IMPACTS OF BSE CRISIS ON THE CANADIAN ECONOMY: AN INPUT-OUTPUT ANALYSIS

Sudarma Samarajeewa, Jeevika Weerahewa, Maury Bredahl
University of Guelph

Randy Wigle
Wilfrid Laurier University

ABSTRACT

This study assesses the impacts of BSE crisis on the Canadian economy at the provincial level using an input-output model. The impacts of reductions in exports of beef and cattle on Gross Domestic Product at provincial level, employment, labor income and industrial production are evaluated for Alberta, Ontario, Quebec and Saskatchewan provinces. The results show that a reduction of value of exports by $10 million would reduce average Gross Domestic Product and labor income in above provinces by $8.7 and $3.7 millions. Approximately 145 jobs per province would be lost and industrial production would be reduced by $19.7million. The sizes of the impacts on various industries are different in different provinces reflecting the heterogeneity in intra-industrial linkages among provinces. A reduction in beef exports has significant adverse effects on animal slaughtering, rendering and meat processing, cattle and animal food manufacturing industries while a reduction in cattle exports has significant adverse effects on cattle, feed grain and animal food manufacturing industries in most of the cases.

INTRODUCTION

The discovery of Bovine Spongiform Encephalopathy (BSE) in May 2003 in Alberta, which is the largest cattle and beef producing province in Canada, caused the closure of international markets to Canadian live cattle and beef exports. Canada was the world's third largest beef exporter behind Australia and the United States, with 15% of world exports in 2002. The border closures, specially the United States created extreme economic hardships to the cattle and beef industries in Canada. This is because approximately 60% of Canada's production was exported in 2002, with the United States accounting for 80% of Canadian beef exports and almost 100% of cattle exports. Therefore, the consequences of the border closures induced by the BSE crisis would be devastating for rural Canada, leading to a downsizing of entire rural economy, especially in Western Canada, where more than 70% of fed cattle are located.

As of April 2006, there has been a partial reopening of export markets for some beef products and live cattle below the age of 30 month, but the border remains closed for exports of other live animals and beef products. The volume of meat exports was, however, down considerably. Canada was merely exporting more high-value products. The financial chaos endured by industry stakeholders during the BSE crisis demonstrates the vulnerability of this export-based industry to a sudden border closure. According to the findings of Auditor

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General-Alberta (2004), which were obtained by comparing the prices and quantities before and after BSE crisis, revenue losses on feeder cattle, fed cattle and beef were $165, $360 and $60 per head respectively.

Apart from these estimates, several researchers have attempted to account direct economic implications of BSE and BSE induced border closures on the Canadian cattle and beef industry (Mitura and Di Piétro, 2004, Le Roy, et. al, 2006, Calberg and Brewin, 2005). Mitura and Pietro (2004), who assessed short-term financial implications of BSE on farm families for a scenario involving 35% reduction in cattle and calf revenue and 20% reduction in beef cattle replacement cost, estimated that the loss to single unincorporated beef cattle farms would be $20,000. Calberg and Brewin (2005) suggested that the industry is estimated to have incurred over $5.5 billion (approximately $11 million per day) in direct financial losses as a result of closures of international borders for live cattle exports. Conversely, Le Roy.et.al (2006) suggested that the $ 5.5 billion loss is overstate and accounted $ 4.9 billion, as a loss due to reduced exports, imports and extra processing costs and redistribution costs due to BSE. However, none of these studies do not account for multiplier effects in rural communities or the Canadian economy as a whole due to BSE induced closure of borders.

The linkages of the Canadian cattle and beef exports with other sectors and industries in the economy are evident from the results of the open input-output model of the Statistics Canada. According to the estimates of this model, for the overall Canadian economy, it is estimated that for each $100 million in exports by the cattle sector, $80 million is added to the national gross domestic product (GDP) (at market prices), $228 million is generated in total output, $41 million is added to labor income, and 3,000 jobs are created[1] (Statistics Canada, 2000). Therefore, the consequences of the BSE crisis reach far beyond the farm-gates. However, according to our knowledge, no study has been conducted so far to evaluate economy-wide impacts of the BSE crisis at a provincial level in Canada. The purpose of this study is to assess the impacts of BSE crisis on industrial production, employment and labor income in Alberta, Ontario, Quebec and Saskatchewan. We employ the "Open-Output Determination Model" developed by the Statistics Canada, to estimate the effects of BSE induced fall in demand for cattle and beef exports on each provincial GDP, Industrial output, trade flows and employment.

The paper is organized as follows. The background section gives the details of the Canadian cattle and beef industry and its economic importance in the provincial economies. It follows with some notes on input-output analysis and the 'Open-Output Determination model' by the Statistics Canada. The results section gives the simulation values of the model for a reduction in $ 10 million exports of cattle and beef, followed by the conclusions. Finally we give some suggestions for further research.

BACKGROUND

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[1] Estimates are based on the economic multipliers generated using the Statistics Canada, 2000 National Open Input- Output Model, System of National Accounts / Input-Output Division. Total output refers to GDP plus intermediate inputs.
Statistics Canada - Catalogue no. 21-601-MIE

Undoubtedly, the cattle and beef industry is an important source of provincial wealth creation and employment in Canada. Two-thirds of Canada's beef cattle farms are located in the Prairie Provinces. The highest concentration of beef cattle production is located in Alberta, which is 42% of total heads of cattle followed by 18% in Saskatchewan, 15% in Ontario, and 9% in Quebec (Statistics Canada, 2002). In 2000, 37% of beef cattle farms were located in Alberta, accounting for 56% of the value of production.

Since the late 1980s, the Canadian cattle and beef industry has grown to an estimated $7.7 billion in annual sales by 2002. Between 1991 and 2001, the number of cattle on Canadian farms increased by 19.9% to a record 15.6 million head, mostly due to expansion in beef cattle (Beaulieu and Bedard,2003). Most of the increase was in Alberta, and also it has the highest average number of cattle and calves per farm among the provinces (Table 1). This expansion was primarily driven by exports to the United States, as it was stimulated by policies favoring freer trade (through the implementation of Free Trade Agreements) and a declining Canadian dollar currency exchange value (Report of the Standing Committee, 2004, House of Commons, Canada).

Table 1. Provincial distribution of beef animal units in 1991 and 2001

	1991		2001		
	Animal units	%	Animal units	%	Average number of cattle and calves per farm[a]
Canada	6928	100	8831	100	127
Quebec	325	4.7	375	4.2	85
Ontario	926	13.4	903	10.2	76
Manitoba	658	9.5	886	10.0	126
Saskatchewan	1452	21.0	1856	21.0	129
Alberta	3035	43.8	4249	48.1	208
British Columbia	402	5.8	445	5.0	105
Other provinces	129	1.9	117	1.3	-

Source: Buaulieu and Bedard, (2003). A Geographic Profile of Canadian Livestock, 1991-2001. Catalogue no. 21-601-MIE-No.062, Statistics Canada
[a] Source: Livestock Statistics,2002

Figure 1 shows total exports of live cattle and calves, and Figure 2 shows exports of beef products over the past two decades. These exports consisted of $1.8 billion worth of cattle and calves and $2.2 billion in beef products. Domestic consumption of beef products, on the other hand, remained either stable or declined over the period.

Figure 1. Canadian exports of live cattle and calves, 1980 to 2005 (Thousand head)
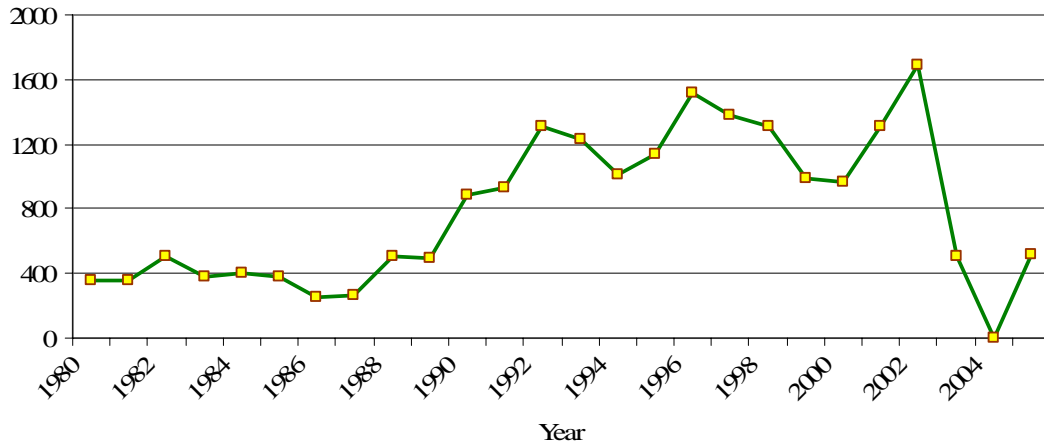
Note: In 2004, the border was closed driving exports to zero
Source: CANSIM data, 2005

Figure 2. Canadian beef exports, 1980 to 2005 (Thousand pounds)
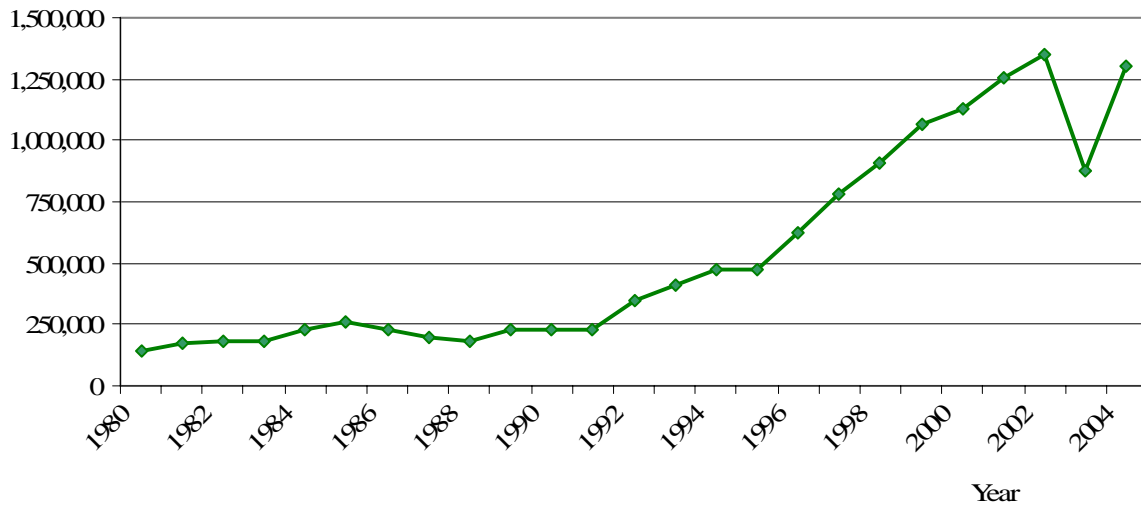
Note: Beef Total, chilled and frozen
Source: Statistics Canada.

Approximately 60% of Canada's production was exported in 2002, which came down remarkably in 2004 due to the crisis induced by BSE. The exports of beef to the biggest trading partners of Canada, i.e. United States, Japan and South Korea were virtually zero after the border closures in 2004 (Table 2).

As a result, the impact of a sustained fall in beef exports is likely to be hit hard on the provincial economies. Upon the border closures in May 2003, steer prices in Alberta decreased from $105/cwt prior to May 20th to as low as $30/cwt, demonstrating the vulnerability of this export-based industry to a sudden border closure.

Table 2. Export markets and export quantities of Canadian beef in 2002 and 2004

Country	Total Beef Exports (metric tons)		Exports of live cattle and calves (number)[b]
	2002	2004	2001
United States	295,864	0	1,306,155
Mexico	77,543	86,422	-
Japan	23,939	0	-
South Korea	17,320	0	-
Other	29,492	29,951	2,343
Total	**444,158**	**116,373**	**1,307,051**

Note: Shows changes in export quantities in pre-BSE and post-BSE situation
Total beef exports include-Carcasses, cuts bone- in, cuts boneless, pickled & cured, cooked & canned, prepared, trimmings, offal & other.
Source: Annual Livestock and meat Report, 2004. Agriculture & Agrifood Canada
[b]Source: Livestock Statistics, 2002. Live cattle exports in 2004 were almost zero for all destinations.

The ban by the United States and other countries on Canadian beef has directly impacted the beef, dairy and stock-breeding industries. In addition, the ban is affecting employment in several related sectors, including meat packing, food processing and the transportation industry. Of all Canadian provinces, Alberta is clearly losing the most. Its average beef exports from January to April 2003 were about $160 million per month. Alberta is followed by Ontario where exports were averaging $62 million per month and by Saskatchewan ($23 million) and Quebec ($11 million) (Pouline and Boame, 2003).

INPUT-OUTPUT ANALYSIS

The Canadian cattle and beef sector is linked to other sectors in the economy through a network of input purchases and output sales. Changes in the level of demand for beef in the provinces and in other markets will have knock-on effects on the quantity of inter-industry sales and purchases. An input-output analysis was performed so as to incorporate the capacity of cattle and beef industries to generate forward linkages and backward linkages in the provincial economies.

Use of input-output analysis to assess the implications of BSE crisis has been attempted by several researchers (Caskie & Moss, 1998, Caskie, et.al, 1999). Both these studies estimated impacts of BSE induced fall in beef demand in the context of United Kingdom, where BSE

was a significant crisis in the agrifood economy. These studies used input-output models to analyze the changes in the regional and macro economy, by introducing exogenous stimulus to the economic system via a change in final demand; either household or export demand.

Input-output analysis captures the economic interdependence between different industries, households and government institutions (Miller and Blair, 1985). The premise of input-output analysis is that the structure of the economy is technologically fixed, such that for a given level or change in final demand, output or employment for a particular industry or region there will be predictable changes in other linked sectors of the economy. These changes are measured by estimating the regional economic multipliers associated with the particular industry using a matrix inversion procedure applied to the matrix of inter-industry transactions.

To capture all the effects in a single set of equations we can express the input-output system in a matrix form, where matrix equation represents a set of equations,
$X – AX = Y,$
Where, X and Y are column vectors of gross output and final demand respectively, and A is an $n \times n$ matrix of direct input coefficients, a_{ij}. By restoring to the identity matrix I,
$(I- A) X = Y$
We may use the inverse matrix to express gross output as a function of (exogenous) final demand,
$X = (I – A)^{-1} Y,$ where $(I – A)^{-1}$ is the Leontief inverse matrix.
Let $B = (I –A)^{-1}$, then, we may write $X = BY$
We can multiply the inverse matrix B by any size and composition of final demand in order to obtain the level of gross output for each industry. This provides us with a powerful tool of analysis since it enables us to measure the total impact on the economy of exogenous disturbances (i.e. changes in final demand).

Repercussions of changes in the level of expenditures on total income can be estimated via the concept of the multiplier. Input-output models enable us to derive sets of multipliers, i.e., output, income or employment. The output multiplier for industry i simply measures the sum of direct and indirect requirements from all sectors needed to deliver one additional $ of output of i to final demand. The income multiplier is expressed as the ratio of the direct plus the indirect income change to the direct income change resulting from a unit increase in final demand for any given sector. The employment multiplier analogues to the income multiplier is the ratio of the direct and indirect employment change to the direct employment change

The Canadian Input-output Table

The Canadian input-output accounts are available at national level and provincial level, given in three main data tables (matrices). These are the output table, input table, and the final demand table. In addition, provinces' and territories' tables are linked together through an inter-provincial flows table that shows each jurisdiction's exports to, and imports from, other provinces and territories as well as abroad (Statistics Canada,2000-2001). The Canadian input–output tables contain two sets of interrelated accounts: the commodity accounts and the

industry accounts. The most detailed tables, the Worksheet tables, groups all transactions into 727 commodities. Tables that are published electronically-known as the "Small" tables-compact this detail into 59 commodities. The basic identities of the input-output structure include the following: i) The total output of any industry equals its total intermediate inputs plus its total primary inputs, ii) The total output of any commodity equals its total use as an intermediate input and for final demand, iii) the output of all commodities equals the gross output of all industries. An input-output multiplier is a quantitative measure created by a particular input-output-based economic model. It is an analytical answer to a hypothetical question about how expenditure is expected to impact the economy.

Data

Input-output analysis concerns the flows of products from each industrial sector considered as a producer to each of the sectors considered as consumers. The basic information from which an input-output model is developed is contained in an inter-industry transactions table known as input-output table. The rows of such a table describe the distribution of a producer's output throughout the economy. The columns describe the composition of inputs required by a particular industry to produce its output. The flow of products between sectors is measured in dollars and referred to as transactions between the various sectors. An important assumption of input-output analysis is that transactions between sectors are a fixed and constant proportion of the amount of products being produced. For example, the dollar amount of cattle that the beef sector buys is a fixed proportion of the dollar amount of beef products produced. In this study, an input-output framework was utilized to estimate the direct, indirect and induced economic impacts of the loss of exports of beef and cattle induced by the border closures due to BSE crisis in Canada. For this study the Statistics Canada input-output table at the worksheet level for the year 2001 were used (Statistics Canada, 2005).

The 'Open- Output Determination Model'

The "Open-Output Determination Model" is one of several possible input-output models-a class of economic models that exploit technological and accounting inter-relationships among industries to simulate or predict outcomes hypothetical of economic events (Statistics Canada, 2000-2001). The key attribute of "open" models is that the behavior of final users is open to specification as an exogenous variable, rather than being pre-determined by the model. In these models, an exogenous shock, such as a change in spending by a final user, causes all industries to adjust their input and output levels interdependently as the system moves toward new equilibrium. Another main feature of input-output tables is the accounting identity between inputs and outputs of any group of transactors such as industries. This implies an industry cost equation that is homogeneous or degree 1, or an industry production function that displays constant returns to scale. As a result, multipliers can be scaled up or down in a linear fashion to fit larger positive or negative spending shocks.

RESULTS

In this study, the impacts on macro-variables and output industries and commodities were investigated as a result of reductions in international exports of beef (beef, fresh, chilled and frozen) and cattle (calves and cattle) by $10 million from the provinces of Alberta, Ontario, Quebec and Saskatchewan. The model was run by the Statistics Canada, Input-output Division to generate results for the specified shock. Table 3 gives the simulation results for the changes in GDP, employment and labor income.

a) GDP and Multipliers

The reductions in provincial GDP and labor income are approximately $8.7 and $3.7 million respectively. The reduction in GDP in Quebec as a result of a reduction in cattle exports by $10 million is as high as $9.4 million and the reduction in GDP in Ontario as a result of a reduction in beef exports by $10 million is as low as $ 8.0 million. The highest reduction in labor income is observed in Quebec for a shock in beef ($4.5 million) and the lowest reduction is observed in Saskatchewan for a shock in cattle exports ($2.4 million).

Table 3: Impacts on total GDP, Employment and Total Labor Income due to a shock of reduction in $10 million worth of exports

Province	Shock	Reduction in total GDP at basic price ($ million)	Reduction in Employment Direct and indirect, all (number)	Reduction in total labor income ($ million)
Alberta	Beef	8.5	143	4.0
	Cattle	8.9	158	4.0
Ontario	Beef	8.0	121	4.2
	Cattle	8.5	145	3.1
Quebec	Beef	8.4	135	4.5
	Cattle	9.4	135	4.1
Saskatchewan	Beef	8.6	151	3.4
	Cattle	9.3	173	2.4

Source: Statistics Canada Open Output Determination Model simulation results,2005

Table 4 shows the ratios and multipliers. Alberta shows the highest numbers for output multipliers. This indicates that $ 3.01 reduction in total direct and indirect requirements from all the other sectors needed to deliver one additional dollar of output of beef to final demand as a result of a reduction of beef exports by $10 million. This is followed by Saskatchewan beef industry generating an output multiplier of 2.68 for a similar reduction in exports. For a reduction in cattle exports by a same value, again Alberta shows the highest output multiplier value, which is 2.44 followed by Saskatchewan, which is 2.18. This clearly, shows the impact

of reduction in exports on other sectors in the provincial economies especially in the Prairie Provinces were higher where cattle and beef production is comparatively advantageous than that of other provinces. Especially, Alberta has the highest on average per farm cattle population and may operate at highest level of economy of scale in cattle production as well

Table 4: Ratios and Multipliers

Province	Shock	Ratio of total to direct GDP	Ratio of total to direct labor income	Ratio of total to direct employment	Output multipliers
Alberta	Beef	8.25	5.94	10.73	3.01
	Cattle	3.88	2.63	2.33	2.44
Ontario	Beef	3.82	3.11	5.58	2.54
	Cattle	2.55	3.07	2.07	2.11
Quebec	Beef	4.43	3.55	3.96	2.66
	Cattle	2.13	2.26	1.90	2.00
Saskatchewan	Beef	4.73	3.31	5.53	2.68
	Cattle	2.47	6.35	2.14	2.18

Source: Statistics Canada Open Output Determination Model simulation results,2005

b) *Employment and labor income*

On average, 145 jobs per province will be lost and the highest reduction (173) is observed in Saskatchewan for a shock in cattle exports and the lowest reduction (121) is observed in Ontario for a shock in beef exports (Table 3). However, some caution must be used when interpreting these employment numbers. Some producers may respond by increasing or introducing other farm activities. Others may be forced to continue in beef production, despite worsening economic conditions, because of lack of alternative on or off -farm employment.

The reduction in the number of employment in the beef industry is higher relative to the cattle industry. According to a report of the standing committee of the House of Commons in Canada in 2004, before the BSE crisis the direct employment at the beef packers' facilities were around 10,000 people, which created five additional jobs (indirect and induced). Therefore, the impact on labor income in the beef industry could be more responsive to the reduction in exports than that of the cattle industry, threatening to pull down the economic foundations of many rural, farm-based economies.

c) *Industrial Production*

The changes in cattle and beef production activities as a result of cattle and beef export shocks are presented in Table 5. A reduction in cattle exports does not have significant effects on beef production, however a reduction in beef exports have sizable impacts on cattle

production. For example, a reduction in cattle exports in Alberta by $10 million would reduce cattle production by $11.9 million yet beef production is reduced only by $ 8 million. In contrast, a reduction in beef exports in Alberta by $10 million reduces cattle and beef production by $6.1 and $10. 6 millions respectively.

Table 5: Impacts on outputs of commodities in respective provinces

Province	Shock	Cattle and calves ($ million)	Beef, fresh, frozen, chilled ($ million)
Alberta	Beef	6.1	10.6
	Cattle	12.0	0.1
Ontario	Beef	2.2	10.4
	Cattle	10.8	0.1
Quebec	Beef	0.9	9.8
	Cattle	10.1	0.1
Saskatchewan	Beef	2.8	10.0
	Cattle	10.6	0.1

Statistics Canada Open Output Determination Model simulation results, 2005

Together, the comparative and competitive economic advantages in the industry translated into live cattle exports of about 1.6 million head, or more than 30,000 head per week, and into 1 billion kilograms of beef products for Canadian producers in 2002 (Report of the standing committee, 2004). The consequence of the loss of cross-border trade in beef products and cattle led the herds unexpectedly grew in size across Canada, exposing all Canadian cow-calf and cull cow operators to losses in revenue and increased feed costs. Canada's cattle and beef products industry is structured quite differently at the different stages of production, where each stage involves different type of operations. The aggregation of commercial activity involves roughly four live animal markets, and several wholesale and retail markets. Thus the BSE impacts are likely to be passed down the supply and value chain from packers to cattlemen and our results show that cattle exports generate bigger impacts than those of beef exports.

The impacts on industrial production on the major affected industries are presented in tables 6 and 7. The total industrial production will be reduced approximately by $19.7 million ($21.0 and $18.4 million for beef and cattle shocks respectively) per province. The sizes of the impacts on various industries are different in different provinces showing heterogeneity in intra-industrial linkages among provinces. In general, a reduction beef exports has significant adverse effects on animal slaughtering, rendering and meet processing, cattle and animal food manufacturing industries while a reduction in cattle exports has significant adverse effects on cattle, feed grain and animal food manufacturing industries.

Animal slaughtering is the most affected industry as a result of a reduction in beef exports in all the provinces (Table 6). Cattle industry is the second affected industry in Alberta and Saskatchewan and rendering and meat processing industry is the third affected industry in

Alberta. Hog industry has sizable effects especially in Quebec followed by Ontario and Saskatchewan. The hog and poultry industries also show significant effects due to changes in exports of beef and cattle. This could be due to the fact that the ruminant rendered material may still be used for feeding hogs and chickens, though since 1997 the use of ruminant meat meals in feed of ruminant cattle has been prohibited. Though Canada had introduced a ban in 1997 on feeding ruminant protein materials to ruminants, it could still be used in poultry, pet, and other types of feed.

Table 6: Impacts on Selected Industrial Production due to a Beef Export Shock (reduction in $ 10 million exports)

NAICS Code	Industry	Reduction in total provincial industrial production ($ million)			
		Alberta	Ontario	Saskatchewan	Quebec
311611	Animal (except Poultry) Slaughtering	8.6	7.3	9.3	7.2
112a02	Cattle	6.4	3.4	3.6	1.3
311614	Rendering and Meat Processing from Carcasses	1.9	3.5	0.1	2.5
111a06	Other Crops	0.8	0.6	1.0	0.4
111a02	Feed grain	0.7	0.4	0.7	0.4
311100	Animal Food Manufacturing	0.5	1.0	0.4	1.3
112a03	Hogs	0.4	2.1	2.5	3.1
311615	Poultry Processing	-	-	-	0.8
410000	Wholesale Trade	0.3	0.6	0.3	0.4
211100	Oil and Gas Extraction	0.3	-	0.1	-
541B00	Other Professional, Scientific and Technical Services	0.2	0.2	0.2	0.2
324110	Petroleum Refineries	0.2	0.1	0.1	0.1
5A0130	Banking and Other Depository Credit Intermediation	0.2	0.2	0.1	0.1
541A00	Legal, Accounting, Tax Preparation, Bookkeeping and Payroll Services	0.2	0.1	0.1	0.1
484000	Truck Transportation	0.2	0.2	0.1	0.1
2300H0	Repair Construction	0.1	0.1	0.1	0.2
221100	Electric Power Generation, Transmission and Distribution	0.1	0.2	0.2	0.2

Note: NAICS= North American Industry Classification System code
The reduction in values for poultry processing is negligible in other provinces except in Quebec
Statistics Canada Open Output Determination Model simulation results, 2005

Cattle industry is the most affected industry as a result of reduction in cattle exports in all the provinces. Other crop industry is the second most affected industry in all the provinces except for Quebec, for which it takes the third most affected industry. Feed grain is the third

most affected industry in Alberta and Saskatchewan and animal food manufacturing is the third affected industry in Ontario and second affected industry in Quebec (Table 7).

Table 7: Impacts on Selected Industrial Production due to a Cattle Export Shock (reduction in $ 10 million exports)

NAICS Code	Industry	Reduction in provincial industrial output ($ million)			
		Alberta	Ontario	Saskatchewan	Quebec
112a02	Cattle	12.3	11.5	10.9	10.1
111a06	Other Crops	1.4	1.1	1.7	1.0
111a02	Feed grain	1.2	1.0	1.2	0.6
311100	Animal Food Manufacturing	0.9	1.0	0.3	1.6
541B00	Other Professional, Scientific and Technical Services	0.4	0.3	0.4	0.4
211100	Oil and Gas Extraction	0.4	-	0.1	-
410000	Wholesale Trade	0.4	0.4	0.3	0.3
324110	Petroleum Refineries	0.3	0.2	0.1	0.2
541A00	Legal, Accounting, Tax Preparation, Bookkeeping and Payroll Services	0.3	0.3	0.1	0.3
2300H0	Repair Construction	0.2	0.3	0.2	0.4
5A0130	Banking and Other Depository Credit Intermediation	0.2	0.2	0.1	0.2
484000	Truck Transportation	0.2	0.2	0.1	0.1
111a01	Wheat	0.2	-	0.6	-
221100	Electric Power Generation, Transmission and Distribution	0.2	0.3	0.2	0.4

Note: NAICS= North American Industry Classification System code
Source: Statistics Canada Open Output Determination Model simulation results,2005

Table 8 and 9 show inter-provincial imports and international imports in Ontario due to cattle and beef export shocks respectively. Note that the leakages are shown only by international imports as the total provincial imports are equal to total provincial exports when all the provinces are pooled. Due to presence of such leakages the change in GDP is always smaller than the size of export shock (Table 3).

Table 8. Reduction in inter-provincial trade flows (all commodities) due to a reduction of $ 10 million worth of beef exports (values are in $ million)

	Ontario	Quebec	Saskatchewan	Alberta
Ontario	20.0	0.1	0.1	0.1
Quebec	0.8	0.6	0.1	0.1
Saskatchewan	0.4	0.1	0.4	0.1
Alberta	0.7	0.1	0.1	0.2

Note: Along the diagonal are the values of own provincial supply
Source: Source: Statistics Canada Open Output Determination Model simulation results, 2005

Table 9. Reduction in inter-provincial trade flows (all commodities) due to a reduction of $ 10 million worth of beef exports (values are in thousand dollars)

	Ontario	Quebec	Saskatchewan	Alberta
Ontario	18.1	0.1	0.1	0.1
Quebec	0.4	0.3	0.1	0.1
Saskatchewan	0.3	0.1	0.2	0.1
Alberta	0.4	0.1	0.1	0.3

Note: Along the diagonal are the values of own provincial supply
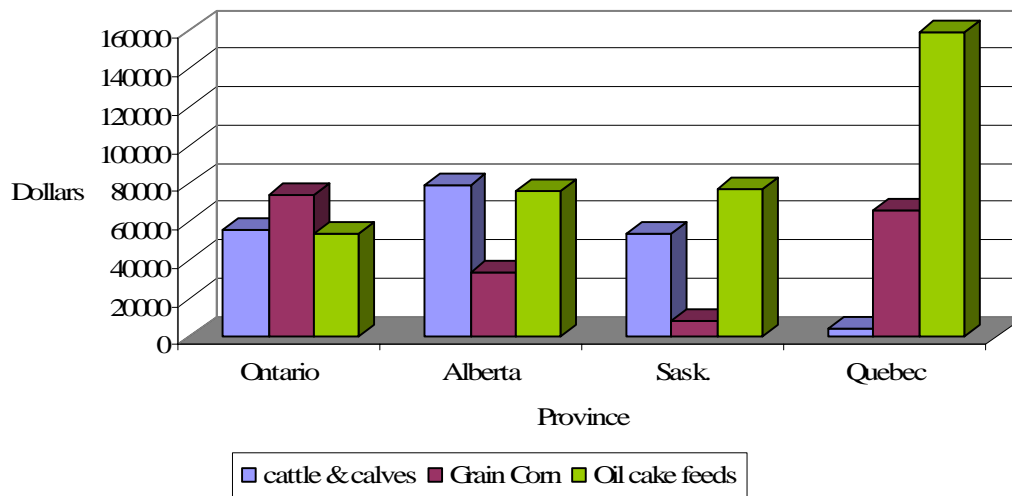Source: Source: Statistics Canada Open Output Determination Model simulation results, 2005

Figures 3 and 4 represent the changes in provincial import values resulting to a reduction in cattle and beef exports by $ 10 million.

Figure 3. Reduction in Import value for a $ 10 million reduction in beef exports in each province
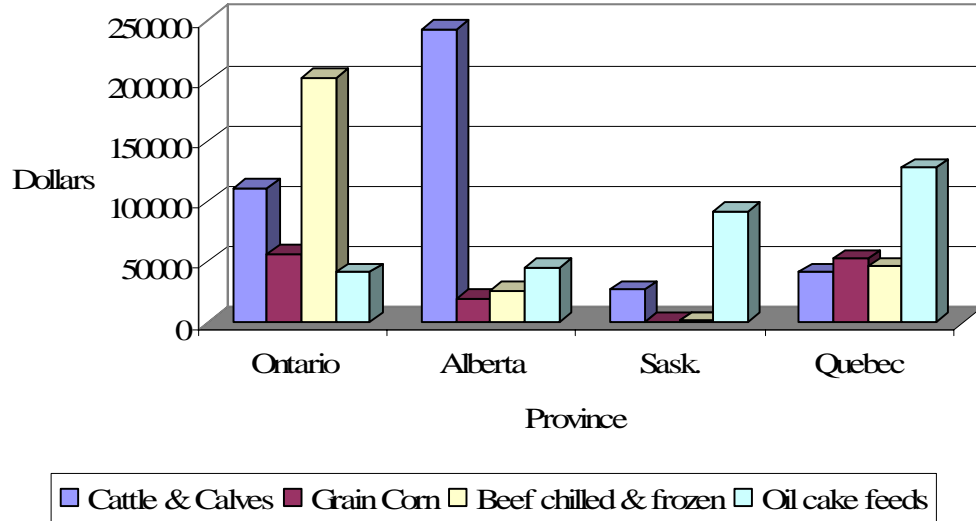
Source: Statistics Canada Open Output Determination Model simulation results, 2005

Figure 3. Reduction in Import value for a $ 10 million reduction in cattle exports in each province

Source: Statistics Canada Open Output Determination Model simulation results, 2005

CONCLUSION

Canada's production of cattle and beef has grown steadily over time, and the industry has been more and more dependent on exports. The industry was thrown into chaos by the discovery of BSE in May of 2003. The short-term impacts of BSE ensue from the closing of borders across the industrialized world to Canadian beef and cattle. These impacts fell disproportionately on cattlemen and other livestock producers, but also on packers, their employees and suppliers. Also, the impacts of the crisis have been demonstrated to be beyond the cattle and beef industries.

The importance of cattle and beef exports to the provincial economies in Canada was demonstrated by the magnitudes of economic linkages established by the input-output analysis. To estimate the potential long term effects of a BSE induced fall in export demand for cattle and beef on the provincial economies an input-output model shock of a reduction in $ 10 million worth of beef and cattle exports was performed.

The results suggested that the cattle and beef exports generate considerable economic activity in the provinces considered in terms of GDP, employment, industrial output, etc. The impacts on total GDP, employment and total labor income as a result of reductions of value of exports of beef and cattle by $10 million are different among provinces and are also different for different shocks; i.e. cattle exports versus beef exports. Impacts on GDP and employment are higher when cattle exports are shocked compared to beef exports. Impacts on labor income are higher when beef exports are shocked compared to cattle.

The results indicated that the animal slaughtering, cattle, rendering and meat processing, feed grain and animal food manufacturing industries are significantly affected by the reduction in beef and cattle exports in all provinces. In addition, other crops, hogs and poultry industrial outputs are also showed notable output changes for the shocks. The results of this study show that different provinces would respond differently to a similar export shock indicating the need for different types of mitigation mechanisms in different provinces to a crisis. Also, the results show clearly that the long-run effects of BSE on the provincial economies would be serious in the absence of effective stabilization measures.

However, input-output analysis, by construction, has several limitations and hence the results should be interpreted with caution. Firstly, prices are independent the level of production in the economy (fixed price models). Secondly, Supply is infinitely elastic at the cost price and output is demand determined. Thirdly, the production function assumes Leontief technology and no substitution among inputs are allowed. Even with these limitations, input–output analysis allows to capture not only the direct effects of a fall in demand on beef and cattle exports in provinces, but also the wider impacts on allied industries and other nonagricultural sectors. Use of general equilibrium models, which can overcome above limitations yet uses the same data set, to address this research issue is suggested as further research in this area. Currently, the limitations of public availability of the Canadian input-output table at its worksheet level due to its confidentiality, prevent us to work for such an endeavor.

References

Annual Livestock and meat Report, 2004. Agriculture & Agrifood Canada

Auditor General Alberta. Report of the Auditor General on the Alberta Government's BSE-related Assistance Programs" 2004.

Buaulieu Martin S. and Bedard Frederic, (2003). A Geographic Profile of Canadian Livestock, 1991-2001. Catalogue no. 21-601-MIE-No.062. Statistics Canada.

Canadian Animal Health Coalition "BSE Economic Impact Assessment" Serecon Management Consulting Inc., June 2003.

CANSIM, Statistic Canada's on-line data retrieval service. Various matrices. Statistics Canada, Ottawa, 2005.

Carlberg Jared G. & Brewin Derek G.. (2005). Managing an Industry in Crisis: BSE in Canada. Selected Paper prepared for presentation at the Southern Agricultural Economics Association Annual Meetings, Little Rock, Arkansas, February 5-9, 2005. http://agecon.lib.umn.edu/cgi-bin/pdf_view.pl?paperid=15710&ftype=.pdf

Le Roy.Danny G, Kurt Klein and Tatiana Klvacek. (2006). The losses from BSE in Canada. Paper presented at the Canadian Agricultural Trade Policy Research Network. Toronto. Ontario, February 11, 2006. http://www.uoguelph.ca/~catprn/PDF/Workshop_2006_LeRoy.pdf.

Livestock Statistics. 2002. Statistics Canada. Catalogue No-23-803.XIE

Miller, R.E. and P.D. Blair. *Input*-Output Analysis: Foundations and Extensions. Prentice-Hall, Englewood Cliffs, New Jersey, 464 p., 1985.

Mitura, V. and Lina Di Pietro (2005) "Canada's Beef Cattle Sector and the Impact of BSE on Farm Family Income: 2000-2003" Statistics Canada. Agriculture and Rural Working Paper Series. Cat No. 21-601-MIE-No 069.

Mon.Pon Nya and Holland David W.. (2005). Organic apple production in Wshington States: An input-output analysis. Working paper series. WP 2005-03. Washington States University.

Poulin, Denis and Boame Attah K.. (2003). Mad cow disease and beef trade. Catalogue no. 11-621-MIE — No. 005. Statistics Canada.

Report of the Standing Committee on Agriculture and Agri-Food. (2004). Canadian livestock and beef pricing in the aftermath of the BSE crisis. House of Commons. Canada.

Statistics Canada. Open -Output Determination Model--2001: Results for Shocks in Beef and Cattle Exports. Released in December 2005 as per the request of the authors.

Statistics Canada.(2000-2001). The input-output structure of the Canadian Economy. Catalogue no. 15-201-XIE.