International Journal of Business and Applied Social Science

E-ISSN: 2469-6501
VOL: 8, ISSUE: 12
December/2022
DOI: http://dx.doi.org/10.33642/ijbass.v8n12p4

Regional economic impacts of the Canadian beef processing sector

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ABSTRACT

Observations of direct contributions of a sector are easily observable and are frequently used as a measure of the importance of an economic sector. However, it is the contention of this study that such a process seriously underestimates the total contribution made by an economic sector. In this study, the economic impacts of the beef processing sector are estimated as total economic impacts which include the direct contributions made by the beef processing sector plus all the secondary impacts. Impacts were measured in terms of the level of sales, gross domestic product (GDP), labor income, and employment levels. In each of these cases, multiplier activity generated by the beef processing sector was two to five times (and in some cases even more) the direct impacts. It is the conclusion of this study that the total economic impacts of a sector are a better indicator of the importance of an economic sector than direct impacts.

Keywords: **Canada, beef processing, Western Canada, Eastern Canada, Economic impacts**

1.0 Introduction

1.1 Background

The Canadian beef sector, which comprises farm-level cattle raising plus the processing of live animals into beef, is an important sector for the Canadian economy, particularly for beef processing activities. Internationally, Canada holds a prominent place in the production and exports of beef and beef products. It holds 11th place in world beef production, and 7th position in world exports (Canadian Cattlemen's Association, 2020). In 2020, Canada exported 513 thousand tonnes (metric tonnes) of beef to 62 countries, although exports to the USA dominated (Beef2Live, 2022). Total beef production in Canada was at 1.2 billion kilograms, of which 50% was sold to the international market (Statistics Canada, 2021b). Canadian meat processors produce a variety of meat products including fresh, frozen, processed, smoked, and canned meat. Furthermore, domestically, its importance at the farm level can be observed through supporting 84,740 workers (hired and owner-managers) on 60,000 farms in Canada, and 27,716 worker's various forms of meat processing. On the surface, it may appear to most that beef production is an important economic activity in Canada. However, it is the contention of this study that this economic contribution is seriously underestimated. The processing of cattle, in addition to supporting cattle producers, supports many workers engaged in supporting activities required for the efficient functioning of the entire system from producers to the final consumers. Such activities include transportation, warehousing, retailing, and the service industries, among others. Although some of the beef animals are exported live to many countries, the number is small, and therefore, beef cattle producers in Canada depend on processing activities to a major extent. The direct economic impacts listed above are important but they make up only a portion of the total economic significance of the beef processing sector.

The major objective of the study is to estimate the total impact of the beef processing sector in Canada and two of its regions eastern Canada and western Canada. These impacts are shown over and above the impact on cattle producers in each of these regions.

1.2 Canadian Beef Cattle Processing Industry

The beef processing industry activities start with the slaughtering of cattle purchased from farms. In 2020, a total of 3.4 million cattle were slaughtered in Canadian slaughtering plants. In Canada, to sell processed or slaughtered beef across provincial borders or for export, the plant must be registered with and inspected by the Canadian Food Inspection Agency. There are three plants in Alberta where most of the Canadian-fed cattle are processed, accounting for 85% of Canada's cattle slaughter. The number of federally inspected beef processing plants, through consolidation, has decreased from 26 in 2010 to 20 in 2020, with the province of Quebec showing the largest decline. In Western Canada, Manitoba and Saskatchewan have limited federally inspected slaughter capacity, and their cattle for slaughter are sent to Alberta. In addition, there are 316 provincially inspected slaughter and meat processing plants, which tend to be smaller in capacity and generally process several animal species, including beef. Approximately 5% of the cattle slaughtered in Canada are processed at provincially regulated plants. Also, there is some uninspected slaughter which has been less than 1% of the total slaughter yearly.

The number of cattle slaughtered in Canada is presented in Figure 1. Slaughter numbers have returned to 2010 levels after declining and hitting a low point in 2015. Even though the beef cattle herd has been in decline over this period, higher slaughter numbers have been achieved because fewer fed cattle and slaughtered cows are being exported to the USA for slaughter. Also, fewer calves and yearlings are being exported to be fed in the USA. In addition, there have been increased imports of fed

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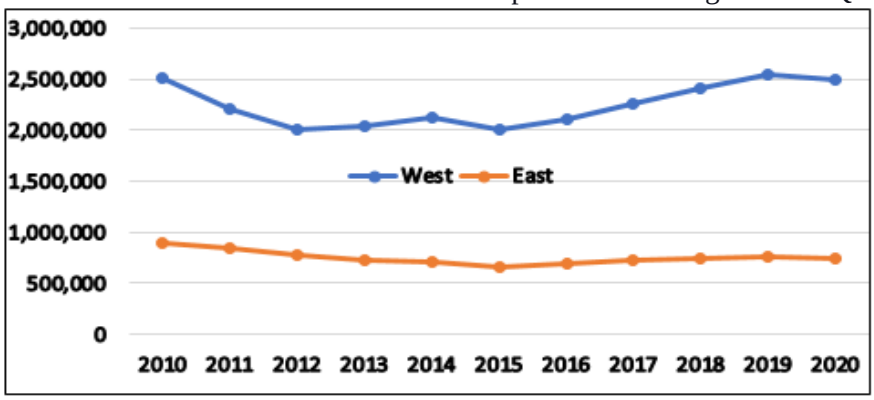
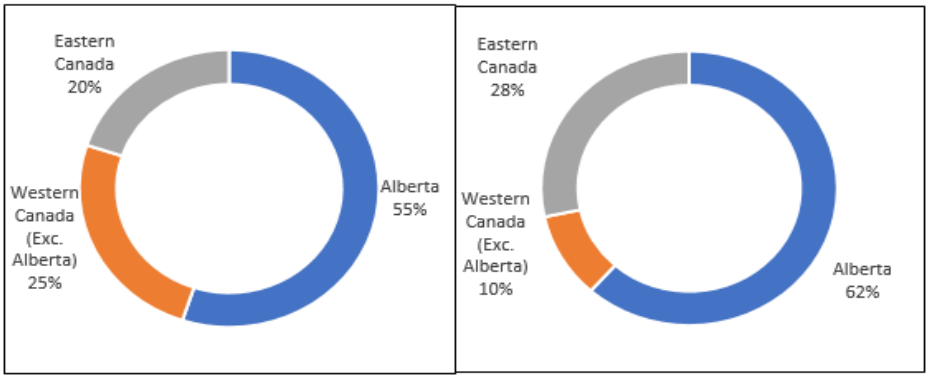
cattle and cows for slaughter from the USA. Most of the calves over this period were slaughtered in Quebec (AAFC, 2020).



Source: Canada Beef Grading Agency (2021).

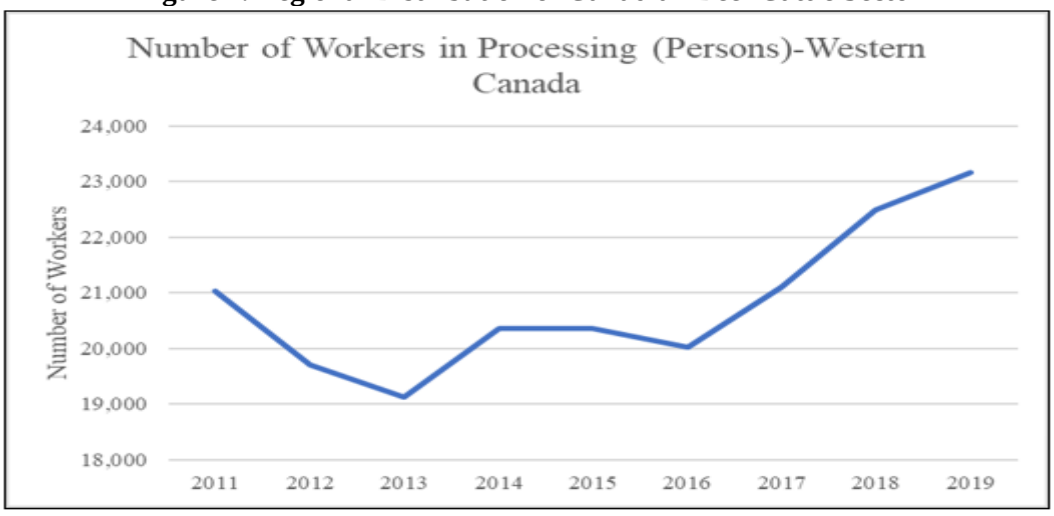
Figure 1. Number of Cattle Slaughtered in Eastern and Western Canada, 2010-2020

Despite having a smaller beef herd, processing of live animals and meats is located more in Eastern Canada, where, based on the number of employees, 61% of the capacity (as measured through employment) is present (Figure 2). Eastern Canada has a large poultry and pork sector which supports a large slaughter and processing sector. In Western Canada, much of the beef processing is in Alberta while the main pork slaughter plants are in Manitoba and Alberta poultry processing is at a smaller scale than in Eastern Canada. Employment in meat processing in Western Canada has increased since 2016, after a period of consolation in the early part of the decade (Figure 3).



Farm Value of Production Slaughtering and Meat Processing

Figure 2. Regional Distribution of Canadian Beef Cattle Sector



Source: Source: Statistics Canada (2019a)

Figure 3. Number of Workers in Meat Processing in Western Canada, 2011-2019

The Canadian per capita disappearance of meat products has fallen over the 1980-2019 period with total meat consumption in the range of 95.2 to 108.7 kg per year with an average of 101.2. Beef held the top position in terms of consumption until 2004 when chicken meat consumption caught and proceeded to overtake beef as the top choice. The decline in

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beef consumption per capita seems to have stabilized in 2016 through 2019 at 26-27 kg. However, Canadian beef and veal exports have increased by 116,844 tonnes a 36% increase from 2015 to 2019 before falling in 2020 by 13,400 tonnes (-3%) due to COVID processing plant shutdowns. In 2020 due to COVID, the consumption of meats and meat substitutes was affected. George-Cosh (2020) reports a rise in the consumption of meat substitutes during the first wave of COVID in March-April of 2020 of 52% YoY for tofu and meat alternatives. Whether these changes are short-term or will affect consumer preferences once the pandemic and life return to "normal" will be seen in 2021-2022.

The major export market for Canadian beef is the USA which tends to be seasonal with the December to March exports the lowest and the summer months being the high export months because of the barbecue season. The barbecue season affects the supply chain of slaughter cattle since the beef sales are primarily fresh over the counter. The impact of COVID on the export of beef and veal is visible in the 2020 data as exports fell in April and May due to plant closures. This created a backlog of fed animals in feedlots which seems to have been cleared through the system by 2021 (Statistics Canada, 2021b).

1.3 Review of Literature

The study of the economic impacts of beef processors in Canada has not been a popular topic. Although studies estimating the economic impacts of promotional measures (Williams et al. 1991), disease outbreaks, such as Foot-and-Mouth disease (Cairns et al. 2017), trade issues such as imports (Nelson et al. 2015), regional comparisons (Artz et al. 2005) have been reported, very few studies have been undertaken for the entire beef sector. Studies by Nieberg et al. (2014), Kerna et al. (2014), MacNamara et al. (1993) and the NAMI (2015) are examples of the U.S. beef sector on the regional economy. Economic impacts have also been estimated using a plant closure approach, although these tend to be community-specific (Dubensing et al. 2019). Some of these studies described the contributions of the sector as against impacts. As suggested by Watson (2007), the economic contributions of a sector are not synonymous with economic impacts. Contributions reflect gross changes in the economy, whereas economic impacts are based on a 'with and without' framework, and therefore, are marginal gains or losses in the economic system. The lack of studies for the Canadian context prompted this current study on estimating the economic impact of the Canadian beef processing sector.

2.0 Material and Methods

2.1 Description of Total Economic Impacts of an Economic sector

In physics, the law of motion is based on an interaction between some action and a reaction. Although this law may not function quite as in physics, in the economic world, it does have a parallel: for every change created by an economic agent, other changes are created somewhere else. These changes are based on the rule that in a modern economy economic performance of a goods-producing firm depends on other firms in the region. These types of changes are the core of economic impact assessment.

The economic impacts of a new project or set of activities are dependent on the complexity of the economic system where such activities occur. In a system where there is no production, and all goods and services are obtained from outside the region (imports), the level of impact of any change on its economy would be very small / or even zero. However, in a more mature economic system, an exogenous change would trigger an interrelated set of changes throughout the economy that require a formal method of modeling to determine the magnitude of these changes.

Economic interdependencies among various economic good-producing industries exist in all sectors and beef processing is no exception to it. Major types of impacts associated with actions of a given economic sector (or a firm) include:

1. *Direct impacts* which include any actions taken by the primary decision maker Beef processing firms). These may be one of two types:

(i) New capital investment in expanding production capacity, a part of which could be in terms of purchases of goods and services, and another in terms of hiring additional workers for the job. These expenditures are associated with only new plants that would into operation at a future date.

(ii) Additional level of production from the added capacity, resulting in higher input purchases, and higher workforce (additional employment).

2. *Indirect Impacts* are based on purchases of commodities (inputs) needed for production. These could be further divided into two types:

(i) Backward linkage-based impacts. These impacts are created in response to the increased input requirements under direct impacts that are supplied by other businesses. These inputs may be related to (i) Capital investment and (ii) Additional production-related expenditures. Like in the previous case, more workers could be needed to perform these activities.

(ii) Forward linkage-based impacts. Some of the output (sales) of the slaughtering plants are made to other meat processing firms (businesses) for further processing. These firms, depending on their current capacity, may be involved in (i) Capacity investment relate to expansion or new plants. (ii) Expansion of production of these associated meat production firms, with the help of additional workers.

(3) *Induced impacts*: All the additional workers in any of the above sets of impacts would receive compensation either as wages and salaries or as profits (if they were self-employed in the unincorporated businesses). These higher incomes would be spent on necessary goods and services for everyday living. These actions of the consumers would create another round of demand for them, which must be produced, thereby creating additional economic impacts, called "induced impacts".

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In the input-output analysis, all these impacts are combined into two types: Type I impacts, which include direct and backward plus forward impacts; and Type II impacts, which include, in addition to Type I impact, induced economic impacts.

2.2 Study Input-output Model

A sector is defined as encompassing all firms/businesses selling a similar mix of products. To estimate the total contributions of an economic sector, one needs a tool for estimating the spin-off effects of the sector from its direct impacts. The most common method is that of Input-Output (I-O) analysis. An I-O model is a useful method of estimating the secondary impacts of economic development projects. This model is preferred for the following reasons:

1. Every industry's impact is treated as unique, allowing its specific economic impacts to be estimated.

2. Different types of economic stimulus can be applied to undertake economic impact analysis. Thus, the economic impacts of consumer spending, exports, or purchases by other firms, for example, could be estimated uniquely.

3. Development of the model can be region-specific, thereby allowing regional differences in the production processes, technology, and trade patterns.

The study I-O model was based on actual observations of sales and purchases by all economic agents in Canada for the year 2016. These actions are termed 'economic transactions' and presented as a transactions table. The accounting system for the study I-O model was the rectangular accounting system, where a sector can produce more than one commodity. In the transactions table, firms/businesses are called sectors, and the goods and services they purchase and/or sell are called commodities. This table is the heart of the model as it denotes the interdependence (in terms of sales and purchases of goods and services) among three types of economic agents: producers of various goods and services (called economic sectors); owners of resources (land, labor and capital, and management); and final user agencies. The latter category of economic agents is the major driver of all economic activities in the region. The goods and services bought by them leave the regional economy and do not re-enter for further sales. Examples of these would include consumer demand, export sales, and government expenditures.

Various goods and services that are used in the production process of economic sectors are divided into two types: Intermediate inputs/commodities, and Primary inputs/commodities. Intermediate inputs refer to those commodities that are purchased by other sectors for further processing. These goods are traded between one economic sector and another. Primary inputs are those that refer to the owner of land, labor, capital, and management resources. These inputs receive compensation/payment for their services, which is typically aggregated into GDP (Income based) for a region, and in economic impact analysis, become the source of induced impacts.

The I-O analysis is a demand-driven process. If the commodity is demanded, either by other sectors or by final demand agencies, it is assumed that goods-producing sectors would gear up to produce that amount. This suggests that the economy has no capacity constraint; all resources are available as and when needed.

The study I-O model had some special features: (i) It contained a disaggregated account of the Canadian and regional economies. (ii) Non-survey technique (method of location quotient) was used to develop coefficients for the sectors in the two study regions (Western Canada and Eastern Canada). (iii) The I-O model was appended with an employment module to estimate the effect of change in economic activities on employment levels of various sectors, where employment coefficients were estimated as the number of full-time equivalent workers per thousand-dollar worth of sectoral output; and (iv) For estimation of induced impacts, marginal propensity to consume was incorporated. The study model contained 58 goods and services producing sectors, and 67 intermediate goods, plus several final demand and primary inputs.

The rectangular I-O model framework is based on two basic Matrices-U-matrix and V-matrix, as displayed in Figure 4. Let *s* be the number of sectors in the economy, and *c* be the number of commodities. These two matrices are first converted into the coefficient matrix (per unit of output) and are called B-matrix and D-matrix. The first matrix represents the technical coefficient for each sector by commodities and the market share of different sectors for various commodities. The total economic impact on the output (sales) of the sector (EI) is estimated using equation (1).

$$EI = (I-DB)^{-1}(DF) \quad (1)$$

where *EI* is a vector of sales of *s* sectors, *F* is a vector of direct impact under a given scenario, and *B* and *D* matrices, as defined above.

	Commodities (Dimension) 1, 2, …, c	Sectors (Dimension) 1, 2,…, s	Final Demand Agencies (Dimension) 1, 2, …f	Total
Commodities		U-matrix (c by s)	F-matrix (c by f)	Total commodity output (c by 1)
Sectors	V-matrix (s by c)			Total sectoral output (s by 1)
Primary Inputs		Yp	Yf	Total gross national product by source of Income
Total	Total Commodity output (1 by c)	Total sectoral output (1 by s)	Total Final Demand (1 by f)	

Figure 4. Schematics of an economy using rectangular input-output model format

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The other economic indicators are estimated as a fixed proportion of the change in the output of a sector. This includes GDP and labor incomes. As noted above, change in employment is also calculated using the sectoral output and is the employment coefficient.

2.3 Estimation of Regional Input-Output Models

Using the transactions table for Canada, two separate sub-models were developed using non-survey methods, one for western Canada and another one for eastern Canada. The non-survey method used was that of location quotient (LQ). An LQ is a measure of a region's self-sufficiency in meeting its requirements for various goods and services. If a region is self-sufficient, it would first meet its requirements and export the rest to other parts of Canada or the rest of the world. It is calculated using equation (2):

$$LQ_{rc} = \text{Share of the commodity } c \text{ in region } r \;/\; \text{Share of commodity } c \text{ in Nation} \quad (2)$$

If the LQ ≥1, the region has a surplus for a given commodity and can meet all its requirements. For this reason, its technical coefficients are like those of the nation. If LQ < 1, the region is a deficit region for a given commodity, and a new set of coefficients are created. The estimation involves the use of equation (3):

$$A_{cr} = A_{cn} * LQ_{rc} \quad (3)$$

Where, A_{cr} is the technical coefficient for the commodity c in region r, and A_{cn} is the technical coefficient for that commodity for the nation.

Like the Canadian model, each of the regional models was appended with an employment module to estimate the impact of employment of workers by sectors. For these regions, employment coefficients were for the selected region. Consumer behavior in the model was modeled as the marginal propensity to consume in the region of interest.

2.4 Concept of a Multiplier

Although economic impacts are normally presented as the total impact of a given change (or scenario), these can be converted into a multiplier. A multiplier is simply a ratio of the total impacts of a given scenario by its direct impacts. Mainly these multipliers are either Type I or Type II. Depending on the choice of direct impact, one can calculate two types of multipliers: Pseudo multipliers, and Ratio-form multipliers. A pseudo multiplier is estimated for the scenario using equation (4).

$$PM(I) = \Sigma s\ EI(I)_s / (DO) \quad (4)$$

where $PM(I)$ is the pseudo multiplier (Type I), $EI(I)s$ is the total economic impact of the s^{th} sector (Type I), and DO is the total direct output of the sector selected for the study scenario. The pseudo multiplier (Type II) is estimated similarly, except the *EI* estimates include direct, indirect, and induced impacts. These multipliers are estimated for various economic indicators, namely, output (sales), GDP, labor income, and employment.

A ratio-form multiplier is estimated for all economic indicators also, but it involves dividing the total change in that economic indicator by the direct change in the same indicator. For example, the ratio-form multiplier for GDP is estimated using equation (5):

$$RF(I)(GDP) = TC(I)(GDP) / \text{Direct GDP} \quad (5)$$

where, $RF(I)(GDP)$ is ratio-form multiplier Type I for GDP under the selected scenario, and $TC(I)(GDP)$ is the total change (Type I) in GDP under the selected scenario.

To estimate total economic impacts, three decisions were made: (1) the Nature of the scenario reflecting final demand for the economy, which in this study was assumed to be beef processing activity. (2) Economic activities undertaken in the study scenario, called direct impacts. The total output of the sector was disaggregated into various commodities using the Statistics Canada transactions matrix (B-matrix). (3) Decide the period for the analysis. Due to year-to-year fluctuation in the direct impacts, the study was undertaken using data for an average of the 2018-2020 period. The direct impacts under this scenario were estimated first and then inputted into the I-O model to yield total economic impacts on the economy.

3.0 Results

3.1 Results for the Canadian Economy

Economic impacts of the Canadian (and its two regions) beef processing impacts are presented in two formats: One, in terms of total impacts-both Type I (direct plus indirect impacts), and Type II (Type I impacts plus induced impacts); Two, Type I and Type II multiplier-pseudo and ratio-form.

The starting point of this analysis was the estimation of the direct impacts of beef processing activities in Canada. These direct impacts were then disaggregated into various commodities that are demanded to process cattle and further into beef products. In summary form, these direct impacts contributed about $10.3 billion worth of goods, which resulted in $2.7 billion to Canada's GDP, including $0.36 billion as wages and salaries and profits of unincorporated non-farm businesses. Some 27,716 workers were employed by this sector during the 2018-2020 period (Table 1).

Table 1. Direct Economic Impacts of Canadian Beef Processing Sector, 2018-20

Particulars	Unit	Value
Production of Goods and Services	Mill. $	$10,307
Gross Domestic Product at Market Prices	Mill. $	$2,699
Labor Income	Mill. $	$357
Employment	Person-Years	27,716

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The direct impacts of Canadian beef processing activities affected the level of sales (or output) as well as the other three economic indicators (GDP, labor incomes, and employment). These impacts were estimated by the Canadian I-O model. In terms of the total impact on the sales (output) of various sectors, total production of goods and services in Canada increased by $23 billion through Type I (direct and indirect) impacts, and almost $28 billion through Type II (direct, indirect, and induced) impacts (Table 2). This increase in output resulted in additional GDP of $11 billion, including $6 billion through direct labor income (wages of workers and profits of unincorporated non-farm businesses). In addition, approximately 171,000 jobs in Canada were generated by beef processing activities in Canada.

Table 2. Total Economic Impacts of Canadian Beef Processing Sector, 2018-20

Particulars	Unit	Type I Impact Level	Type II Impact Level
Production of Goods and Services	Mill. $	$22,714	$28,256
Gross Domestic Product at Market Prices	Mill. $	$7,434	$10,738
Labor Income	Mill. $	$3,284	$5,581
Employment	Person-Years	93,034	171,190

The total economic impacts of the Canadian beef processing sector were converted into two types of multipliers Pseudo multipliers and Ratio-form multipliers. In terms of pseudo multipliers, as shown in Table 3, for every dollar worth of goods produced by this sub-sector, Canadian GDP increases by 72 cents, including a personal income of 32 cents, based on direct and indirect impacts. This contribution increases to 1.04 if all impacts are to be included. For each million-dollars' worth of output of the sub-sector, nine workers are employed for every thousand dollars in sales of this sector in Canada. Type II multipliers, as expected, are even larger, as shown in Table 3. One should also remember that these impacts are inclusive of impacts on farm level beef cattle.

Table 3. Pseudo and Ratio-Form Economic Multipliers for the Canadian Beef Processing Sector, 2018-20

Particulars	Unit	Pseudo Multipliers		Ratio-Form Multipliers	
		Type I Impact Level	Type II Impact Level	Type I Impact Level	Type II Impact Level
Gross Domestic Product at Market Prices	$	0.721	1.042	2.644	3.819
Labor Income	$	0.319	0.542	9.203	15.640
Employment	Person-Years	9.027	16.610	3.357	6.177

Interpretation of ratio-form multipliers is similar it is on a per dollar worth of direct output. As shown in Table 3, for every dollar of GDP produced by the Canadian beef-producing sub-sector, another 1.64 is generated by other sectors, making a multiplier of 2.64. Similarly, for every worker employed by the sub-sector four workers are employed in Canada (counting only direct and indirect impacts) and almost ten workers are employed (per thousand dollars' value of sales of this sector) elsewhere.

Processing of beef in Canada affects several economic sectors of the country, besides the agricultural sector (Figure 5). Through farm-level production activities, it assists the development of communities and small businesses in the local areas. Beef cattle production and the agricultural processing industries contribute almost two-thirds of the new employment generated in Canada. Other sectors that also benefit in terms of employment are services industries, trade, and the transportation sector.

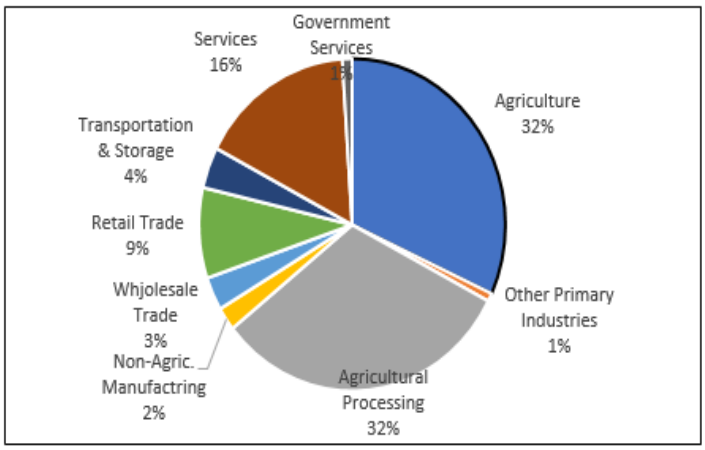

Figure 5. Distribution of employment by sectors from processing of beef in Canada.

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3.2 Western Canadian Beef Processing Sector Economic Impacts

This methodology for the western Canadian meat processing sector was similar to that used for the Canadian beef processing sector. In other words, total economic impacts were obtained using the western Canadian I-O model by inputting its direct impacts. In terms of the direct impact of the sub-sector, during 2018-2020, it produced a total of $7 billion worth of beef and related commodities (Table 4). This generated almost two billion dollars' worth of GDP in western Canada (including slightly over a quarter of a billion dollars in terms of labor income). Total employment generated in Western Canada amounted to 17,631 full-time equivalent jobs.

Table 4. Direct Economic Impacts of Western Canadian Beef Processing Sector, 2020

Particulars	Unit	Value
Production of Goods and Services	Mill. $	$7,386
Gross Domestic Product at Market Prices	Mill. $	$2,015
Labor Income	Mill. $	$256
Employment	Person-years	17,631

The direct economic activity of the beef processing sector in Western Canada resulted in higher economic activities in the region. Combining all direct, indirect, and induced impacts, it contributed $7.6 billion to the regional GDP and employed 118,591 workers (Table 5). Converting the total economic impacts on a per dollar's worth of output resulted in the estimate of pseudo multipliers. Based on including only direct and indirect impacts (Type I impacts), one dollar of goods sold by the sub-sector results in $0.72 in terms of GDP in the region (Table 6). This also generates almost 9 person-years of employment per million dollars of sales of goods. If all impacts (Type II) are considered, the total employment increases to 16 workers per million dollars of sales.

Table 5. Total Economic Impacts of Western Canadian Beef Processing Sector

Particulars	Unit	Type I Impact Level	Type II Impact Level
Production of Goods and Services	Mill. $	$16,266	$20,041
Gross Domestic Product at Market Prices	Mill. $	$5,325	$7,586
Labor Income	Mill. $	$2,347	$3,920
Employment	Person-years	64,381	118,591

Table 6. Pseudo and Ratio-Form Economic Multipliers for the Western Canadian Beef Processing Sector

		Pseudo		Ratio-form	
Particulars	Unit	Type I Impact Level	Type II Impact Level	Type I Impact Level	Type II Impact Level
Gross Domestic Product at Market Prices	$	0.721	1.027	2.643	3.765
Labor Income	$	0.318	0.531	9.176	15.328
Employment*	Person-Years	8.717	16.057	3.625	6.726

* Please note that on account of smaller direct impacts, some of these multipliers are high.

Ratio-form multipliers for the beef cattle processing sector show a higher multiplier activity. If all impacts are included, the output of the western Canadian region increases 2.7 times the level of output of the sub-sector. The GDP of the region increased by almost four times, and employment by a little under four times. One should note that since the sub-sector is purchasing inputs from the farm-level production sub-sector, these multipliers reflect more than processing-level impacts.

3.3 Eastern Canadian Beef Processing Sector Economic Impacts

Eastern Canada has a larger beef processing sector than Western Canada, but the slaughter of beef cattle sector is larger in Western Canada. The Eastern Canadian beef processing sub-sector (excluding processing of other live animals) produced a total value of goods and services worth $2.9 billion, which generated a regional GDP of $765 million, including $101 million as labor income. It is estimated to have employed 10,085 workers on a full-time basis, as shown in Table 7.

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Table 7. Direct Economic Impacts of Eastern Canadian Beef Processing Sector, 1980-2020

Particulars	Unit	Value
Production of Goods and Services	Mill. $	$2,921
Gross Domestic Product at Market Prices	Mill. $	$765
Labor Income	Mill. $	$101
Employment	Person-years	10,085

The total economic impacts of the processing sub-sector in eastern Canada were estimated at a total GDP of $3.2 billion, which included $1.7 billion as labor income. The sub-sector was also responsible directly or indirectly for creating 52,600 person-years of employment.

Table 8. Total Economic Impacts of Eastern Canadian Beef Processing Sector, 1980-2020

Particulars	Unit	Type I Impact Level	Type II Impact Level
Production of Goods and Services	Mill. $	$6,448	$8,214
Gross Domestic Product at Market Prices	Mill. $	$2,109	$3,152
Labor Income	Mill. $	$938	$1,662
Employment	Person-Years	28,653	52,599

The total impacts as reported above were converted into multipliers-pseudo and ratio-form. In terms of the level of production of goods of the sub-sector, one-dollar worth of production of eastern Canada's beef processing sector leads to a total regional level production of 2.21 dollars with both indirect and induced changes included (Table 9). The GDP increased by 72 cents including 32 cents as labor income. Every one-million-dollar worth of goods sold by the sub-sector generates 10 person-years of employment through direct and indirect impacts, and 18 person-years through all impacts.

Table 9. Pseudo and Ratio-Form Multipliers (Type I and II) for the Eastern Canadian Beef Processing Sector

		Pseudo		Ratio-form	
Particulars	Unit	Type I Impact Level	Type II Impact Level	Type I Impact Level	Type II Impact Level
Gross Domestic Product at Market Prices	$	0.722	1.079	2.647	3.956
Labor Income	$	0.321	0.569	9.271	16.430
Employment	Person-Years	9.810	18.008	2.841	5.216

Ratio-form GDP multiplier of this sub-sector suggests that every dollar of direct GDP generated results in a total GDP creation of 4 dollars if all impacts are considered. Similarly, every worker employed by this sub-sector results in total employment of 5.2 person-years in Canada through trade linkages with other regions.

4.0 Conclusions

Beef processing is an important activity in Canada. Although directly it contributes to the Canadian GDP, as well as creates employment for workers and owners of unincorporated businesses, its total economic impact is much higher than that obvious to the open eyes. During the 2018-2020 period, this sector contributed:

- Direct production of beef processing activities was $10.3 billion annually divided into 72% in Western Canada (direct activity of $7.4 billion) and 28% in eastern Canada ($2.9 billion) per annum.
- Through various interdependencies that exist in a modern economic system, this direct contribution of the sector created a total of $22.7 billion (if induced impacts are excluded) or $28.3 billion (induced impacts are added to the previous level of impacts). This amounts to a multiplier activity of 2.6 to 3.8 times for a situation when induced impacts are excluded and included, respectively.
- In a regional setting, the contribution of the beef processing industry in Western Canada was $16.3 billion (without induced impacts) and $20 billion including all economic impacts. Comparative estimates for eastern Canada showed a value of $6.4 and 8.2 billion, (without and with induced impacts).
- Based on the estimates of this study, beef processing activities are more important in western Canada since the magnitude of total economic impacts is about two and a half times the level in eastern Canada.

The use of an I-O model for estimating economic contributions made by economic activity is a more accurate method of estimating the socio-economic significance of a given activity. Although the direct contribution of a sector is commonly used, such usage underestimates the real importance of the sector significantly.

International Journal of Business and Applied Social Science

E-ISSN: 2469-6501
VOL: 8, ISSUE: 12
December/2022
DOI: http://dx.doi.org/10.33642/ijbass.v8n12p4

Acknowledgements

Funding received from the Canadian Cattlemen's Association for this research is gratefully acknowledged. Author would like to thank Cec Nagy and Jillian Brown for their help in collecting data for this project.

Conflict of Interest

The author has no conflict of interest.

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