 tonnes	−1	0%	−1	0%	−1	0%	−1	−31%	0	0%	−1	0%
Exports high quality	000 tonnes	123	91%	176	59%	174	78%	136	67%	80	27%	109	52%
Price whls. carcass (cows)	$/cwt	−9	−7%	−22	−15%	−24	−20%	−5	−4%	−9	−6%	−12	−10%
Price whls fore quarter (steer)	$/cwt	−4	−3%	−11	−5%	−12	−7%	0	−3%	−4	−2%	−6	−3%

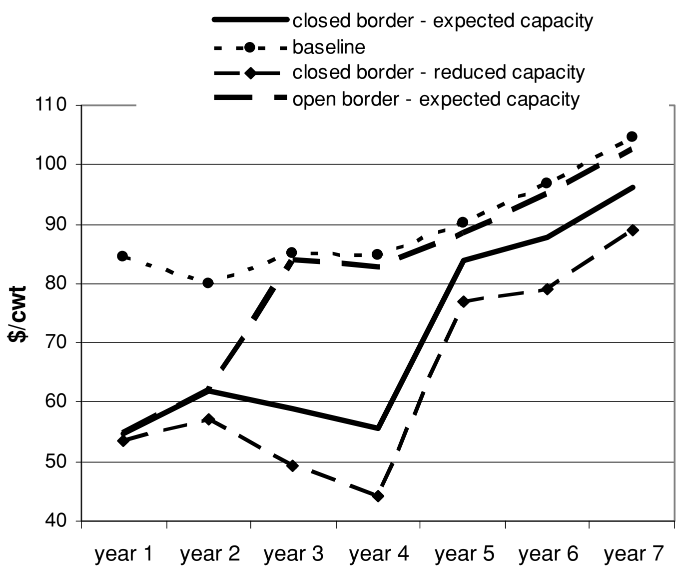

Figure 1. Impact of closed border on fed prices

By the end of the simulation period (columns 5 and 6 of Table 6), the stock of cows and bulls declines by 2% relative to the baseline. Marketings of cows and bulls decline by 10% from the baseline and cow and bull slaughter increase 46%. The slaughter of steers and heifers increases by 29%. Low quality beef production is up by 33% and as a result, low quality beef prices are down by 19% with domestic consumption increasing by 5%.

The price paths for fed and cull animals differ with the fed prices recovering more than cull prices. There are a number of reasons for these differences. There was less pressure

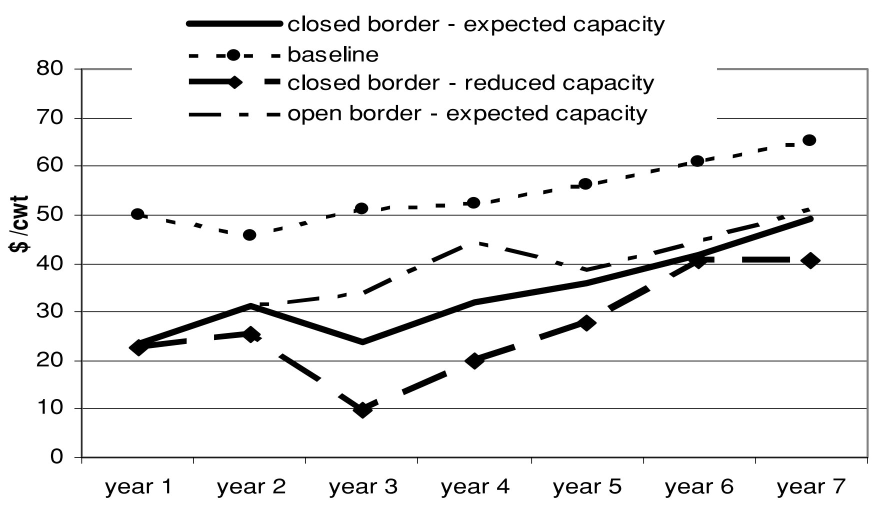

Figure 2. Impact of closed border on cull prices

to find slaughter hook space for fed than cull animals because there was initially more domestic capacity[17] and the projected growth in potential new capacity is somewhat faster for fed animals (43% versus 42% growth rate). Furthermore, fed cattle consist of a much higher percentage of high quality meat and since the price of high quality meat remains at baseline levels there is less downward pressure. Cull cattle consist almost entirely of low quality beef, and consequently there is much more downward pressure on cull prices.

Scenario 2: Fed Cattle Trade with Projected Slaughter Capacity

The open border scenario links the Canadian price of fed animals to the U.S. price of steers, but includes a $5 per cwt border inspection fee which is comprised of pregnancy testing for heifers, as well as age and brand verification (CFIA 2006). The results of this scenario are shown in Table 6 (columns 9–14). This simulation starts in the third year and the first two years are the same as the closed border simulation.[18] There is still a problem that the breeding inventory increases because of the initial reduction in cull marketings which puts extra cattle into the system, but these impacts mostly impinge on cull cattle prices. Since Canadian fed prices are now linked to baseline U.S. prices, fed prices only decline by 1% versus a 31% average decline in the closed border scenario. The result is lower margins for fed cattle packers and thus lower slaughter numbers cause exports of live steers and heifers to resume. This has the effect of putting less low quality beef into the Canadian market, relative to scenario 1, so that low quality beef prices are stronger. This increases the processing margins, for packers of cull animals, and increases their slaughter demand. So cull cow prices are stronger than in the closed border scenario. In third year, relative to the baseline, cull prices decline by 33% versus 53% with a closed border. By the end of the simulation, the initial gap between baseline and scenario two cull prices closes from 53% to 22% (see Figure 2).

The initial increase in the stock of cows and bulls means that by the third year of the simulation, the supply of fed cattle is 10% higher than in the baseline. Over the entire simulation period, the supply of fed animals is up by 8% over the baseline. With more fed marketings, third year slaughter is up 28% from the baseline. However, fed cattle packing plants have lower margins than when the border was closed to exports of fed cattle, so in the third year slaughter numbers are 340,000 fewer head than if the border remained closed. These extra fed cattle are exported for slaughter in the United States. While there are Canadian exports of fed steers and heifers, the level is down 51% from the baseline. By the end of the simulation period, fed exports are only 3% below the baseline.

At the end of the simulation, the stock of cows and bulls has increased by 6% above the baseline. Marketings of cows and bulls are down, but by a considerably smaller number than if the border remained closed. On average, cow and bull slaughter is 33% above baseline levels. Cull slaughter levels are also higher than for the closed border scenario. With higher volumes of slaughter for cull and fed animals, low quality beef production is up 24%, relative to the baseline, by the end of the simulation. As a result, low quality beef prices are down by 8% and consumption increases by 2%.

Scenario 3: Limited Slaughter Expansion

Cow and bull slaughter has a significant effect on the entire system. Lower kill rates, as a result of capacity constraints, increase breeding inventories and this increases animal and beef production. Increased volumes of low quality beef lowers its price and reduces the margins for cull packers and lowers the demand for cull slaughter and the cull cow price.

Given that cow and bull slaughter can have a significant effect on cattle prices, it is important to determine the implications for these prices should plans for new slaughter capacity not materialize. A wide variety of factors may prevent firms from operating at capacity limits, including the need to perform regular maintenance and labor shortages. Therefore, an alternative scenario is run with slaughter capacity for cows and bulls reduced by 20% below the projected growth rates. In order to conserve space this sensitivity analysis is run only for the scenario where there are no live cattle exports to the United States. This reduction in processing capacity is imposed from the second to the final year of the simulation and the impacts of the reduction in capacity are shown in Figures 1 and 2.

The most noticeable effect is the decline in cull prices to $10/cwt in the third year of the simulation—a level to which prices did fall in July 2003. As a result of the reduction in processing capacity, cull prices are on average an additional 11% below baseline prices relative to scenario 1. The reduction in projected cow and bull slaughter capacity also reduces fed prices on average by an additional 8% below baseline prices relative to the first scenario. The effect on fed prices is more noticeable later in the simulation period because of the adjustment lag relative to the growth in the breeding stock.

Scenario 4: Implications of Low Quality Beef Trade

The price of live animals is not only affected by slaughter capacity, but also by the volume of sales for low quality beef. The price of high quality beef is based on U.S. prices and as such, high quality beef prices do not change and thus do not directly affect live cattle prices. However, the price of low quality beef is assumed to be determined in the Canadian market, and changes in this price will in turn affect the price of fed and cull cattle. The price of low quality beef is determined by the domestic supply of and demand for low quality beef, as well as exports of low quality beef and imports of low quality (commercial) beef from offshore markets. Increased domestic slaughter significantly increases the production of low quality beef, which is considerably greater than the increase in domestic consumption as result of lower prices, due the inelastic demand for this product. As result, there is sustained downward pressure on low quality beef prices. This downward pressure could be completely eliminated if the surplus could be exported. As well, reducing imports of offshore commercial beef can ease some of the downward price pressure.

While some of the downward pressure can be offset by increased exports of low quality beef to the United States and Mexico, not all of the low quality beef is under 30 months in age. Roughly 70–75% of the production of low quality beef comes from fed steers and heifers, and this product can be exported to the United States. A significant amount of this lower quality beef consists of "trim and grind," approximately one-third of which has historically been ground beef. The post-BSE experience is that Canada has experienced several difficulties with respect to the export of trimmings. For a short period in 2004, Canada was prohibited from exporting trimmings to the United States. Furthermore, the U. S. fed beef industry produces an excess of 50/50 trim but not enough 90% lean beef to mix with it to satisfy domestic ground beef demand. Rather than grinding higher value muscle cuts to satisfy the mixing requirements, the U.S. imports lean beef from offshore markets. Trimmings (50/65 trim) from fat Canadian cattle may not find a

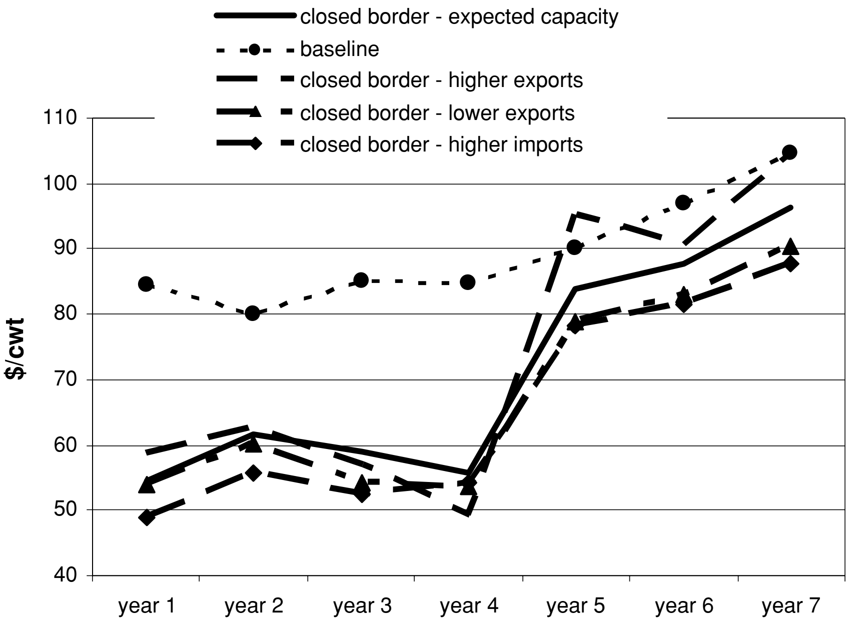

Figure 3. Impact of closed border on fed prices (low quality beef/import sensitivity)

ready market in the United States, because they are not competitive against much leaner offshore imports and are more comparable in fat content to U.S. excess trim.

In order to account for the uncertainties associated with exporting lower quality beef, sensitivity analysis was run to account for the possibility that potential exports were either over or under approximated. To conserve space this sensitivity analysis is only conducted for the scenario with no trade in live animals. The equation for low quality beef exports is adjusted for two contingencies: high export potential and low export potential, whereby the proportion of exported to total under 30 month low quality beef is reduced or increased by 14%, respectively. The impact on these alternative assumptions on the price of cull and fed animals is shown in Figures 3 and 4.

The impact of reduced export potential has similar ramifications as to reducing cow and bull slaughter capacity by 20%. The major difference in scenarios is that with reduced export potential, the price depressing effects are more sustained and prices do not recover over the course of the simulation. The scenario of high export potential does not produce symmetric effects to reducing export potential. Increasing the proportion of beef from animals aged under 30 months that is exported induces a proportionally greater recovery in cattle prices (see Figures 3 and 4). This suggests that marketing strategies to increase the volume of low quality beef exported are necessary if expansion of slaughter capacity is to be successful.

The volume of imports of commercial beef from offshore sources will also affect low quality beef prices in Canada. Canada has a TRQ of 76.4 thousand tonnes for offshore markets (primarily Australia and New Zealand), however imports of commercial beef have historically been around 220% of the TRQ. Of these imports, an average of 56 thousand

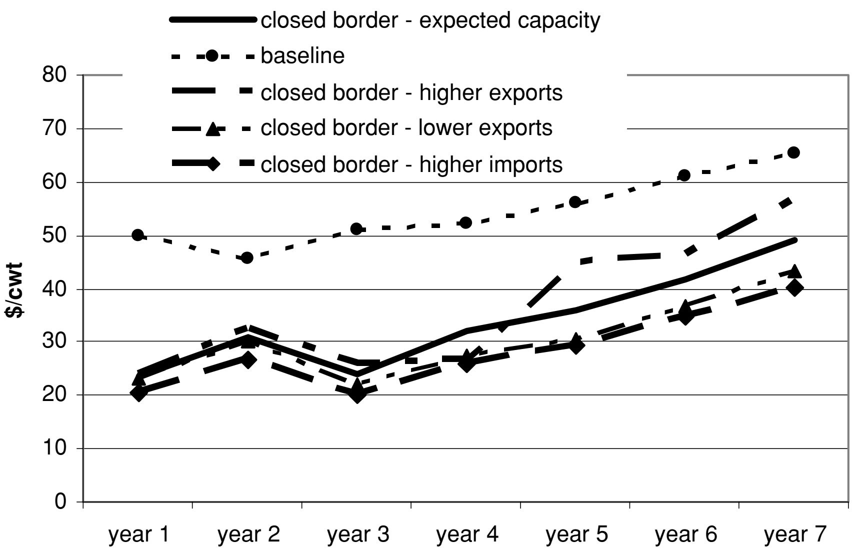

Figure 4. Impact of closed border on cull prices (low quality beef/import sensitivity)

tonnes was granted supplemental import permits (AAFC 2005a). Furthermore, almost half of the imported offshore beef is for grinding, and the remainder is beef cuts. Again, the lean offshore beef is being used to mix with fatter trimmings for fed cattle to create ground beef with the targeted percentage of fat. Since the supply of lean Canadian cull cow meat is only available in significant volumes for four months in the fall of the year, Canadian processors of ground meat have relied on the imports of offshore beef. The seasonal flow of this beef is unlikely to change as slaughter capacity is increased.

The simulations so far have held imports of low quality beef at 96 thousand tonnes over the simulation period. Although this volume exceeds the TRQ by 20 thousand tonnes, in 2003 the supplemental import quota was 55.6 thousand tonnes. The alternative import scenario start imports at 132 thousand tonnes and then has imports grow at the historical growth rate to reach 160 thousand tonnes in the final year of the simulation. The impact on prices is shown in Figures 3 and 4. The results show price paths that are only slightly weaker than the low export potential scenario.

SUMMARY AND CONCLUSIONS

Uncertainties about the future ability to export live animals into the United States have prompted plans for rapid expansion of Canadian slaughter capacity. This paper examined the implications of the extra capacity for cattle prices. The purposes of this paper were to (i) determine the impact of border disruptions on Canadian cattle and beef production and prices; (ii) measure the degree to which extra slaughter capacity offsets price depression and (iii) examine how prices are affected by the ability to market beef. The findings were that while fed prices would almost recover to pre-BSE baseline levels, cull prices remained well below baseline levels. Reduced cull slaughter capacity dampened the recovery of all prices, and the reduced ability to market low quality beef had similar deleterious effects.

While this study did not judge whether the new slaughter ventures would be profitably sustained, it did determine if the extra capacity was a binding constraint. Capacity constraints bind for the second and third years for cull slaughter but were not binding in subsequent periods and the constraints were never binding for fed animals. An important factor driving slaughter demand is the price of low quality beef. Increased import competition, from offshore commercial beef or a reduced ability to export lower quality beef cuts, depresses the price of low quality beef. Low (and high quality) beef from animals over 30 months in age cannot be exported, and there have been difficulties exporting trimmings and other low quality products from fat cattle. When live steers and heifers are exported there is less low quality beef produced in the Canadian market, and this supports the price of low quality beef and cull cows and bulls. So slaughter capacity is not the only constraint that matters but the small Canadian market for beef is a constraint as well.

As a result, it is clear that access to the American market is vitally important. Ultimately, what matters is that a market can be found for all Canadian beef—high and low quality. The ability to export live cattle to United States means that low quality beef crosses the border "on-the-hoof" along with high quality beef, thus easing constraints on the system. Having access for exports of boneless boxed beef is not enough. Opening the U.S. border to imports of beef from fed and cull animals would ease the constraints on the system, as would allowing exports of older animals. The Canadian cattle industry remains in a vulnerable position if the border could closes due to unforeseen events. Added processing capacity reduces the reliance on the American packing sector, but the vulnerability remains unless Canadians can freely export both high and low quality beef.

NOTES

[1]This trade data was obtained from Statistics Canada HS 2013010 - 1602909900. These trade numbers may differ from frequently cited export volumes (Canfax 2004 and AAFC 2005a Livestock Market Review) because they were obtained from Statistics Canada while the alternative number are reported from USDA import numbers for Canada.

[2]Not all the proposed plants are included in this table. For instance Kitchener's Gencor Foods, with a weekly capacity of 1,250 cull cows, was not included. For a complete description of the potential growth in capacity see MacArthur, Briere, and Bell (2005).

[3]This table, with the exception of the 2007-09 forecast, is based on information obtained from discussions with John Ross, Red Meat Section, Market and Industry Services, Agriculture and Agrifood Canada, personal communication.

[4]Data on cull animals includes both beef and dairy cows, since separate data is not readily available. For this stock of animals the 15 year average culling rate is 11%. A reviewer helpfully pointed out that the average cull rate for the dairy industry is only approximately 25–30% of the herd, so the cull rate for beef cows would be slightly higher than 11%.

[5]The 70% share is the historic share of steer and heifer marketings to the cow and bull inventory for the period 1995 to the present.

[6]Conceptually this specification can be thought of as a reduced form equation where an equation for the marketing margin (see Marsh 1991) is substituted into the relation between the price dependent retail demand less the marketing margin.

[7]Low quality meat would consist of the chuck, brisket and shank, and flank of fed animals. Low quality meat also consists of trimmings from other parts of the carcass. Low quality meat consists

of 43% of the carcass after these cuts and trimmings are accounted for. High quality meat is 57% of the fed animal carcass and includes the hip, sirloin, loin, and rib.
[8]In the scenario with an open border for live fed cattle exports, exports adjust to clear the market.
[9]This price is constructed from the industrial product price for ground hamburger.
[10]This price is constructed as an weighted average of the retail price of blade roast plus the retail price of stewing beef plus the retail price of ground beef.
[11]A synthetic model uses pre-existing parameters to create a model that will replicate the baseline values of all endogenous variables, given predetermined elasticities and exogenous variables (Francois and Reinert 1997, chapters 4, 5, and 8).
[12]Data from the Farmbank was obtained with permission from Pierre Charlebois, Economics Sectoral Analysis, Agriculture and Agrifood Canada.
[13]These are new costs associated with border measures implemented after border re-opening. Obtained from discussions with AAFC officials.
[14]Sensitivity analysis is not run for steer and heifer slaughter capacity given that a significant amount of this investment is being made by large existing processors Cargill, Tyson Foods, and XL Foods. Furthermore, the capacity constraint was not binding for initial simulations.
[15]The immediate impact in the summer months of 2003 were price declines of $38/cwt for steers, and $44/cwt for cows. The model results are more modest, with steer prices down $30/cwt from the baseline and cow prices down $27/cwt but these impacts reflect a full year's experience and the continuous ability to export boxed beef.
[16]The production of low quality beef increases because fed steers and heifers are 44% low quality and slaughter numbers are so much higher for steers than cows and bulls.
[17]Just prior to the closing of the border, the ratio of live animals exported to the total number marketed was much higher for cows and bulls (45%) than for fed steers and heifers (17%).
[18]All lagged variables for the third year come from second year variables from the closed border scenario. The average impact, shown in Table 6, includes the first two years of the closed border simulation and the remaining five years of the open border simulation.

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