Assessing the Macroeconomic Impact of COVID-19 on the Canadian Agri-Food Industry

by

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Abstract

The COVID-19 pandemic caused significant changes to Canadians' income, preferences, and purchasing behaviour, thus impacting the demand for goods and services. Industries deemed non-essential and providing consumer-facing services were severely hit, such as the foodservices sector, in which industrial GDP was down 28% from 2019. Meanwhile, sales in food retail stores increased by 10% as demand shifted from food consumed away from home to food consumed at home. Important disruptions occurred in agricultural production sectors, such as in the meat processing industry where outbreaks of coronavirus caused important economic consequences along the supply chain. This research aims at identifying the agri-food sectors that were affected by the pandemic and estimating these effects on the economy to better understand the repercussions on the Canadian food system. To do so, an interregional rectangle input-output model is used to estimate the effects from three scenarios simulating the impact of COVID-19 on food demand. The scenarios are based on three main drivers for food demand changes in 2020: higher sales in food retail stores; lower sales in the foodservice industry; and mixed effects on exports. Results suggest that the overall net impact, direct plus indirect effect, of the pandemic and policies put it place to contain the spread of the virus are estimated to be an industrial sector output reduction of $14.8 billion, a GDP reduction of $7.5 billion, and a loss of 187 thousand jobs. Moreover, the effects were uneven across industrial sectors. For example, the dairy sector and most food processing industries are estimated to be affected by increases in production, while the foodservice sector suffers important economic losses. The regional distribution of the effect is also uneven. The model estimates important reduction of industrial output in most provinces, with the exception of Saskatchewan in which results show an increase in industrial output. Issues not taken into consideration in the model are discussed. Results provide a starting point to assess the effects of the pandemic on the agri-food industry and their sectorial and regional distribution, and contribute to target policy intervention where it is most needed.

Résumé

La pandémie de COVID-19 a provoqué d'importants changements par rapport aux revenus, préférences, et comportements d'achat des Canadiens, impactant ainsi la demande en biens et services. Les industries jugées non-essentielles et fournissant des services en contact avec les consommateurs ont été sévèrement touchées, tel que le secteur de la restauration dans lequel le PIB sectoriel a diminué de 28% comparé à 2019. En parallèle, les ventes dans le secteur du détail alimentaire ont augmenté de 10% alors que la demande s'est déplacée des services de restauration vers les magasins d'alimentation. D'importantes perturbations ont affecté les secteurs de la production agricole, comme dans l'industrie de la transformation de la viande où des éclosions de coronavirus ont entraîné des conséquences économiques significatives tout au long de la chaîne d'approvisionnement. Cette recherche vise à identifier les secteurs agroalimentaires affectés par la pandémie, et à estimer ces effets sur l'économie afin de mieux comprendre les répercussions sur le système alimentaire canadien. Pour ce faire, un modèle d'entrées-sorties interrégional et rectangulaire est utilisé afin de quantifier les effets de trois scénarios simulant les effets de la COVID-19 sur la demande alimentaire. Ces scénarios sont basés sur trois principaux facteurs de changement de la demande alimentaire en 2020 : augmentation des ventes en épiceries, diminution des ventes des services de restauration, et des effets mixtes sur les exportations. Les résultats suggèrent que l'impact net global de la pandémie, soit les effets directs et les effets directs plus indirect, est estimé à une réduction de la production des secteurs industriels de $14.8 milliards, une réduction du PIB de $7.5 milliards, et la perte de plus de 187 000 emplois. En outre, les résultats démontrent aussi que la distribution sectorielle de ces effets est inégale. Par exemple, l'industrie laitière et la plupart des secteurs de la transformation alimentaire semblent bénéficier d'une augmentation de la production, alors que le secteur des services alimentaires souffre d'importantes pertes économiques. De plus, la répartition régionale est aussi inégale. Le modèle estime d'importantes réductions de la production dans toutes les provinces, à l'exception de la Saskatchewan, où les résultats montrent une augmentation nette de la production industrielle. Certains enjeux qui ne sont pas pris en considération dans le modèle sont discutés. Les résultats de cette recherche représentent un point de départ afin d'évaluer les effets de la pandémie sur les secteurs agroalimentaires, ainsi que leur distribution sectorielle et régionale, et contribuent à cibler les interventions politiques là où elles sont le plus nécessaires.

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Chapter 1: Introduction

1.1 COVID-19 and the Canadian agri-food industry

As of August 2021, the Center for Systems Science and Engineering (CSSE) at John Hopkins University reports globally over 200 million cases of COVID-19 and nearly 4.4 million deaths related to the SARS-CoV-2. The increased pressure on healthcare systems around the world is causing catastrophic consequences for patients in need of treatment as well as healthcare workers. In Canada, the spread of COVID-19 has forced hospitals around the country to make difficult decisions regarding the cancelation of elective surgeries and procedures, and further medical activities have had to be delayed as hospitals resources are drained by the ever-increasing number of COVID-19 cases (Jefford, 2020; CBC News, 2021).

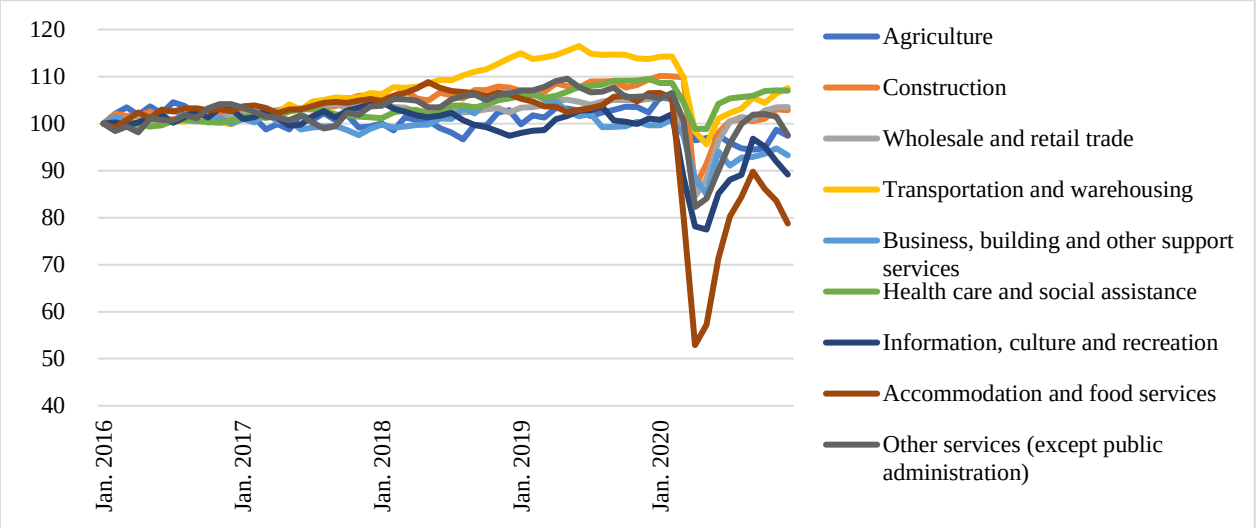
While the population's health is of primary concern, the combined effects of the pandemic and governments responses to the health crisis have induced enormous economic consequences for both the short and the long term. The World Bank predicts that most countries will be affected by recessions in 2020, and estimates the global real gross domestic product (GDP) to fall by 4.3% for 2020 (World Bank, 2021). In Canada specifically, the Conference Board of Canada forecasts the real GDP to decrease by 5.3% in 2020 (Chu, 2021).

This decrease in economic activity can be attributable to multiple factors, such as work absenteeism due to contracting COVID-19, family obligations, lockdown measures, social distancing, and travel restrictions among others. These conditions forced many business closures and a high unemployment rate in several industries. In May 2020, the number of active businesses in Canada dropped by over 100,000 compared to May 2019 (Statistics Canada, 2020a). The impact caused by COVID-19 on the Canadian economy differs significantly across industries. Economic sectors providing consumer-facing services, as well as those reliant on travel and tourism have been particularly affected.

The restaurants and accommodation industry is arguably one of, if not the most severely affected economic sector, due to travel restrictions, social distancing, and lockdown measures. As depicted by *Figure 1*, the average annual growth rate of employment in the *Accommodation and foodservices* sector was approximately 1.6% between January 2016 and January 2020,

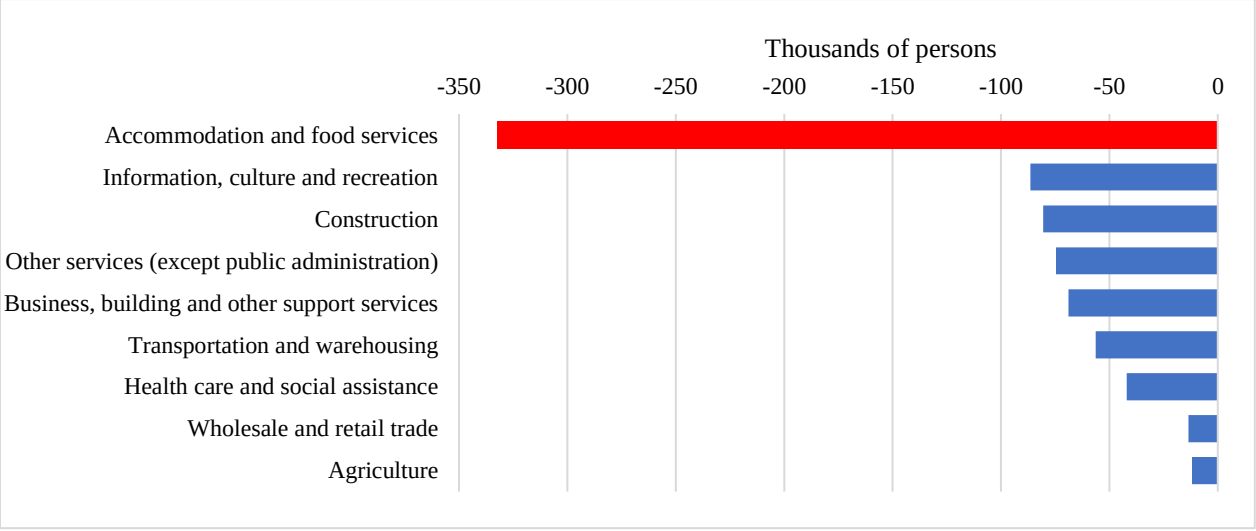
before dropping by a whooping 47% in just two months between February and April of 2020 (Statistics Canada, 2021a). By December 2020, net employment in this sector was 27% lower than in the same month in 2019 (332,300 jobs), still the biggest gap across all Canadian industries as shown in *Figure 2*.

Figure 1: Evolution of employment per sector, 2016-2020 (2016 = 100)



Source: Statistics Canada, Table 14-10-0355-01

Figure 2: Net Employment of selected industries, December 2019 to December 2020

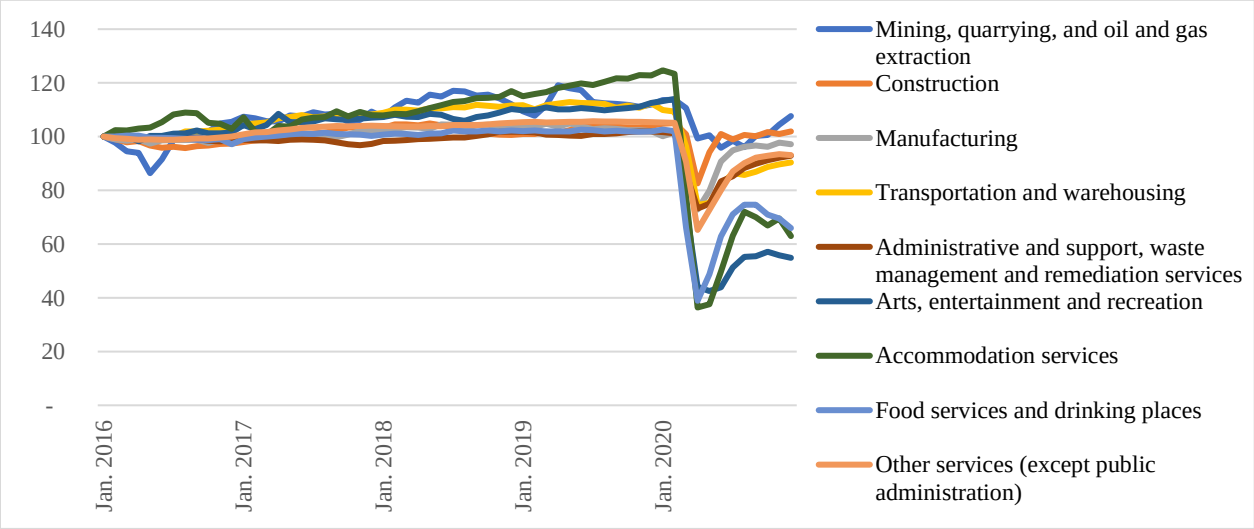


Source: Statistics Canada, Table 14-10-0355-01

In terms of industrial GDP, *Figure 3* shows a massive drop for most industries in March and April 2020, particularly in the *Accommodation services* and *Foodservices and drinking*

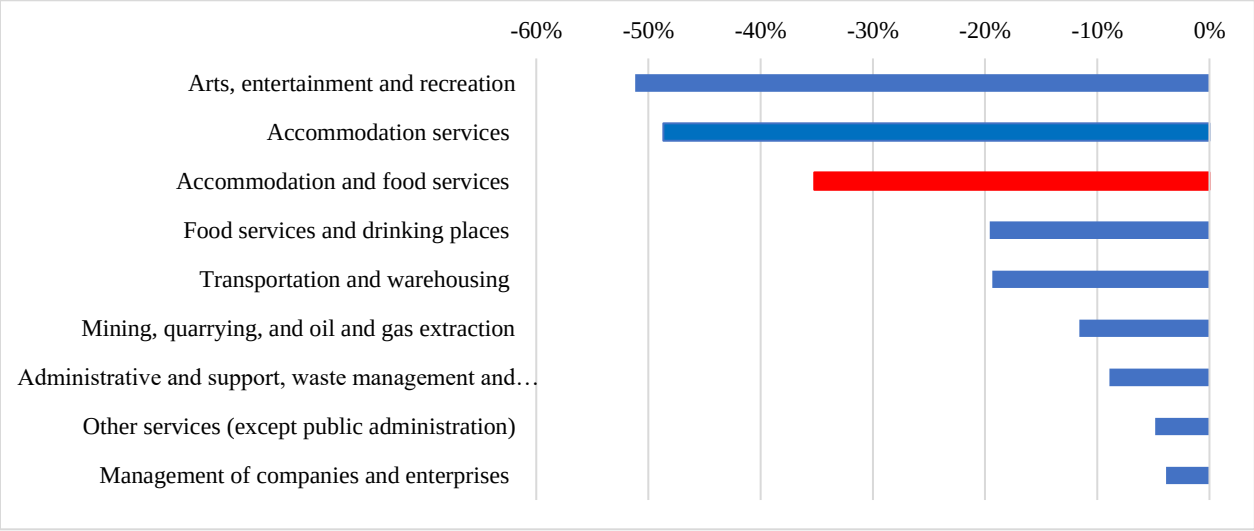
places industries (Statistics Canada, 2021b). Before this period, the foodservice sector GDP was growing at an average annual rate of 0.7% between 2016 and 2020, before dropping 62% in April 2020. By December 2020, the decrease in industrial real GDP in the foodservice sector had recovered some losses but was still approximately 35% lower than its pre-pandemic level. As depicted in *Figure 4*, this reduction in real industrial GDP places the foodservice industry in third place of the most affected industries, behind the *Arts, entertainment, and recreation* sector and the *Accommodation services*.

Figure 3: Evolution of real GDP per sector, 2016-2020 (2016 = 100)



Source: Statistics Canada, Table 36-10-0434-01

Figure 4: Real GDP reduction of selected industries, December 2019 to December 2020



Source: Statistics Canada, Table 36-10-0434-01

1.2 COVID-19, food supply chains, and demand

It is safe to assume that most people have roughly the same dietary and caloric requirements compared to pre-pandemic levels. A lower consumption of food away from home (e.g., restaurants, food trucks, cafeterias) therefore implies an increased consumption of food at home (e.g., grocery stores, delivery services). Indeed, it appears that retail sales from food and beverages stores increased by 10% in 2020 compared to 2019 (Statistics Canada, 2021c). Because eating out is more expensive than cooking at home, the decreased expenditure in the foodservice industry is expected to be larger than the increased expenditure in food and beverages stores.

This shift in food demand happened suddenly and unexpectedly in the early spring of 2020 and created significant disruptions in the food supply chain. Differences in the nature and/or packaging format of food consumed at home and consumed away from home called for adjustments from food manufacturers, causing disruptions upstream in the agricultural production sector, and downstream in the food distribution sector.

In the dairy industry, for example, restaurants closures caused the demand for certain products (e.g., cream, butter, cheese) to drop, while consumption of fluid milk increased. Adjusting production to the shifting demand required time, during which cows continued to be milked. However, raw milk storage capacity was insufficient to absorb milk production in the meantime, therefore leading to an oversupply causing the dumping of milk in April 2020 (Weersink, von Massow, and McDougall, 2020).

In the food retail sector, many consumers engaged in panic buying or hoarding behaviour by stockpiling on food products such as canned or dried goods, baking supplies, frozen produce, and dairy products (Statistics Canada, 2020b), in some cases causing inventory shortages and empty shelves of key food items in supermarkets (Hobbs, 2020). These shortages, however, were more a consequence of the just-in-time approach largely used in Canada being ill-adapted in responding to such a sudden spike in demand, rather than signaling a widespread lack of food products in the system.

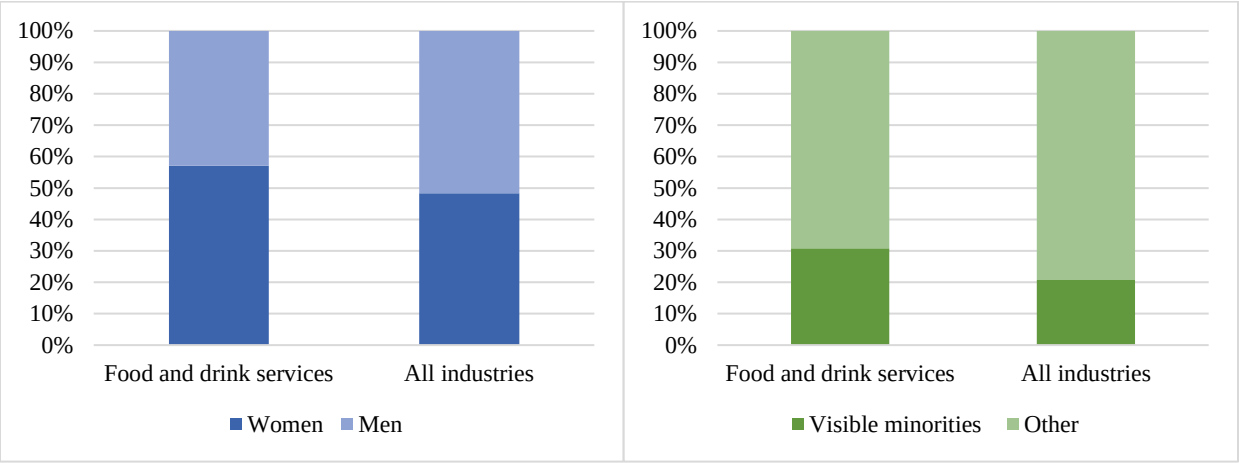
The dumping of milk and shortages in food retail stores are examples of short-term consequences occurring while the supply chain was adjusting to substantial and unpredicted shocks on the demand side, as well as on the production side. The agri-food industry has shown

resilience and successfully addressed several challenges caused by the pandemic, at least partially: empty shelves were restocked rapidly; excess supply of some food items was donated to food banks; most temporary foreign workers were allowed in the country despite travel bans; major concerns about international trade did not materialize; and finally, there has been volatility in food price, but not the drastic increase that some had feared (Cranfield, 2020).

Longer-term effects are also likely to occur. Consumers adapted their food purchasing behaviour during the crisis and the longer these new habits are necessary, the more likely they are to stick, even when the pandemic is over. For instance, online shopping was already trending upward before COVID-19 happened, and the health crisis accelerated its development and its adoption by consumers (Melo, 2020). Another example is the strengthened interest in local food supply supported by consumers' increased concerns regarding food safety, as well as other motivations such as perceived economic, social, environmental, and health benefits (Goddard, 2021; Hobbs, 2020; Melo, 2020).

Another potential longer-term effect of the pandemic in the agri-food industry is the devastating impact on the foodservice sector which could lead to several firms exiting the market. As of December 2020, Restaurants Canada (an industry advocacy group) estimated that 65% of the restaurants were operating at a loss. The interest group also estimated that roughly half of the restaurants in Canada were at risk of closing in the next six months if the situation did not improve (Restaurants Canada, 2020a). Furthermore, the sector's high unemployment rate affects visible minorities and women disproportionally, population groups that are already economically vulnerable. As shown by *Figure 5*, 31% of the labour force employed in foodservices and drinking places belongs to a visible minority, compared to 21% in all industries; and 57% of the labour force in the sector are women, compared to 48% in all industries (Statistics Canada, 2016).

Figure 5: Proportions of women and visible minorities employed in food and drink services, 2016



Source: Statistics Canada, Census of population 2016

1.3 Problem Statement

The COVID-19 pandemic has been the cause of several important changes in Canadians' lives. In an attempt to prevent the spread of the virus, provincial and federal governments have put in place policies such as travel restrictions, social distancing, and lockdown measures. Despite governmental support programs, notably the Canada Emergency Wage Subsidy (CEWS) and the Canada Emergency Response Benefit (CERB), economic hardship still affects a nontrivial part of the economy. Furthermore, the economic consequences related to COVID-19 are uneven across industries and populations. For example, the accommodation and foodservice sector, characterized by an over-representation of women and visible minorities, was severely hit. Canadians have had to adapt their food consumption patterns, which is going to have potentially lasting repercussions throughout the whole food supply chain. Global food demand was altered drastically in a short period of time causing disruptions in international food markets.

All these components of food demand have had a sizeable impact on the Canadian economy, especially in the agriculture and food producing sectors. It is, therefore, crucial to estimate and understand the economic impact that the COVID-19 pandemic has had on the agri-food industry. Assessing how this shift in demand affects the different sectors composing the Canadian agri-food industry and their linkages with other economic sectors will help to identify those that suffered economic losses during this global health crisis and those that were able to

capitalize on potential opportunities stemming from the pandemic. Results from this research are expected to help policy-makers understanding the repercussions of COVID-19 on the Canadian agri-food industry, particularly regarding their industrial and regional distribution, and will contribute to targeting policy intervention where it is most needed.

1.4 Objectives

The main objective of this research is to estimate the economic impact of COVID-19 on the Canadian agriculture and food producing industries. An important element of the analysis will be to study the distribution of the pandemic effects among the different sectors, but also to assess the geographical distribution of these effects across Canadian provinces and territories. Indeed, Canada is a vast country and provinces tend to specialize in economic production activities. In the agriculture and food producing sectors, regional specialization may occur due to factors such as weather conditions, farmland quality and availability, relative prices of factors of production, access to natural resources, proximity to marine ecosystems, tradition, etc.

A sub-objective, that actually precedes the above main objective, is to determine the impact of COVID-19 on different components of food demand. Indeed, the pandemic has caused significant disruptions in both the supply and demand of food products. This study aims at assessing the demand-side effects of this issue by quantifying the variation in food demand and using it to shock a model of the Canadian economy. This element will contribute to identifying the immediate economic consequences of the coronavirus crisis on the food system.

This research also aims at discussing policy implications related to the challenges brought forward during the COVID-19 crisis. In a context of expected provincial and federal budget deficits and with governments planning an economic recovery, it is crucial to determine the sectors suffering the most from the pandemic, and to identify potential ways to mitigate their economic losses.

1.5 Structure of the thesis

The structure of the thesis is organized as follows. *Chapter 1* provides background information, identifies issues related to COVID-19 and the agri-food industry, and presents the problem statement as well as the objectives of the research. In *Chapter 2*, the literature

concerning COVID-19 and the Canadian agriculture and food producing sectors is reviewed. A summary of the economic research around the pandemic impact is also provided in this section. *Chapter 3* presents the method and the data used to address the research problem, as well as the different scenarios designed to shock the economic model. Results are presented in *Chapter 4* and *Chapter 5* provides an analysis and discussion of these results, as well as suggestions regarding potential policy solutions. Limitations from the research are also discussed, as well as ideas for further research to improve upon the results and conclusions. Finally, *Chapter 6* concludes the thesis by summarizing the research and its results.

Chapter 2: Literature Review

COVID-19 and its economic consequences form a growing body of literature and will remain a topic of discussion for years to come. *Chapter 2* reviews some of the research on COVID-19 and its economic impact. The first section focuses on the effects of the pandemic in Canada, specifically in the agriculture and food producing sectors. Emphasis is put on studies with a broader perspective on COVID-19 and the related economic shocks in the second section. Finally, economic models relevant to this research are presented and discussed.

2.1 COVID-19 and the agri-food sector in Canada

2.1.1 Supply and demand shocks

Market disruptions caused by COVID-19, from both the supply and demand side, have had a significant impact on the Canadian agri-food sector. As the pandemic was unfolding during the spring of 2020, academics used theoretical concepts to predict the economic impact of COVID-19 on the agri-food industry. With over a year since the beginning of the coronavirus crisis, researchers now have the means to empirically test the hypotheses previously proposed, as relevant data becomes increasingly available.

For instance, Deaton and Deaton (2020) examine the effect of COVID-19 on food insecurity in Canada using two different perspectives: the income shock resulting from the pandemic as well as the capacity of the food system to provide an adequate supply of food. They predict that the pandemic would result in increased food insecurity through the income shock, but the food system should prove resilient enough to ensure adequate food supply without an important generalized price increase. Revisiting their hypotheses a year later, Deaton and Deaton (2021) confirm that COVID-19 did increase the prevalence of food insecurity in Canada and that the food system proved resilient and was successful in providing an adequate an supply of food while avoiding a rapid increase in food prices. They also argue that concerns regarding the increased prevalence of food insecurity in Canada are valid, but should not be interpreted as a failure of the Canadian food system.

Cranfield (2020) explores the impact of COVID-19 on consumer demand for food, notably through the structure of preferences, income and time constraints, and price effects. He

predicts income loss would lead to consumers rearranging their food expenditure, by the means of substitution between and within food groups, but that this substitution effect would be tempered by people spending more on food consumed at home and less on food consumed away from home. The author emphasized that new routines developed during the pandemic may lead to people developing new food habits. Finally, he suggests that strong attention should be given to the effects of income and wages policy interventions on food demand. While his hypotheses have not been empirically tested, this thesis is expected to shed further insights into the effects of COVID-19 on food demand.

Goddard (2020) provides an early assessment of the impact of the pandemic on the foodservice and food retail sectors. The author notes the importance of the effect on employees working in the food supply chain, as well as how the pandemic introduced changes in how people buy and consume food. In hindsight, Goddard (2021) confirms that the food retail sector has adapted to the needs of consumers, as multiple channel retailing gains in popularity, rather than specializing in bricks and mortar or online shopping, but that it contributed to generate higher costs which may well be transmitted down to consumers through food price increases.

The food processing sector is another important industry in the Canadian food system. Hailu (2020) attempts to predict the effects of the pandemic on food processors by identifying potential demand and supply shocks caused by the health crisis. Demand-side shocks include the shift in demand from foodservice to food retailers and lower exports of processed food due to the thickening of borders. Supply-side potential shocks include the effect of borders thickening on imports, labour market disruptions (e.g., transportation, foreign workers), productivity loss, and additional costs incurred by adapting production processes (e.g., health and safety practices, reorganizing production lines). A year later, Hailu (2021) notes that the effects of the pandemic were uneven across processing subsectors, with labour-intensive industries (e.g., beef, pork, and poultry processing) being more affected than others. While the author mentions that the capacity utilization rate was reduced during the pandemic, labour productivity increased compared to 2019, potentially due to investments (e.g., automation) (di Mauro & Syverson, 2020), low productivity firms/plants closing (temporarily or permanently), and/or firms shedding unproductive workers (Berger, 2012). Finally, borders remained open for essential goods and services, which includes food and transportation services, allowing Canadian firms to continue importing and exporting food products with their trading partners.

Hobbs (2020) predicts demand and supply shocks similar to those analyzed by Cranfield (2020) and Hailu (2020). The author believes that growth in online grocery shopping should last longer than the pandemic. However, she doubts that the increased interest in local food will continue in the long run, as the fundamental economics of the sector remains the same. With over a year into the pandemic, Hobbs (2021) expresses similar thoughts, adding that the food system may have been permanently changed with increased automation, digitalization, as well as infrastructure for online delivery services.

Gray (2020) examines how the pandemic is likely to affect transportation services related to agri-food products. The author argues that the economic shutdown should increase the availability of transportation services to agri-food products as there is less competition from other sectors, thus freeing up capacity to transport agricultural and grocery supplies. While the various forms of transport (e.g., rail, ocean freight, air freight, truck) will be affected in different ways, he expects costs to decrease due to lower overall demand for transportation services, on top of lower oil prices reducing fuel costs. Revisiting the predictions made in Gray (2020), Gray & Torshizi (2021) conclude that agricultural transportation systems performed exceptionally well during the pandemic, in some cases setting record volumes of movement for 2020. This was a consequence of freed up capacity, as well as innovation, institutional arrangements, communication channels, and policy changes.

2.1.2 COVID-19 and agri-food subsectors

In terms of specific commodities, Brewin (2020) estimates that the Canadian grains and oilseeds market should not be severely affected by the pandemic, other than some downstream effects related to labour and income disruptions, notably because he predicts stable production and prices. Indeed, the sector was able to harvest a large crop, and prices increased near the end of 2020, confirming these predictions (Brewin, 2021). Exports of grains and oilseeds were affected by the pandemic, but the author's forecast of a near-normal year for 2020 in this sector was relatively accurate.

In Richards & Rickard (2020), concerns were raised regarding the effect of labour availability in the fruit and vegetable sector due to constraints on migrant workers. The authors forecast that disruptions in labour markets in the U.S. would have dramatic effects on production and therefore on trade flows and commodity prices. They also predict irreversible shocks in the

sector, such as consolidation and a move towards online shopping. However, Chenarides, Richards & Rickard (2021) analyze that despite a severe short-term impact following the economic shutdowns in the spring of 2020, the fruit and vegetable sector proved resilient as production and trade flows were minimally affected. They argue that policy responses from the Canadian and the American governments, combined with a strong, relatively constant demand for food were successful in ensuring the continuity of the food system.

Exploring the effects of COVID-19 on the supply-managed sectors of dairy, poultry, and eggs, Weersink et al. (2020) conclude that these industries should recover quickly from short-term disruptions due to their underlying structure (e.g., pooling of costs and revenues, coordinated marketing, and transportation). However, despite their ability to adapt to the demand shift from foodservice to retailing, significant disruptions remain, particularly in the poultry processing sector as it is still adjusting to the evolving situation (Weerskin et al., 2021).

In the pork industry, McEwan et al. (2020) identify concerns that could potentially have a severe impact on the sector, mostly related to the uncertainty around international trade in the context of a pandemic, as well as labour availability. Ultimately, market access to live pigs and pork products was maintained, even leading to increased pork exports to China mostly due to African Swine Fever (ASF) (McEwan, Marchand & Shang, 2021). Furthermore, the industry proved resilient in addressing labour challenges caused by the pandemic, notably by increasing inter-provincial shipments as well as increasing live pig exports south of the border (McEwan et al., 2021).

Rude (2020) provides a preliminary analysis of the cattle and beef sector during the first wave of the pandemic. His predictions do not differ much from those made in other agricultural sectors: consumer demand shifting from foodservice to retail causing logistical challenges and price effects, consumers income effect, labour constraints (especially in the processing sector, less so in the cattle sector), and concerns regarding international trade and market access. With the benefit of hindsight, Rude (2021) argues that while some demand-side disruptions did occur in the early days of the pandemic, the real impact on the sector stemmed from labour shortages and the shutdown of processing facilities. The closure of several meat processing plants in the first half of 2020 caused a divide between (higher) retail and (lower) farm-level prices. Despite the challenges faced by the industry, the beef sector eventually returned to near normal, as production and prices came back close to their pre-pandemic levels. However, it is noted that the

effects on the processing sector may not be fully felt by the producing sector yet due to the long cycle of production in the cattle industry. The author also argues that smaller, local processing plants would not necessarily have been able to better contain the spread of the virus and that their sustainability is questionable due to economies of scale in the processing sector. Finally, Rude (2021) notes that the disruptions related to COVID-19 in the beef processing sector may provide further incentives for firms to invest in labour-saving technology, such as robotics.

2.1.3 International trade

The Canadian agricultural industry is export-oriented, justifying the serious concerns regarding the impact of the pandemic on international trade. The World Trade Organization forecasted the impact of the coronavirus crisis on global trade to represent a decline of 13% to 32% in total merchandise volumes (Azevêdo, 2020). Barichello (2020) argues that due to their low income elasticities, food products should also decline, but relatively less than products from other industries (e.g., automotive products, electronics, services). Income elasticities vary also across food categories, such as meat products having higher elasticities than staple foods like cereals. In addition to this decline in food exports demand, supply-side concerns persist such as labour availability (e.g., migrant workers, absenteeism of domestic workers). Unexpectedly, Barichello (2021) finds that agricultural trade in Canada increased by 11% to 15%, mostly due to increased crop exports (cereals, oilseeds, and lentils). While some of this growth is related to price increases, most of the growth was caused by a larger quantity of goods exported. However, the author argues that this exports boom was not caused by the pandemic, but rather due to commodity-specific circumstances: China rebuilding its pig herd, small lentils harvest in India, and increased demand for Canadian cereals. He notes that higher cereals exports were facilitated by high initial stocks and lower than usual final stocks, concluding that this level of exports will likely not be sustained in the next years. He concludes that very few exports restrictions policies were adopted during the pandemic, effectively supporting food availability as well as relatively constant prices[1].

Regarding imports, there were early concerns expressed by industry of possible crucial agricultural input shortages (Ker, 2020; USDA, 2020). In the eventuality of borders thickening,

[1] At least, relatively constant compared to potential increased prices due to exports restrictions, as was the case during the 2008 food price crisis (FAO, 2011).

reduced input availability could have led to lower output production, lower farm income, and further disruptions to agri-food supply chains. This issue was avoided as most governments identified agri-food products as essential and refrained from adopting policies that might have disrupted the flow of agricultural and food products.

2.1.4 Labour issues

A major issue common to almost all industries during the pandemic was labour. Larue (2020; 2021) explores several aspects of actual and potential labour challenges faced by the agri-food sector, some of which are discussed in the following section. First, the economic shutdown caused a historic increase in the unemployment rate (especially in the foodservice sector, and other travel and tourism-related industries) with the potential of a feedback loop through lower consumer income reducing demand, and therefore further reducing production and demand for labour. This income shock could also trigger a rearrangement of consumers' preferences and demand, prompting further adjustments in supply and related factors of production such as labour (Baqaee & Farhi, 2020; Cranfield, 2020; Larue, 2020).

Second, measures adopted to protect workers' safety could lead to increased costs and/or lower productivity. For instance, Saba (2020) reports that despite an increase in revenues of 7.4% in the second quarter of 2020, food retailer Loblaw's net earnings dropped 29% year-over-year, allegedly due to increased costs induced by the pandemic such as the "hero pay" wage increase provided to their employees. Such costs increase could accelerate the adoption of automation and other labour-saving investments in food production and distribution (Hailu, 2021; Casey & Smith, 2020). Larue (2021) finds that despite the temporary wage increases offered by most major food retailers, employment in grocery stores between May and August of 2020 dropped by 2% in Quebec and 5% in Ontario, suggesting that the improved conditions did not provide enough incentive to effectively mitigate the perceived risk of working in grocery stores.

Third, despite the adoption of safety measures to contain the spread of the virus at work, employees in labour-intensive industries, such as food processing, remain at risk of contracting and/or spreading COVID-19. Indeed, several outbreaks occurred in meat processing facilities across Canada in 2020 and 2021, some of which also caused entire plants shutdowns. In some cases, processors can relocate production to other facilities (Larue, 2020), but this option is

limited by processors' capacity utilization, and therefore constrained by labour availability, among other factors (Hailu, 2021). COVID-19 outbreaks in slaughterhouses during the spring of 2020 caused major upheavals in the pork and beef supply chains, with both upstream and downstream consequences, disrupting labour markets in various subsectors.

Fourth, farm-level production may be less labour-intensive, but domestic labour shortages remain a recurring issue in the agricultural sector (Larue, 2020). Each year, temporary foreign workers (TFWs) are recruited to mitigate this shortage and they represent a significant fraction of agricultural workers. Serious concerns have been expressed by farmers regarding the burden of employing TFWs during COVID-19 (e.g., departure postponements, additional costs for providing accommodation and meals during workers' quarantine), prompting the federal and provincial governments to provide funds for those extra costs, effectively avoiding lower production due to a lack of foreign workers.

While it would make sense, in theory, for workers laid off in other industries to look for available jobs in the agricultural sector affected by a labour shortage, especially considering the sector's need for unskilled workers, domestic workers also had access to a generous federal program of income support (CERB), in many cases providing enough incentive not to look for another job during lockdowns. Recognizing this, the government of Quebec announced in April 2020 a wage subsidy program (100$ per week) contributing to incentivize workers to seek jobs in the agriculture sector, as well as other types of subsidies (e.g., help to meet public health regulations, employers-employees matching service) (Entreprises Québec, 2020). Larue (2021) finds that such measures have contributed to an increase in the number of agricultural workers in the fall of 2020 compared to 2019, while it dropped slightly in the rest of Canada and the U.S.

Finally, although governments around the world put policies in place to reduce the economic consequences (e.g., wage subsidies, stipends to laid-off workers, business loans), the globalized nature of most supply chains implies that the labour market in Canada will also be affected by that of other countries, which will ultimately depend on their respective handling of the COVID-19 crisis and recovery.

In summary, the COVID-19 pandemic brought significant disruptions in the labour markets that will have repercussions on the demand as well as on the production side. Short-term effects such as high unemployment rate are already being felt, while longer-term effects such as widespread recessions and supply chain structural adjustments are beginning to surface. Overall,

it is likely that the coronavirus crisis will increase labour costs in the agri-food sector, although less than in other industries, and this may accelerate the adoption of labour-saving technologies.

2.1.5 COVID-19 and farmland markets

Lawley (2020) explores the potential repercussions of COVID-19 on the Canadian farmland markets. With the uncertainty that the pandemic and the induced disruptions in supply chains around the globe, consequences are expected on commodity prices, farm costs and revenues, as well as other macroeconomic factors such as inflation, exchange rates, and interest rates. These factors usually correlate with farmland values, which represent the largest single component of Canadian farms' assets (Statistics Canada, 2021d). Therefore, it is likely that COVID-19 will have an impact on the farmland market in Canada.

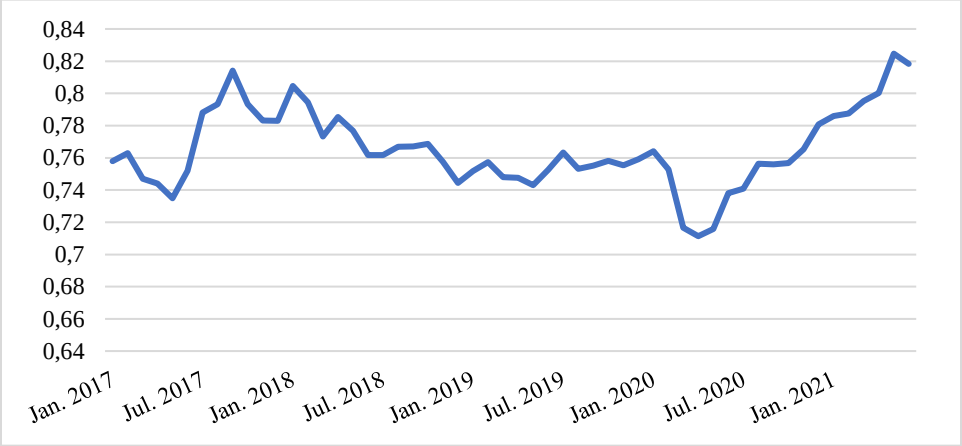
The short-term effect of COVID-19 on commodity prices has been deflationary (Mutikani, 2020; FAO, 2020a). Following the capitalization theory, the value of an asset represents the discounted sum of its future returns, which in the case of lower-income due to the pandemic (e.g., lower demand and/or prices) should result in a reduction of farm real estate value. However, Lawley (2021) finds that farming returns increased in 2020 by over 9% compared to 2019, due to increases in receipts from crop (+15%), livestock (+0.3%), and government program payments (+12%). More recent estimates from the FAO (2021) also find that the food price index in June 2021 was 34% higher than its level in 2020, suggesting that the deflationary effect of the pandemic on food commodity prices was temporary and even reversed during the second half of 2020, continuing on its uptrend during the first half of 2021.

Lawley (2020) presents evidence that low real interest rates tend to support an increase in farmland values, noting the historical correlation between these two variables. The economic shutdown brought by the pandemic forced central banks around the world to reduce already low-interest rates even further, possibly also supporting an increase in farmland values. As of July 2021, interest rates are still low, but evidence of inflation is starting to show and concerns about possible interest rate hikes are emerging (Long, Van Dam, & Fowers, 2021). With real estate (including farmland) being traditionally a way to hedge against inflation, an upcoming increase in interest rate could also support higher farmland values, but this remains to be seen.

To some extent, exchange rates also affect farmland values. A lower value of the Canadian dollar makes Canadian exports globally more competitive, but relatively more

expensive imports (e.g., input) mitigate this effect. However, farmland markets may be more directly affected by exchange rates through demand from foreign buyers, effectively putting upward pressure on land prices in Canada with a lower Canadian dollar value (Lawley, 2020). *Figure 6* shows the Canadian dollar value dropping (compared to USD) in the early days of the pandemic until the end of spring of 2020 and then climbing steadily to levels last seen in 2017 (Bank of Canada, 2021).

Figure 6: Monthly exchange rate, USD/CAD, 2017-2021



Source: Bank of Canada, 2021

Another factor that could influence the course of farmland markets is the demand for residential and commercial development around large urban areas (Lawley, 2020). COVID-19 caused a major transition for many people to start working remotely, decreasing the need to live near their workplace as commuting is less/not an issue. With the possibility of being able to work from anywhere, it is very likely that people move from urban, densely-populated centers to suburban or rural areas, especially with the current affordable interest rates. Lawley (2021) finds that house prices in Guelph increased more rapidly than in Toronto, potentially suggesting a shift in demand to low-density population areas. However, further research would be needed to confirm this hypothesis.

2.1.6 Policy response to COVID-19

The COVID-19 crisis and the related mitigation measures have had severe economic consequences, justifying the need for a prompt policy response from the federal government.

Since the beginning of the pandemic, several programs have been designed to help support individuals, businesses, industries, and communities (Government of Canada, 2021). These policy responses include fiscal measures such as direct aid to households and businesses income (e.g., CERB, CEWS, employment insurance), tax credits and deferrals, and support to the health system, totalling approximately $435 billion (IMF, 2021).

The federal government also put in place measures specifically targeting the agri-food sector, such as a program subsidizing the costs associated with the mandatory quarantine for TFWs, additional funding through Farm Credit Canada, and changes to Business Risk Management (BRM) programs (Government of Canada, 2021; Ker & Biden, 2021). These programs were designed to address challenges stemming from COVID-19 faced by the sector. Other ad hoc programs include support to cattle and hog producers to cover the costs of feeding market-ready animals during processing plant closures.

Ker (2020) offers a preliminary analysis of the potential risks induced by the pandemic and how actual and potential policies will assist farmers in managing these new risks. He categorizes potential risks into three categories (price risk, output risk, and border risk), and assesses how the existing BRM suite can address them.

In terms of price risk, he expects most input (capital, feed, and energy) prices to decline, except for an increase in labour price. He anticipates no significant farm output price decline, assuming borders remain open to trade. The author notes that losses incurred because of price movement would fall under the AgriStability program, but it is highly unlikely that such movement would be large enough to trigger payments from the BRM program (decrease over 30% of net margin).

Ker (2020) notes that the output risk due to COVID-19 is significant, mainly because of issues related to labour, transportation, and processing capacity. He analyzes that BRM programs do not cover losses incurred due to lack of labour, or the inability to transport, or to sell output. However, he notes that the downward price pressure associated with some of these issues would reflect in the net margin and is therefore at least partially covered under AgriStability.

Trade risk is likely the most concerning risk for Canadian farmers, according to Ker (2020), because of the important share of agri-food output exported. He argues that closed international borders would result in a significant price decline, especially for non-storable commodities such as cattle and hogs. Moreover, closed borders would prevent Canadian farmers

to benefit from a relatively low Canadian dollar. He estimates that the price reduction would be sufficient to trigger AgriStability payments, concluding that the BRM programs provide coverage for this important risk.

Ker and Biden (2021) evaluate the ability of BRM programs and the federal government policy response to COVID-19 in the context of the agricultural sector since the onset of the coronavirus pandemic. Their analysis shows that different sectors have faced different risks and challenges during the crisis, but that overall, COVID-19 did not expose significant gaps in BRM programming, notwithstanding the extra funding that the industry may be calling for. They argue that farm income is projected to increase 22% and that AgriInvest savings accounts increased $2.4 billion in 2020, providing evidence that BRM programs do not warrant major adjustments.

2.2 Source and nature of economic shocks

The global economic and financial effects of the COVID-19 pandemic are disastrous. The disease outbreak prompted scientists in various fields of research to assess how its causes and consequences could be prevented and/or mitigated. In early 2020, as the virus began to spread globally, researchers attempted to anticipate the economic impact the disease would have on society. It became clear that limiting the spread of the virus would require economic trade-offs, as governments enforced various mitigation measures such as closing borders, travel restrictions, quarantines, and lockdowns (Nicola et al., 2020).

Baldwin and Weder di Mauro (2020) identify three sources regarding the economic shocks: 1) purely medical, i.e., sick workers unable to produce GDP; 2) public and private containment measures; and 3) intangible, beliefs-based economic shocks. Most economists agree that those shocks have repercussions on both the supply and the demand side of the economy (Baldwin and Weder di Mauro, 2020; Hailu, 2020; Hobbs, 2020; McKibbin & Fernando, 2020; Maital & Barzani, 2020; Brinca, Duarte & Faria e Castro, 2020).

On the supply side, the production of goods and services was altered by multiple factors: workers getting sick or absenteeism due to risks of being exposed to the virus, non-essential businesses closures, adjustments of processes to allow for physical distancing hindering productivity, etc. As these effects were uneven across industries and supply chains, supply bottlenecks occurred, effectively transmitting effects and pressure upstream and/or downstream.

An example of such a bottleneck situation in the Canadian agri-food industry occurred in April 2020, when the beef supply chain was disrupted by COVID-19 outbreaks in two meat processing plants in Alberta, temporarily halting 70% of Canadian beef processing capacity (Statistics Canada, 2020c). Upstream, lower slaughter rates created a backlog of cattle and calves bound for slaughter causing the average price to decline 11.2% compared to the same period in 2019, as some producers preferred to sell animals at a loss rather than to continue raising animals at a higher cost. Downstream, tighter supply and declining stocks, combined with increasing demand from food retailers, led to price increases in the following months compared to 2019, for wholesalers as well as consumers (Statistics Canada, 2020c).

On the demand side, one direct effect of the pandemic is income losses due to unemployment leading to a decrease in demand for certain goods and services. Business closures (temporary or permanent) caused the Canadian unemployment rate to surge to levels unseen since the 1980s, as it increased from 5.6% in February 2020 to a peak of 13.7% in May 2020 (Statistics Canada, 2021e). Recognizing the negative economic impacts that its COVID-19 containment policies could cause, the federal government provided an economic stimulus package to businesses and workers, notably with programs such as CEWS and CERB, in an attempt to mitigate the impending economic slowdown.

Containment and mitigation measures (e.g., sanitary recommendations, social distancing, non-essential businesses closures, incitement to buy online) contributed to a rearrangement of consumer preferences, thus prompting adjustments on the demand side (Baqaee & Farhi, 2020). In the agri-food industry, this was evident in the shift in demand away from foodservice to food retailers and delivery services. Canadians typically spend approximately one-third of their total food expenditures in restaurants (Statistics Canada, 2021f); with restaurants closed, this food expenditure was reallocated elsewhere, notably to grocery stores and food delivery services.

Less tangible, psychological factors also influenced consumer behaviour in several ways. For instance, consumers and firms tend to adopt a “wait-and-see” approach when facing uncertainty, thus delaying purchases and investments (Baldwin & Weder di Mauro, 2020). However, belief-based factors were also a cause of the panic buying chaos in early spring 2020; despite government officials and food industry representatives claiming there was no lack of

food in the system, many consumers engaged in panic-buying and stockpiling behaviours, developing into a self-fulfilling prophecy of temporary food item shortages (Hobbs, 2020).

Supply and demand shocks are not independent of one another; interactions between supply and demand within and across industries abound and feedback effects are likely to amplify the initial first-order shocks caused by COVID-19 (del Rio-Chanona et al., 2020; Mandel and Veetil, 2020). For instance, Guerrieri et al. (2020) showed that in a two-sectored Keynesian model, negative labour supply shocks can lead to a larger negative demand response under some conditions. Understanding these supply-demand interactions requires a model allowing for different shocks in different industries, considering that COVID-19 effects were uneven across sectors. Input-output (IO) models are especially relevant in assessing such industrial economic impacts from shocks in demand and/or supply, as they are well-suited to estimate the direct and indirect effects of an economic shock.

2.3 COVID-19 and IO models

Researchers and academics use a multitude of models to assess the impact of economic shocks such as those related to the coronavirus pandemic. Among these models, IO models have the ability to estimate direct and indirect effects from shocks applied to demand and/or supply. It is a method that focuses on industry interrelations and linkages. Moreover, IO data tables from Statistics Canada are easily available and provide a high degree of precision due to the large number of sectors and commodities included, as well as regional tables allowing for interregional modelling.

Several researchers have recently used IO models to evaluate the macroeconomic effects of the COVID-19 pandemic. The following section presents some of the recent economic literature on estimating the effects of COVID-19 with IO models. While the list is certainly not exhaustive, the variety of the models and their attributes (scope, specifications, and shocks) presents a diversified body of literature on which this research can draw upon.

2.3.1 Supply shocks and production function form

To date, most studies have aimed at estimating the effects of an economic shock stemming from the supply-side, especially labour shocks. This is consistent with the lockdown measures policies and partial or complete sectoral closures applied by most governments, as some workers lost their jobs and others had to work from home or use other sanitary measures to reduce social and physical contacts, potentially affecting productivity. For instance, Santos (2020) analyzes the effects of different mitigation and suppression policies. His results show that the enforcement of suppression measures (e.g., border closures, travel bans, school and business closures) is associated with lower total economic loss than less stringent policy measures.

Barrot, Grassi, and Sauvagnat (2020) use an IO framework to assess the economic sectoral impacts of social distancing in France. They use data on the active workforce to shock the model and estimate the effects on sectoral value-added. They depart from the classical IO framework introduced by Leontief (1936) by allowing substitution in final demand goods, as well as intermediate inputs, by constant factors (constant elasticity of substitution, or CES). Their results suggest that 6 weeks of social distancing lowers annual GDP by 5.6% across all sectors, with upstream industrial sectors being affected more severely than downstream industries.

Baqaee and Farhi (2020) assessed the implications of using different assumptions regarding elasticities of substitution in production. They conclude that models using higher elasticities of substitution will yield lower output reduction than models using lower elasticities of substitution, and that this difference in output reduction increases with the magnitude of the initial shock.

Using CES in production and/or final demand is a common practice in the IO literature, and several authors have used this assumption to estimate COVID-19 impact on the economy, such as in Barrot et al. (2020). Baqaee and Farhi (2020) use CES, as well as nested-CES, to estimate the output reduction related to a shock using different assumptions on production functions. Bonadio et al. (2020) study the implications of the pandemic on global supply chains. They model a supply shock and use arbitrary values to define CES parameters of input substitution. They estimate the average GDP reduction to be 30%, with approximately three-quarters of this variation attributable to domestic impact and one-quarter to international transmission through global supply chains. Mandel and Veetil (2020) also study the implications

of different input substitution elasticities. They argue that this parameter is a crucial determinant of supply chain impacts, as the indirect effects can outweigh the direct effects, especially in the case of inputs considered as strong complements, through supply chain transmission.

The Cobb-Douglas production function is a special case of the CES production function, in which elasticity of substitution is equal to unity. Fadinger and Schymik (2020) use this form to evaluate the costs of confinement in Germany, allowing for input substitution but not for factors of production. They assess both the industrial and regional distributions of the economic impact, identifying the sectors and regions benefitting the most from a lift of the confinement policies to help reactivate the economy while keeping as many workers at home as possible. For instance, they find that the largest positive effects on GDP occurred when lifting confinement in sectors such as telecommunications and insurances, utilities supply (e.g., water, electricity, gas), and some manufacturing industries (e.g., petroleum products, pharmaceutical). Baqaee and Farhi (2020) also study the case of the Cobb-Douglas functional form and show that it yields the lowest output reduction of the elasticities of substitution tested in their models.

Using differentiated elasticities of substitution can be more realistic than the assumption of no input substitution from the classical Leontief model, especially in assessing longer-term effects. However, supply chains are not equally nimble in responding to shocks from the supply-side (e.g., input or factor of production relative price change) and this can also depend on other variables not accounted for in the model (e.g., time, inventories, critical vs non-critical inputs, trade). Furthermore, the degree to which COVID-19 would bring permanent or temporary changes to society, especially in the early days of the pandemic, may have deterred firms from engaging in lasting adjustments of their production process. For these reasons, the classical Leontief production function will be used in this research.

2.3.2 Demand shocks

COVID-19 also caused significant disruptions in the demand for agricultural and food products. Baqaee and Farhi (2020) explore the theoretical effects of changes in the composition of final demand, finding that such demand rearrangements can amplify or mitigate the negative impact from the labour shocks applied to their model. They mention working on a quantitative assessment of those results once more data on final demand will be available. Pichler et al.

(2020) use estimates of sectoral demand impact in a severe scenario of an avian flu pandemic in the United States (US) from a study commissioned by the US Congressional Budget Office (CBO) (Arnold et al., 2006) to shock final demand in their model. This assessment of potential demand shocks during an epidemic is especially relevant to predict actual consequences from COVID-19. *Table 1* shows the industrial demand shocks estimates from the CBO study, also applied in Pichler et al. (2020) and del Rio-Chanona (2020). Interestingly, Arnold et al. (2006) predict a large decline in the foodservice sector and a modest decline in demand for agricultural products.

In time, more data on consumer purchases will become available and it is expected that the economic literature on the impact of COVID-19 will increasingly include estimates of demand changes. This research aims at contributing to this effort by focusing on the demand-side implications of COVID-19 on the agri-food industry and their spillover effects throughout the supply chain and related industries in Canada. To achieve this result, various scenarios depicting specific changes in final demand categories for agricultural and food products will be used to shock an IO model of the Canadian economy.

Table 1: Estimates of demand effect by industry, severe scenario of avian flu pandemic

Industry	Demand shocks (%)
Arts and recreation	-80
Accommodation and foodservice	-80
Transportation and warehousing	-67
Agriculture	-10
Mining	-10
Construction	-10
Manufacturing	-10
Wholesale trade	-10
Retail trade	-10
Other services except government	-5
Utilities	0
Information	0
Finance	0
Professional and business services	0
Education	0
Government	0
Healthcare	15

Source: Arnold et al., 2006

Chapter 3: Method and Data

The following section introduces the method used in this research: input-output analysis. Data used to build the model, design the scenarios, and the specifications of the model are presented. The mathematical framework is also discussed. Three scenarios simulating the impact of COVID-19 on different components of food demand in Canada are used to shock the IO model. The first scenario focuses on sales in food retail stores, the second scenario relates to the foodservice sector, and finally, the third scenario explores the implications of COVID-19 on Canadian exports.

3.1 Input-Output Analysis

IO analysis was first introduced by Wassily Leontief in his 1936 seminal article in which he describes his study as "an attempt to construct […] a *Tableau Économique* of the United States for the year 1919" (Leontief, 1936), in a reference to French economist François Quesnay's main contribution to the economic literature in the eighteenth century. The technique was further developed in his book *The Structure of the American Economy, 1919-1929* (Leontief, 1941) and multiple extensions were later added to Leontief's basic model (Miller and Blair, 2009). His work on IO analysis earned him the prestigious Sveriges Riksbank Prize in Economic Sciences in Memory of Alfred Nobel in 1973, a testament to the importance of the method he developed. The framework set by Leontief 85 years ago is a key component of multiple modern macroeconomic analyses and IO analysis is still one of the most widely applied methods in economics (Baumol, 2000; Miller and Blair, 2009).

The main purpose of IO analysis is to study the economic interrelations of the whole economic system (Leontief, 1936). Simply put, the basic framework of IO models is an accounting system considering all expenditures and revenues for each sector analyzed. Such a system can track the distribution of an industry's output through other sectors of the economy and conversely, to track the origins of the inputs used in the production process. Data is organized in an interindustry transactions table where each column represents industries as consumers and each row represents industries as producers. Additional columns represent final

demand categories (typically based on a system of macroeconomic accounts) and additional rows represent other inputs such as labour, capital, taxes, etc. *Figure 7* (from Miller and Blair, 2009) depicts a simple input-output transactions table as described above.

Figure 7: Input-output transactions table

		PRODUCERS AS CONSUMERS								FINAL DEMAND			
		Agric.	Mining	Const.	Manuf.	Trade	Transp.	Services	Other	Personal Consumption Expenditures	Gross Private Domestic Investment	Govt. Purchases of Goods & Services	Net Exports of Goods & Services
PRODUCERS	Agriculture												
	Mining												
	Construction												
	Manufacturing												
	Trade												
	Transportation												
	Services												
	Other Industry												
VALUE ADDED	Employees	Employee compensation								GROSS DOMESTIC PRODUCT			
	Business Owners and Capital	Profit-type income and capital consumption allowances											
	Government	Indirect business taxes											

Source: Miller and Blair, 2009

The basic model depicted in *Figure 7* is said to be a static single-region square open model. An extension to this simple framework could include adding one (or more) region (multiregional model) to study the economic interrelations between industries of different regions participating in trade. The model could also be made rectangular, i.e., accounting for the fact that an industry can produce multiple outputs, thus increasing the precision of the analysis. Another extension could be to close the model, which involves endogenizing part(s) of the final demand (typically with respect to personal consumption expenditure). A closed model is more consistent with economic theory, as it allows the modeller to analyze the induced effects of a change in final demand - i.e., to estimate how a change in final demand affects industrial production, which in turn affects household income, and therefore expenditure. An open model is considered incomplete, as it does not include the induced effects, effectively underestimating the multiplier mechanisms. Miller and Blair (2009) provide several other potential extensions to IO models (e.g., hybrid, dynamic, supply-side).

3.2 Data and model specifications

The specifications for the model used in this research depend on the data and the degree of precision sought. There is a variety of different IO tables available from Statistics Canada, allowing researchers to pick the most appropriate for a specific analysis. Since this research is aiming at assessing the demand-side impact of COVID-19 on the Canadian agri-food industry, the most relevant dataset is clearly from the *Agriculture and Agri-Food Economic Account* (AAEA), which is based on the commodity-by-industry supply and use tables (SUTs) from Statistics Canada (2020d). In the context of this research, the main advantage of the AAEA dataset is that it includes disaggregated agricultural sectors, offering a higher degree of precision when assessing the distribution of the multipliers through the agri-food industries.

The AAEA SUTs are published both at the national and provincial levels. Using provincial data would allow the geographical distribution of agricultural industries to be accounted for. This is particularly relevant in the context of this research, as industries were affected by COVID-19 in different ways and therefore provinces are not all affected equally. Exploring the pandemic's economic impact on interprovincial trade would further improve the degree of precision of the analysis.

At the time of writing, the latest published AAEA SUTs contain data for the year 2016. This implies projecting the economic data from 2016 to 2020, which will be achieved by using the industrial GDP growth rates published by Statistics Canada (2021b) for each province and territory. The aggregation level between the SUTs and the GDP estimates differs, meaning that subsectors will be assumed to follow the same growth as their parent sector (see *Appendix A*).

The 2016 provincial AAEA SUTs contain 492 commodities, 258 industries, and 275 final demand categories. This level of aggregation provides an interesting degree of precision and will provide detailed information regarding the economic relationships between the industries included in the model.

3.3 Mathematical framework

The basic IO framework is summarized by the following equation:

$$\boldsymbol{x} = \boldsymbol{Zi} + \boldsymbol{f} \tag{1}$$

in which the vector of industrial output ($\boldsymbol{x}$) is a function of intermediate sales between industries ($\boldsymbol{Zi}$), and final demand ($\boldsymbol{f}$). IO analysis relies on the assumption that inputs are used in fixed proportion to produce a unit of output. This ratio, referred to as the *technical coefficient*, is obtained by dividing the value of an input *i* by the total output of industry *j*:

$$a_{ij} = \frac{z_{ij}}{x_j} \tag{2}$$

The *technical coefficients matrix* (**A**) can be used to rewrite (1):

$$\boldsymbol{x} = \boldsymbol{Ax} + \boldsymbol{f} \tag{3}$$

or, alternatively

$$(\boldsymbol{I} - \boldsymbol{A})\boldsymbol{x} = \boldsymbol{f} \tag{4}$$

Standard matrix algebra yields the unique solution to (4):

$$\boldsymbol{x} = (\boldsymbol{I} - \boldsymbol{A})^{-1}\boldsymbol{f} \tag{5}$$

In (5), the term $(\boldsymbol{I} - \boldsymbol{A})^{-1}$ is known as the *Leontief inverse*, or the *total requirements matrix*, and makes clear the relation between gross output ($\boldsymbol{x}$) and final demand ($\boldsymbol{f}$) (Miller and Blair, 2009).

3.3.1 The Canadian national model

The basic model presented in the previous section needs to be modified to account for the specifications mentioned in *Section 3.2*[2]. In the rectangular framework, the intermediate transaction matrix ($\boldsymbol{Z}$) is replaced with the *use matrix* ($\boldsymbol{U}$), and the *make matrix* ($\boldsymbol{V}$). Also, to differentiate with the square model notation, the rectangular framework defines $\boldsymbol{g}_j$ as a vector of total output by industry *j* (instead of $\boldsymbol{x}$), and $\boldsymbol{q}_i$ as a vector of total output for commodity *i*.

$$\boldsymbol{U} = [\boldsymbol{u}_{ij}] \tag{6}$$

$$\boldsymbol{V} = [\boldsymbol{v}_{ji}] \tag{7}$$

[2] See Ghanem (2010) for further details on the mathematical derivation of the Canadian model

$$\boldsymbol{g}_j = \sum_i \boldsymbol{v}_{ji} \tag{8}$$

$$\boldsymbol{q}_i = \sum_j \boldsymbol{v}_{ji} \tag{9}$$

In the *use matrix* (***U***), each element $\boldsymbol{u}_{ij}$ represents the value of purchases of commodity *i* by industry *j* (intermediate inputs and value added). ***U*** is a commodity by industry matrix, and is divided by total industry output ($\boldsymbol{g}_j$) to obtain the *input coefficient matrix* (**B**), in which each element represents the value of input *i* per dollar worth of industry *j* output.

$$\boldsymbol{B} = \boldsymbol{U}\hat{\boldsymbol{g}}^{-1} \tag{10}$$

Similarly, in the *make matrix* (***V***), each element $\boldsymbol{v}_{ji}$ represents the value of the output of commodity *i* produced by industry *j*. ***V*** is an industry by commodity matrix, and is divided by total commodity output ($\boldsymbol{q}_i$) to obtain the market share matrix (***D***), in which each element represents the ratio of total commodity *i* produced by industry *j*.

$$\boldsymbol{D} = \boldsymbol{V}\hat{\boldsymbol{q}}^{-1} \tag{11}$$

The expression of the *total requirements matrix* depends on two factors: 1) the form in which the final demand vector is expressed (i.e., in terms of demand for commodities or industries); and 2) the technological assumption being commodity-based or industry-based[3]. This research will use the final demand expressed in terms of commodities, as provided by the AAEA SUTs. The technological assumption used will be the industry-based assumption, which implies fixed input coefficients for all commodities produced by an industry. Accordingly, the total requirements matrix can be expressed as

$$(\boldsymbol{I} - \boldsymbol{DB})^{-1}\boldsymbol{D} \tag{12}$$

Three other sources of supply must be considered to account for leakages in the economy and to eliminate as much distortion as possible: imports, scraps, and inventory withdrawals. Define $\boldsymbol{\mu_i}$ as the share of imports, $\boldsymbol{\beta_i}$ as the share of inventory withdrawals, and $\boldsymbol{\alpha_i}$ as the share of scraps of commodity *i* in total supply, then

[3] The industry-based assumption states that all outputs for a given industry are produced in the same way. Conversely, the commodity-based assumption implies that each commodity has a unique recipe regardless of the industry producing it. (Lesage, n.d.)

$$\boldsymbol{\mu_i} = \frac{-\boldsymbol{m_i^D}}{\sum_j \boldsymbol{u_{ij}} + \boldsymbol{e_i}} \tag{13}$$

$$\boldsymbol{\beta_i} = \frac{-\boldsymbol{n_i^W}}{\boldsymbol{u_i} + \boldsymbol{e_i} + \boldsymbol{c_i^T} + \boldsymbol{x_i}} \tag{14}$$

$$\boldsymbol{\alpha_i} = \frac{-\boldsymbol{s_i}}{\boldsymbol{u_i} + \boldsymbol{e_i} + \boldsymbol{c_i^T} + \boldsymbol{x_i}} \tag{15}$$

where $\boldsymbol{m_i^D}$ represents imports for domestic demand, $\boldsymbol{e_i}$ is the final expenditure, $\boldsymbol{c_i^T}$ are travel-related personal expenditure, and $\boldsymbol{x_i}$ are exports of commodity *i*. Substituting equation (12), and adding equations (13)-(15) into the model, industry output is determined by the equation

$$\boldsymbol{g} = [\boldsymbol{I} - \boldsymbol{D}(\boldsymbol{I} - \widehat{\boldsymbol{\mu}} - \widehat{\boldsymbol{\beta}} - \widehat{\boldsymbol{\alpha}})\boldsymbol{B}]^{-1}\boldsymbol{D}[(\boldsymbol{I} - \widehat{\boldsymbol{\mu}} - \widehat{\boldsymbol{\beta}} - \widehat{\boldsymbol{\alpha}})\boldsymbol{e} + (\boldsymbol{I} - \widehat{\boldsymbol{\beta}} - \widehat{\boldsymbol{\alpha}})\boldsymbol{x} + \boldsymbol{r^D}] \tag{16}$$

Note that the model also considers the economic impact of re-exports, $\boldsymbol{r^D}$, on industrial output.

3.3.2 The Canadian interprovincial model

The interprovincial model builds on the national model presented above, the main difference being that it considers interprovincial trade flows. Interprovincial trade flow tables include the value of shipments from region *p* to all regions, and for each commodity *i*. The Canadian interprovincial model contains 14 regions: 13 provinces and territories and the enclaves abroad.

Building on the variables defined in the national model, vectors of domestic final demand $\boldsymbol{e}$, industrial output $\boldsymbol{g}$, and commodity output $\boldsymbol{q}$ must be indexed for each region *p*, and then stacked on top of one another to represent the national portrait:

$$\boldsymbol{e} = \begin{bmatrix} \boldsymbol{e_1} \\ \vdots \\ \boldsymbol{e_{14}} \end{bmatrix} \qquad \boldsymbol{g} = \begin{bmatrix} \boldsymbol{g_1} \\ \vdots \\ \boldsymbol{g_{14}} \end{bmatrix} \qquad \boldsymbol{q} = \begin{bmatrix} \boldsymbol{q_1} \\ \vdots \\ \boldsymbol{q_{14}} \end{bmatrix} \tag{17}$$

The *input coefficient matrix*, $\boldsymbol{B}$, and the *market share matrix*, $\boldsymbol{D}$, are also indexed for each region *p* and rearranged in a bloc diagonal matrix:

$$\boldsymbol{B} = \begin{bmatrix} \boldsymbol{B_1} & \dots & \boldsymbol{0} \\ \vdots & \ddots & \vdots \\ \boldsymbol{0} & \dots & \boldsymbol{B_{14}} \end{bmatrix} \qquad \boldsymbol{D} = \begin{bmatrix} \boldsymbol{D_1} & \dots & \boldsymbol{0} \\ \vdots & \ddots & \vdots \\ \boldsymbol{0} & \dots & \boldsymbol{D_{14}} \end{bmatrix} \tag{18}$$

To consider interprovincial trade, define a variable $\boldsymbol{t_{iod}}$, representing the value of imports of commodity *i* by province of origin *o* into province of destination *d*. The value of total interprovincial imports from province *p*, $\boldsymbol{m_{ip}^R}$, is defined by the equation

$$\boldsymbol{m_{ip}^R} = \sum_{\boldsymbol{o}} \boldsymbol{t_{iop}} \tag{19}$$

Conversely, the value of total provincial exports from province *p*, $\boldsymbol{x_{ip}^R}$, is defined by summing $\boldsymbol{t_{iop}}$ over the destination dimension, *d*:

$$\boldsymbol{x_{ip}^R} = \sum_{\boldsymbol{d}} \boldsymbol{t_{iop}} \tag{20}$$

With the information contained in the interprovincial trade flow tables, namely total provincial imports $\boldsymbol{m_{ip}^R}$ and international imports $\boldsymbol{m_{ip}^D}$, it is possible to define a trade coefficient $\boldsymbol{r_{iop}}$ for each commodity and each region, such that

$$\boldsymbol{r_{iop}} = \frac{\boldsymbol{t_{iop}}}{\boldsymbol{m_{ip}^R + m_{ip}^D}} \tag{21}$$

These trade coefficients can then be rearranged in a vector $\boldsymbol{r_{op}}$, and diagonalized to form the interprovincial market share matrix $\boldsymbol{R}$:

$$\boldsymbol{R} = \begin{bmatrix} \boldsymbol{\hat{R}_{1,1}} & \dots & \boldsymbol{\hat{R}_{1,14}} \\ \vdots & \ddots & \vdots \\ \boldsymbol{\hat{R}_{14,1}} & \dots & \boldsymbol{\hat{R}_{14,14}} \end{bmatrix} \tag{22}$$

Similar to the national model, inventory withdrawals and scraps are dealt with by diagonalizing the leakages vectors, $\boldsymbol{\beta}$ and $\boldsymbol{\alpha}$, and rearranging them in block diagonal matrices:

$$\boldsymbol{\beta} = \begin{bmatrix} \boldsymbol{\hat{\beta}_1} & \dots & \boldsymbol{0} \\ \vdots & \ddots & \vdots \\ \boldsymbol{0} & \dots & \boldsymbol{\hat{\beta}_{14}} \end{bmatrix} \qquad \boldsymbol{\alpha} = \begin{bmatrix} \boldsymbol{\hat{\alpha}_1} & \dots & \boldsymbol{0} \\ \vdots & \ddots & \vdots \\ \boldsymbol{0} & \dots & \boldsymbol{\hat{\alpha}_{14}} \end{bmatrix} \tag{23}$$

Equations (17) to (23) lay the groundwork on which the output determination equation can be built. The model is based on the supply identity of equation (24), stating that regional industrial output must equate total exports[4] (interprovincial and international).

$$\boldsymbol{q_{ip} - n_{ip}^{W} - s_{ip} \equiv x_{ip}^{R} + x_{ip}} \tag{24}$$

Substituting the equations previously defined in this section, and then multiplying both sides by $\boldsymbol{D}$ and isolating $\boldsymbol{g}$ provides the equation for provincial industrial output determination:

$$\boldsymbol{g = [I - D(I - \beta - \alpha)RB]^{-1} D(I - \beta - \alpha)(Re + x)} \tag{25}$$

3.4 COVID-19 Impact Scenarios

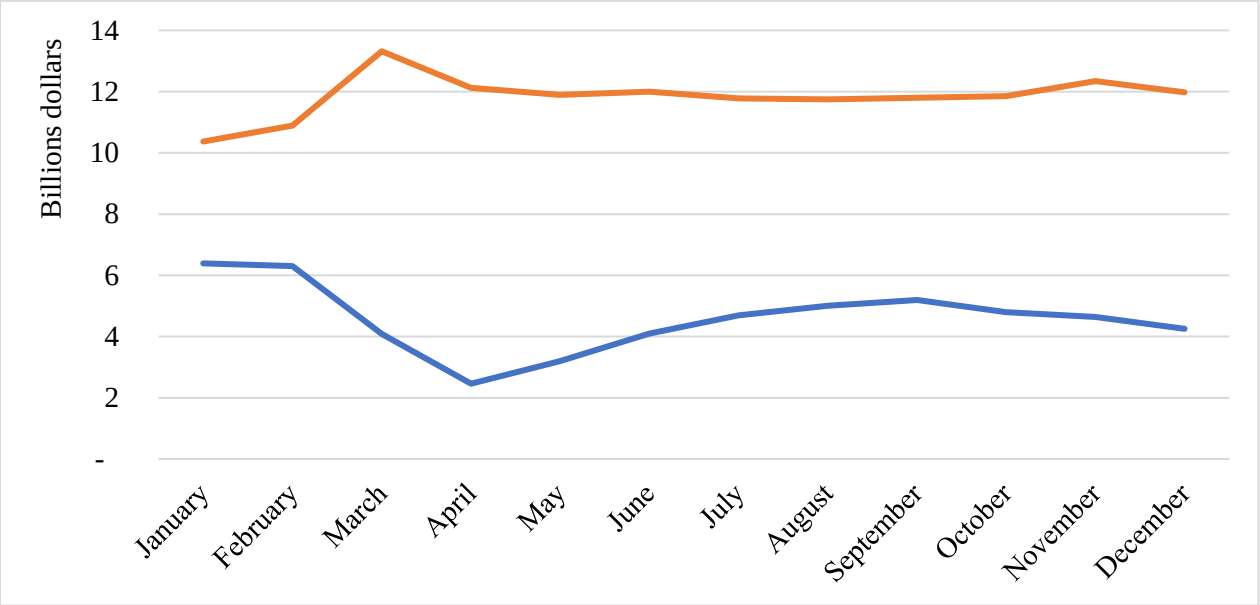
3.4.1 COVID-19 Impact on food retail sales

COVID-19 changed the way Canadians buy and consume food. Notably, demand shifted away from the foodservice industry to grocery retail stores, as depicted by *Figure 8*. As noted by Cranfield (2020), the pandemic and its related mitigation measures affected consumer food demand through the structure of their preferences and budget, price effects, sociodemographic factors, and consumption behaviour. Understanding how these changes in food demand are likely to impact the upstream agricultural sector is of particular interest, especially if COVID-19 significantly modified what food Canadians buy and how much.

The first scenario uses purchasing data collected by The Nielsen Company through checkout scanners in food retail stores (The Nielsen Company, 2021). The original dataset provides the volume and value of sales for 359 food and beverages items. To study the effect of the pandemic on food purchasing, data have been compiled for the year prior to the onset of the pandemic in Canada (52-week period ending February 29, 2020) and is compared with data for the first year of the pandemic (52-week period ending February 27, 2021). Since Nielsen data is more disaggregated than the commodities contained in the AAEA SUTs, a concordance system has been designed by grouping the relevant Nielsen categories into the ones included in the SUTs (*Appendix B*).

[4] Including exports of a region to itself

Figure 8: Food and beverages monthly sales per industry, 2020



Source: Statistics Canada, Table 21-10-0019-01, Table 20-10-0008-01

Finally, the data collected by Nielsen is available at the national level, as well as for 6 regions in Canada (Ontario, Quebec, Alberta, British Columbia, Manitoba-Saskatchewan, and the Atlantic provinces). Because Nielsen data is more aggregated than the regions included in the AAEA SUTs, provinces that are grouped in the former dataset will be shocked with their respective data for the aggregated region. For the provinces and territories for which Nielsen does not collect data (Yukon, Northwest Territories, and Nunavut, as well as Canadian enclaves abroad), the national Canadian average will be used as a proxy for demand change. The latter assumption comes at the cost of some precision, but these regions account for only a small percentage of total expenditure: together, these four regions account for less than 1% of total final demand. Therefore, it is expected that these modifications will not have a significant impact on the results from the simulation.

Scenario specifications

Table 2 shows the national food and beverages expenditure categories that will be shocked in the IO model, their respective share of total expenditure, and the percentage change

between the pre-pandemic period and the first year of COVID-19 both in terms of volume and value. Regional data is presented in *Appendix C*.

Because IO models assume constant prices, the shock applied to final demand will use variations in sales volume not value. This allows the direct and indirect effects to be studied through linkages to other sectors instead of accounting for price effects included in the value variations. For most categories, changes in value and in volume go in the same direction, except for *Bread, rolls and flatbreads*, and *Cookies, crackers and baked sweet goods*, two categories in which volume of sales declined during the pandemic, but increased in value due to price effects.

Table 2: Household food expenditure, value share[5], value and volume change

Categories	Canada		
	Value share (%)	Δ Value (%)	Δ Volume (%)
Bottled water, soft drinks and ice	3.24%	10.65%	6.77%
Bread, rolls and flatbreads	4.47%	8.99%	-3.03%
Breakfast cereal and other cereal products	1.44%	9.12%	5.57%
Butter and dry and canned dairy products	1.74%	18.62%	19.22%
Cheese and cheese products	5.15%	16.73%	11.26%
Chocolate (except confectionery)	0.11%	31.06%	29.17%
Coffee and tea	2.23%	18.88%	18.76%
Confectionery products	3.24%	4.75%	4.55%
Cookies, crackers and baked sweet goods	4.53%	3.37%	-9.86%
Eggs in shell	1.44%	19.39%	9.04%
Fish, crustaceans, shellfish and other fishery products	1.04%	15.74%	18.58%
Flavouring syrups, seasonings and dressings	2.27%	23.16%	17.33%
Flour and other grain mill products	0.52%	27.79%	31.26%
Flour mixes, dough and dry pasta	0.85%	23.26%	15.60%
Fresh and frozen beef and veal	4.46%	17.88%	9.33%
Fresh and frozen pork	1.59%	18.48%	12.70%
Fresh and frozen poultry of all types	4.18%	8.93%	5.85%

[5] Value share refers to the pre-pandemic share of total food expenditure

Fresh fruits and nuts	8.89%	8.86%	6.05%
Fresh potatoes	0.95%	14.43%	15.74%
Fresh vegetables (except potatoes)	8.78%	14.81%	10.18%
Fresh, frozen and canned fruit and vegetable juices	2.65%	9.00%	4.15%
Grain and oilseed products, n.e.c.	0.59%	20.79%	18.67%
Ice cream, sherbet and similar frozen desserts	1.41%	21.35%	10.69%
Margarine and cooking oils	0.94%	21.60%	16.84%
Other food products, n.e.c.	2.58%	20.26%	15.02%
Other miscellaneous crop products	0.14%	15.76%	15.79%
Prepared and packaged seafood products	1.70%	24.54%	19.52%
Preserved fruit and vegetables and frozen foods	12.25%	17.41%	15.72%
Processed fluid milk and milk products	6.26%	8.86%	6.63%
Processed meat products, other miscellaneous meats and animal by-products	5.64%	15.40%	9.46%
Snack food products	4.45%	9.16%	6.21%
Sugar and sugar mill by-products	0.30%	21.95%	21.70%
Sub-Total	**100.00%**	**13.68%**	**8.32%**

Source: The Nielsen Company, provided by AAFC, 2021

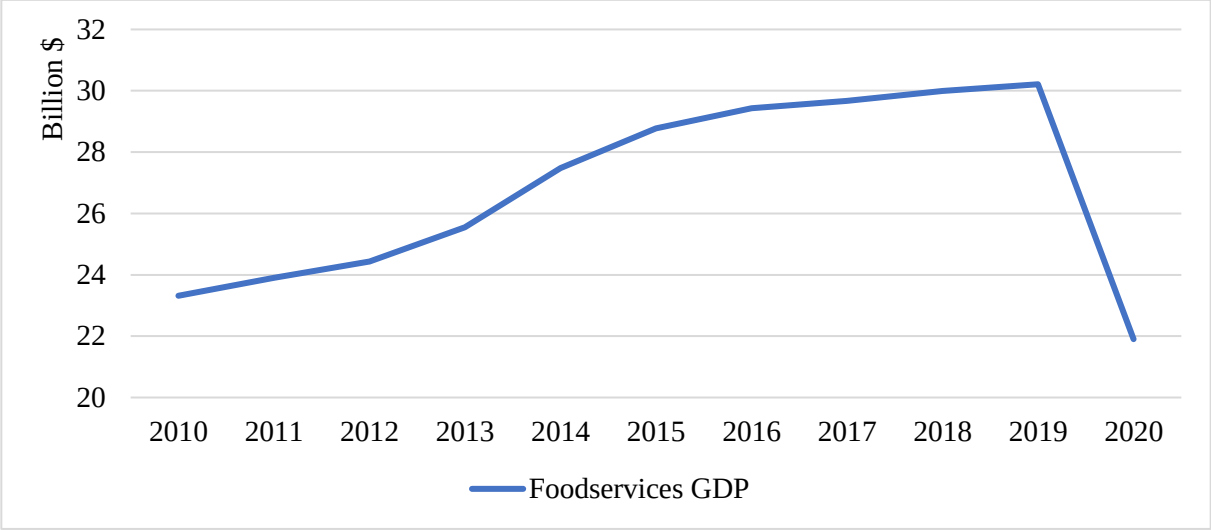
3.4.2 COVID-19 impact on the foodservices industry

Foodservices industry pre- and post-COVID-19

In 2019, the foodservices industry contributed $30.2 billion to Canadian real GDP (1.5%) and provided over 1.1 million jobs (6% of all employment). Between 2010 and 2019, the sector's GDP grew at an average annual growth rate of 2.9%, although growth has been slower in recent years, as shown by *Figure 9* (Statistics Canada, 2021b). The industry can be disaggregated into 4 sub-categories: full-service restaurants, limited-service restaurants (e.g., coffee shops, fast foods, take outs), special foodservices (e.g., foodservices contractors, caterers, mobile foodservices), and drinking places. *Figure 10* shows the share of 2019 and 2020 sales in each sub-industry category, with full-service and limited-service restaurants accounting for the vast majority (89% and 97%, respectively) of the sector's sales. In terms of provincial distribution, Ontario

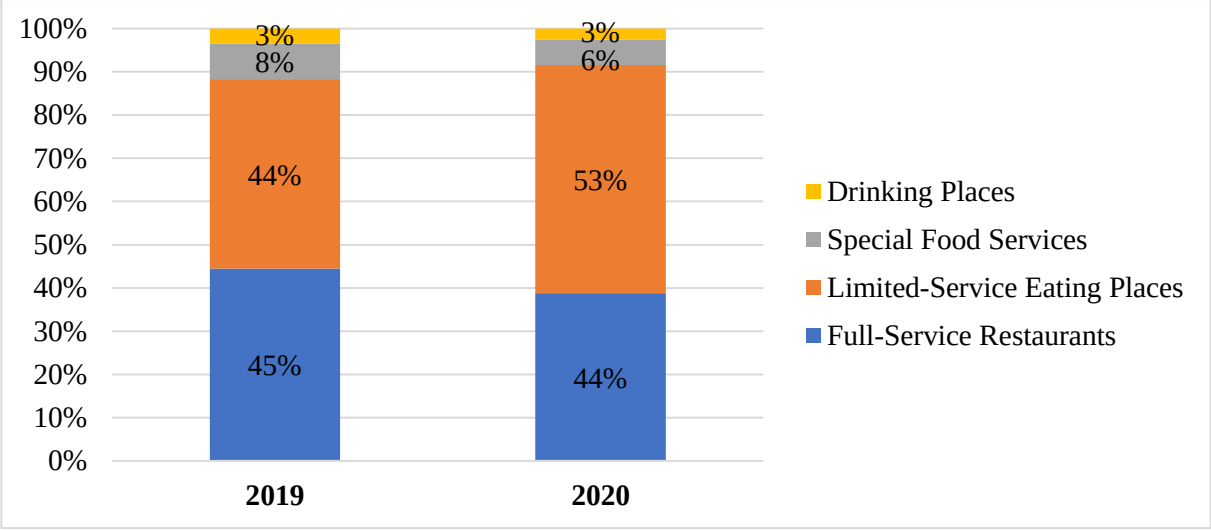
represents the highest yearly sales ($30.6 billion), followed by Quebec ($14.9 billion), British Columbia ($13.1 billion), and Alberta ($9.9 billion) (Statistics Canada, 2021g).

Figure 9: Foodservice industrial GDP, 2010-2020



Source: Statistics Canada, Table: 36-10-0434-01

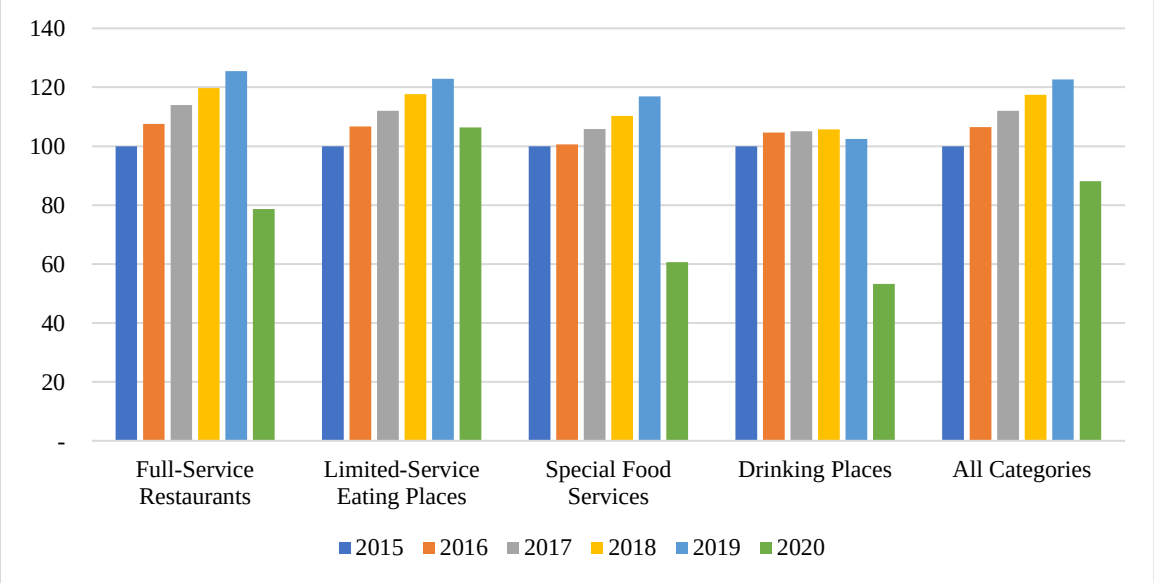
Figure 10: Share of sales by restaurant type, 2019-2020



Source: Statistics Canada, Table: 21-10-0019-01

COVID-19 and the policies adopted to contain its spread caused severe economic consequences in the foodservices industry: sectoral GDP decreased 31% in 2020 over 2019 and more than 330 thousand jobs were lost (27%). *Figure 11* depicts the evolution of sales for each sub-category between 2015 and 2020 (2015 = 100), and while most restaurants have been negatively affected by the events of 2020, impacts have been uneven across sub-industry categories (Statistics Canada, 2021g). Compared to 2019, receipts from full-service restaurants were 37% lower (a decrease of $12.8 billion) and those from special foodservices and drinking places were down 48% each (decreases of $3 billion and $1.4 billion, respectively). As expected, the impact on sales from limited-service eating places was lower ($4.5 billion, -13%), as most of these establishments were able to continue operating under restrictive lockdown policy measures due to their focus on delivery, drive-thru, and takeout rather than dine-in. Overall, sales from the foodservices industry totalled $55.1 billion in 2020, 28.8% lower than Restaurants Canada's pre-COVID-19 forecast of $77.4 billion (Restaurants Canada, 2020b).

Figure 11: Foodservice sales per restaurant category, 2015-2020 (2015 = 100)



Source: Statistics Canada, Table: 21-10-0019-01

COVID-19 pandemic and structural changes

In addition to foregone sales, the pandemic may also trigger structural changes in the industry. Foodservices establishments are adapting to a new environment in which consumers

are less likely to eat away from home due to concerns regarding health and safety measures, as well as lower disposable income (Restaurants Canada, 2020b). Several traditional dine-in restaurants have adapted their operations to survive in a COVID-19 world, such as offering curbside pick-up, delivery, meal kits, lunch boxes, etc. Lower seating capacity due to physical distancing between customers is also likely to influence staffing decisions, which may contribute to changes in employment and wages.

Food delivery apps (e.g., Uber Eats, DoorDash, Skip the Dishes) have benefited from people staying at home and ordering food online, which contributed to the increase in the number of users and revenues. The online food delivery market was forecasted to grow by 17% in 2020 due to COVID-19 (Rotar, 2021). This increase in online food market may have mitigated some of the impact on the industry, it was insufficient to globally increase sales, and the tighter margins from these delivery services make it difficult for restaurants to turn a profit from this market (Tkacik, 2020).

In summary, structural changes brought forward by COVID-19 may lead to a rearrangement in the cost structure of restaurants and could provoke lasting changes in the food supply chain that will impact the linkages to other sectors of the economy.

Scenario specifications

The foodservices sector is modelled in the SUTs through the *Foodservices and drinking places* industry, which uses agricultural and manufactured food commodities, among other inputs, to produce it main output, *Prepared meals*. The link to expenditures is through the final demand category *Food and non-alcoholic beverage services*, which consists exclusively in purchases of *Prepared meals*. The pandemic's impact on the foodservices industry will be modelled through this final demand category, as a decline in consumers' expenditure on *Prepared meals* proportional to the estimated reduction in sales that occurred in 2020. Although the variation in sales from the sector is calculated in value, and not in volume, it is safe to assume that the price effect in the decline in sales is negligible. Indeed, sales dropped not because foodservice prices decreased, but because foodservice establishments had to close and/or operate with reduced capacity. If any, prices may have even increased to mitigate lower capacity and the variation in sales used to shock the model may be slightly underestimating the volume.

While Statistics Canada compiles provincial data for four foodservices sub-industries, the SUTs do not. This implies that the variation in final demand will use the aggregate value for all restaurant types rather than using differentiated data for full-service restaurants, fast foods, etc.

3.4.3 COVID-19 impact on international trade

Portrait of Canadian food exports

Several Canadian agricultural sectors are reliant on exports. According to the Canadian Agri-Food Trade Alliance (n.d.), a significant portion of agricultural commodities produced in Canada are exported, notably in the following industries: cattle/beef (50%), soybeans (70%), pork (70%), wheat (75%), canola (90%), and pulses (95%). In 2020, over $73 billion worth of agricultural products[6] were exported, mostly destined to the US (52%), China (13%), and Japan (7%). It is, therefore, crucial to understand if and how COVID-19 affected international demand for Canadian agricultural products, as trade impediments caused by the pandemic could lead to economic hardship for Canadian producers. Alternatively, it is also possible that increased demand for certain products represents an opportunity for Canadian producers to capitalize on and increase revenues.

In a report analyzing the early impacts of COVID-19 on trade published by Global Affairs Canada, the Government of Canada mentions that exports of agricultural products have fared well compared to most other products (Government of Canada, 2020). Trading sectors such as *Electronics* (-26%), *Automotive* (-23%), and *Energy* (-21%) saw a decrease in the year-over-year value exported in March 2020, while agricultural exports were up 13%, led by *Oilseeds* (60%) and *Vegetables* (49%). If these considerable increases in exports — despite the chaos caused by the pandemic — can represent an opportunity for Canadian producers, it is necessary to look at the longer-term effects. In particular, a demand spike such as this could be a sign of high volatility in a period characterized by uncertainty rather than a sign of sustainable growth.

Table 3 shows the top Canadian agri-food exports in 2020 and their respective value, as reported by the Canadian International Merchandise Trade (CIMT) database (Statistics Canada, 2021h). *Figures 12-13* depict the evolution of these exported commodities between 2013-2020.

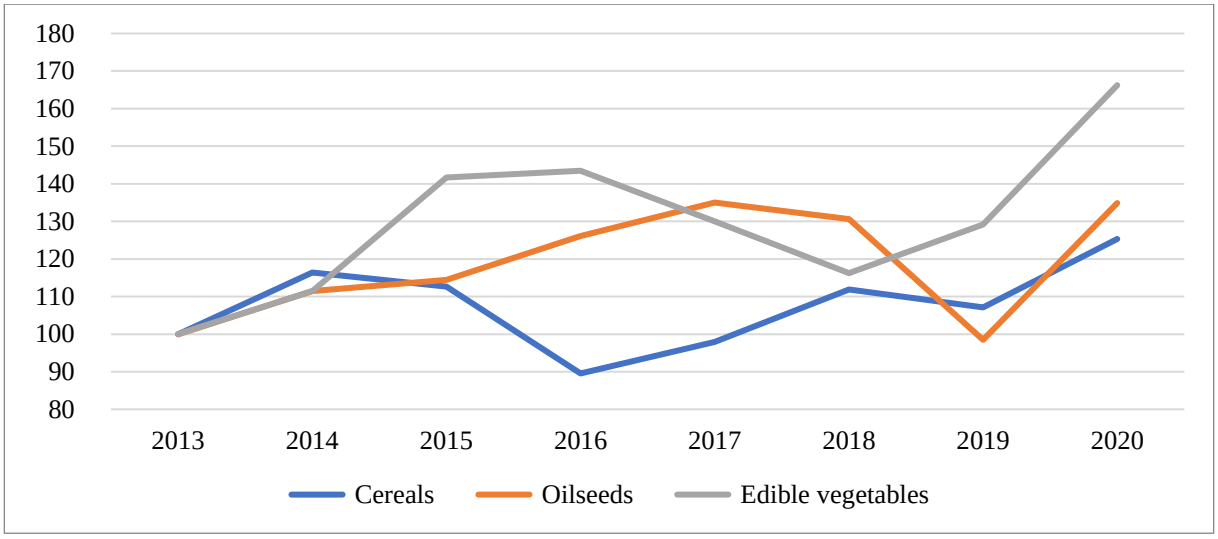
[6] Includes Harmonized System Sections I-IV (Live animals and animal products, Vegetables products, Animal or vegetable fats and oils and their cleavage products; prepared edible fast; animal or vegetable waxes, and Prepared foodstuffs; beverages, spirits, and vinegar; tobacco and manufactures tobacco substitutes).

Table 3: Top exported agricultural commodities, 2020

Rank	Commodity	Value (in million $)
1	Cereals	10,406
2	Oilseeds	10,108
3	Meat and edible offals	8,339
4	Edible vegetables	7,095
5	Fish and crustaceans	5,783
11	Live animals	1,803

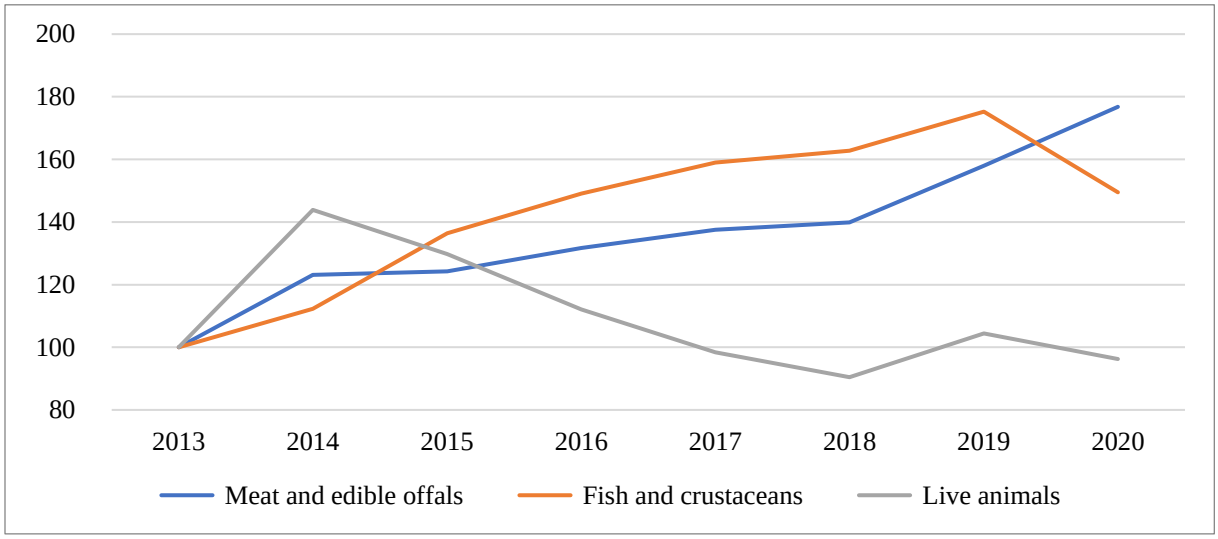
Source: Statistics Canada, CIMT database

Figure 12: Exports of vegetable products, 2013-2020 (2013 = 100)



Source: Statistics Canada, CIMT database

Figure 13: Exports of animals and animal products, 2013-2020 (2013 = 100)



Source: Statistics Canada, CIMT database

Identifying how much of the variation in exports is due to COVID-19 could represent a research problem in itself. The *Medium Term Outlook for Canadian Agriculture 2018* (hereafter MTO), published by Agriculture and Agri-Food Canada (AAFC), uses data from Statistics Canada, the Organization for Economic Cooperation and Development (OECD), and the Food and Agriculture Organization of the United Nations (FAO) to project a plausible future for the agriculture and agri-food markets. Those projections are meant to be used as a benchmark for scenario analyses (AAFC, 2018) and will therefore be used as a starting point for the baseline scenario for exports.

However, as depicted by *Figure 12* and *Figure 13*, there is volatility in the value of some export categories. Thus, projections are likely to over- or underestimate the impact of the pandemic. Volatility can be a consequence of multiple factors, including exchange rate dynamics, relative prices for commodities and/or factors of production, market access, global economic situation, and geopolitical issues. In any case, ad hoc analyses of market dynamics will be needed to provide a more complete picture and will help understand the importance of COVID-19 on the evolution of exports during the crisis.

Vegetable products

Exports of vegetable products[7] represent a sizable proportion of Canadian agricultural exports, valued at approximately $31 billion in 2020 (43% of all agri-food exports), led by *Cereals* ($10 billion), *Oilseeds* ($10 billion), and *Edible vegetables* ($7 billion). Annual value growth in 2020 was the largest between 2013 and 2020 for these 3 products categories. *Table 4* presents the top commodities exported in each category and their respective year-over-year annual growth in 2020 both in quantity and value. *Cereals* exports were up 17% in value, led by wheat and durum. *Oilseeds* exports were up 37% in value[8], led by rapeseeds and soybeans. Finally, *Edible vegetables* exports were up 29%, mostly due to an increase in the value of lentils exports.

Table 4: Annual growth (YoY) for selected commodities, vegetables products, 2020

Category	Commodity	2020 Annual growth (YoY)	
		Quantity	Value
Cereals			**17%**
	Wheat	14%	15%
	Durum	17%	32%
Oilseeds			**37%**
	Rape or colza seeds	43%	47%
	Soya beans	11%	27%
Edible vegetables			**29%**
	Lentils	47%	85%
	Peas	5%	9%

Source: Statistics Canada, CIMT database

Cereals

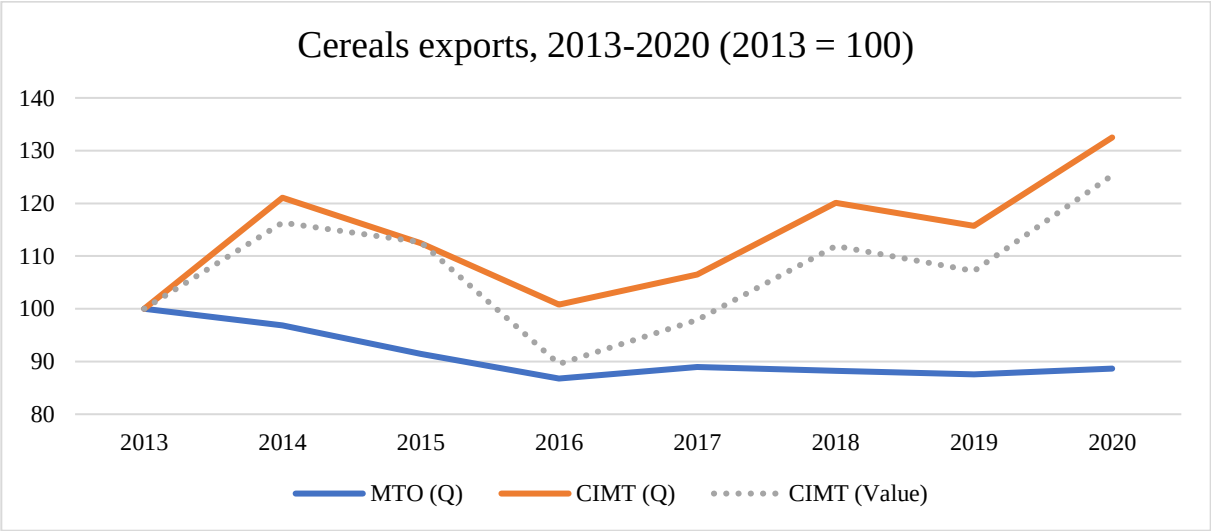
Figure 14 shows that exports of cereals increased sharply between 2013 and 2014 before declining close to 2013 levels in 2016 and then rising again steadily until 2020. High exports in 2014 were likely due to high inventory stocks following the record cereals production of 2013

[7] In this context, *vegetable products* refers to the Harmonized System Section II, which includes cereals, oilseeds, edible vegetables, roots and tubers, fruits and nuts, etc.

[8] The important annual growth in *Oilseeds* for 2020 is not surprising, due to trade restrictions applied by China in 2019, notably on Canadian oilseeds. Value of exported oilseeds in 2020 is comparable to its 2018 level (+ 3%).

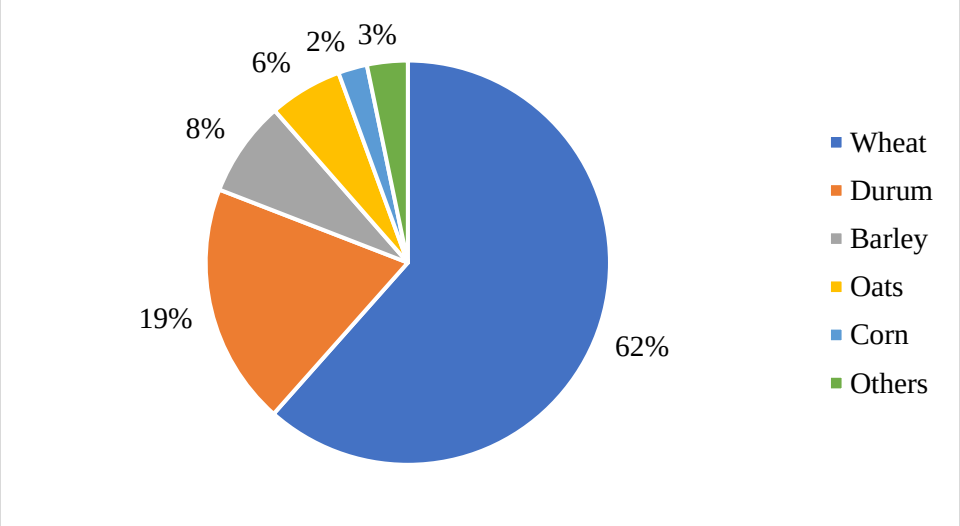
both in Canada and the US, as well as lower prices due to a larger global supply. Wheat and coarse grain exports between 2014 and 2016 follow the trend in declining production, which could be caused by lower area harvested for those commodities as farmers rotated to other crops (notably canola, soybeans, lentils, and dry peas). From 2016 to 2020, cereals exports were mostly increasing (except for a slight dip in 2019) reaching $10.4 billion in 2020, up 40% in value compared to 2016 and up 32% in quantity.

Figure 14: Cereals exports, 2013-2020 (2013 = 100)



Source: Statistics Canada, CIMT database, and AAFC, 2018

Figure 15: Value share of cereals exported, 2020



Source: Statistics Canada, CIMT database

Between 2016 and 2020, most of the growth in cereals exports came from the increased volume of wheat and durum traded and 2020 was a record year in terms of both value and quantities exported for those two commodities. Variation in wheat exports is mostly the result of a volatile demand from the larger markets of China and the US. Between 2017 and 2020, China's imports of wheat increased 380%, while US imports dropped 40%. But the record exports to China in 2020 are likely due to increased demand for feed wheat as China rebuilds its national pig herd following recent outbreaks of African Swine Fever (ASF). Apart from China, other major destinations for Canadian wheat exports had a stable demand between 2019 and 2020, except for higher exports to Peru (+45% in quantity, +46% in value). That being said, it is hard to find a rationale why COVID-19 could be a catalyst in the increase of wheat exports.

The second most exported Canadian cereal is durum, which is mostly used for human consumption when transformed into products such as pasta, couscous, and bulgur. The pandemic and lockdowns around the world increased consumption of those staples, which could help explain why quantities of exported durum were 17% higher in 2020 compared to 2019, and 24% higher than the average between 2013 and 2019. Quantities exported to Italy and Morocco were up significantly from 2019 (+81% and +37%, respectively), but down in other important markets such as Algeria (-58%) and the US (-11%). It seems plausible to assume that COVID-19 has had a net positive effect on exports of durum wheat. A simple linear forecast for 2020 based on export data between 2016 and 2019 results in an estimated increase of 12%, a slightly smaller increase than the year-over-year variation of 17%.

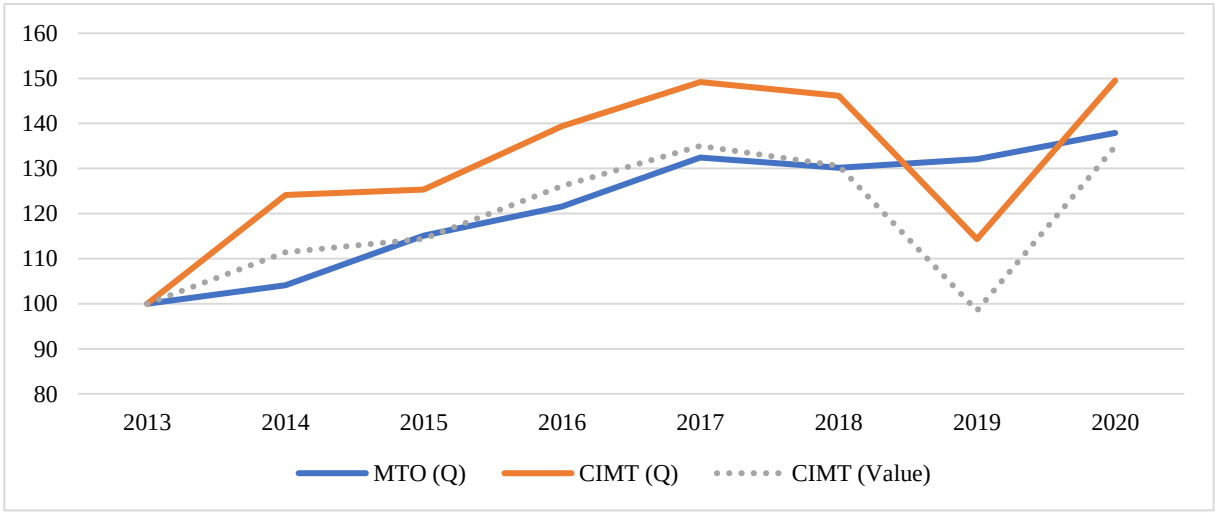
Oilseeds

AAFC's MTO projected exports of oilseeds to increase gradually between 2013 and 2020, and were expected to reach a little over 18 million tonnes in 2020 (38% higher than in 2013). Actual data from the CIMT database shows that this uptrend did materialize, although at a slightly faster pace than anticipated: quantities of exported oilseeds in 2020 were 50% higher than in 2013. The important drop in 2019 resulted from the trade sanctions imposed by the Chinese government, which banned canola shipments from two important Canadian exporters (Canola Council of Canada, n.d.). China being the main destination for Canadian canola, the market access issues of 2019 caused a 68% drop in the quantities exported to China. Although a

certain amount was rerouted elsewhere (e.g., France, United Arab Emirates, Pakistan, Germany, Bangladesh), total quantities of canola exported in 2019 were 20% lower than in 2018. Canola exports then increased significantly in 2020, as China's imports shoot up 67%, as well as other countries showing important increases compared to 2019 such as France (+93%) and the United Arab Emirates (+54%). As exports of canola in 2020 came back to similar levels seen in 2017 and 2018 in both quantity and value, COVID-19 does not appear as a significant factor explaining the important increase in 2020.

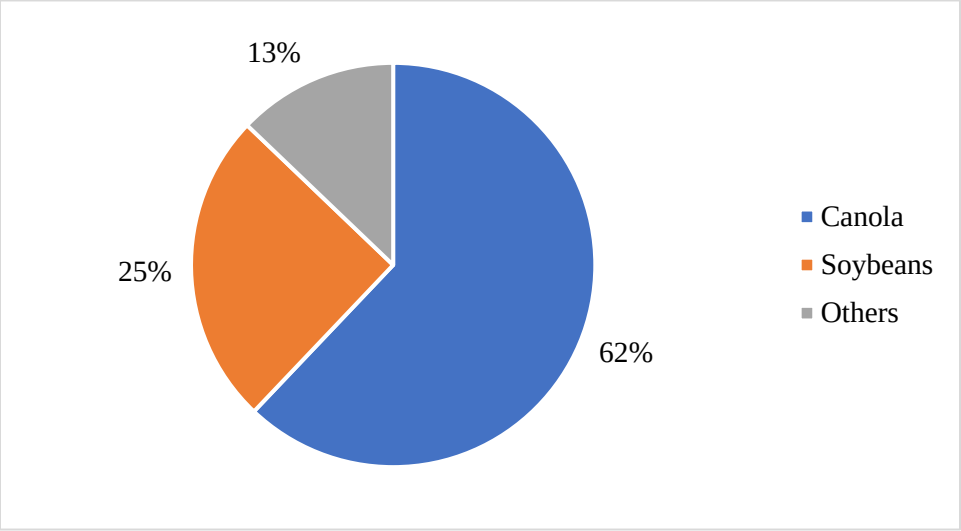
Soybeans are the second-largest exported commodity in the oilseeds category. Canadian exports of soybeans peaked in 2018 at 5.4 million tonnes, of which 65% was destined to China. Quantities of soybeans exports then dropped 27% in 2019 as China imports declined almost 99% during this year. Two main factors can help explain this drastic decline in the Chinese imports: diplomatic issues have complicated trade relationships between the two countries in recent years and the Chinese pig herd being decimated by ASF lowered the demand for animal feed, which includes soybeans. Total quantities of Canadian soybeans exported increased moderately in 2020 compared to 2019 (+11%), mostly due to shipments to China picking up slowly despite still representing only a fraction of their 2018 levels. There is little evidence suggesting that the coronavirus pandemic could be a major factor contributing to the recent increase in Canadian exports of soybeans.

Figure 16: Oilseeds exports, 2013-2020 (2013 = 100)



Source: Statistics Canada, CIMT database, and AAFC, 2018

Figure 17: Value share of oilseeds exported, 2020

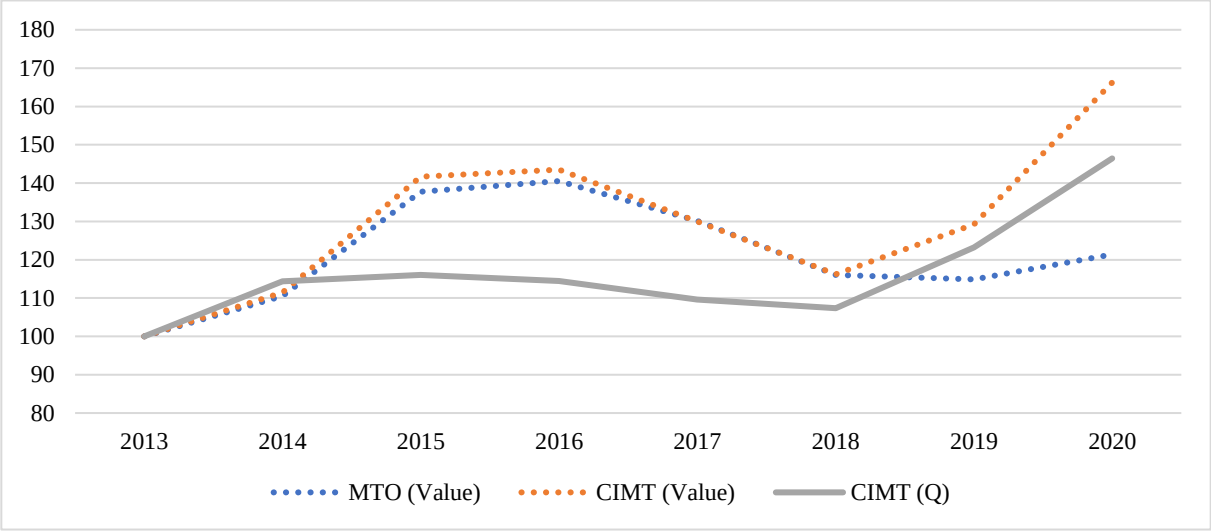


Source: Statistics Canada, CIMT database

Edible vegetables

Figure 18 shows the evolution of edible vegetables exports from 2013 to 2020 (2013 = 100), which includes dried pulses, vegetables, and certain roots and tubers. AAFC's MTO includes a projection of the value of exports for this category but does not forecast the evolution in quantities. The value of exported edible vegetables increased rapidly between 2013 and 2015, while the quantities exported increased modestly, suggesting an important price effect during this period. The total value of edible vegetables exports then declined between 2016 and 2018 as pulses prices dropped back down and quantities exported remained mostly stable. Quantities exported then increased sharply in 2019 and 2020, reaching over 8.3 million tonnes valued at approximately $7 billion in 2020.

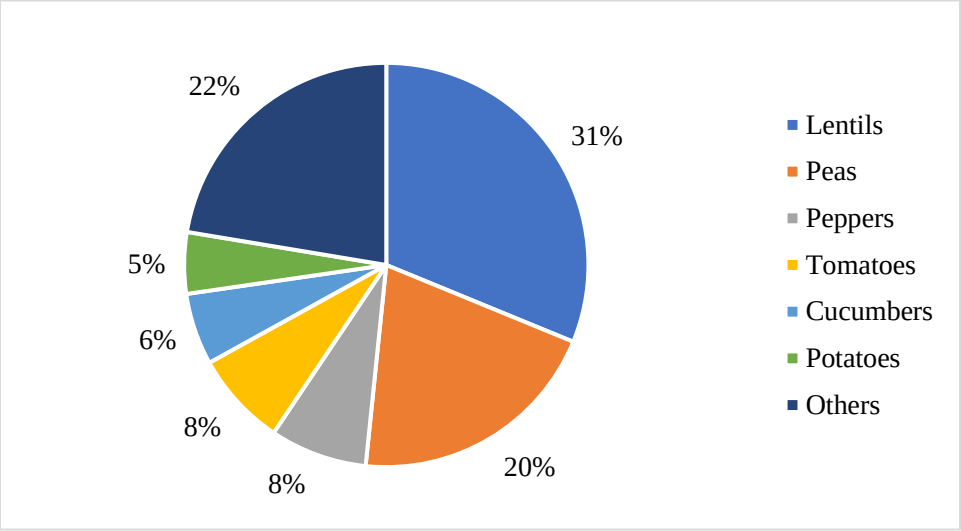
Figure 18: Edible vegetables exports, 2013-2020 (2013 = 100)



Source: Statistics Canada, CIMT database, and AAFC, 2018

Lentils are the most exported commodity in this category and lentils price almost doubled between 2013 and 2016 (Statistics Canada, 2021h). This was mostly due to severe water shortages in India in 2015-2016 (Mishra et al., 2016), which explains the surge in the value of exports between 2013 and 2016. Prices declined to their lowest point in 2018 and remained low through 2019, stimulating higher exports to India despite tariff rates on Canadian exports of lentils. With COVID-19, lockdown measures and the related economic consequences in 2020, the pandemic most likely contributed to an increase in the demand for affordable protein sources with long shelf life, such as lentils, peas, etc. This put upward pressure on prices in the first half of 2020. Year-over-year, lentils exports grew 84% in value in 2020 and 47% in quantity. All three main destinations for Canadian lentils exports purchased significantly higher quantities between 2019 and 2020: +59% in India, +179% in Turkey, and +47% in United Arab Emirates. While exports to India have been encouraged by temporary tariff reductions in 2020, higher global lentils exports can be partially attributed to the demand surge caused by the pandemic. The strong assumption that the entirety of the variation in exported quantities of lentils (47%) will be modelled, as well as a relaxed assumption that will consider only half of this variation as attributable to COVID-19.

Figure 19: Value share of edible vegetables exports, 2020



Source: Statistics Canada, CIMT database

As depicted in *Figure 19*, the edible vegetables category is diverse and includes other commodities such as peas, peppers, tomatoes, cucumbers, potatoes, and others. Among those, the 2020 year-over-year variation in quantities exported was significant for potatoes (+19%) and peppers (+11%). Despite a 19% increase in the volume of potatoes exported compared to 2019, the quantity exported is similar to levels seen in 2017 and 2018, suggesting that other factors could have caused higher exports in 2020. As for peppers, the 2020 year-over-year variation was similar to the previous year and is consistent with increased production capacity over recent years (Statistics Canada, 2021h). Therefore, these variations will not be considered as caused by the COVID-19 pandemic.

Live animals and animal products

Exports of live animals and animal products was approximately $17 billion (23% of all Canadian agri-food exports) in 2020, including *Meat and edible offal* ($8 billion), *Fish and crustaceans* ($6 billion), and *Live animals* ($2 billion). *Table 5* shows the 2020 annual growth in quantities and value for the top commodities exported in each category. Exports of *meat and edible offal* increased 12% in value, mostly due to a notable increase in the quantity of pork products exported (+23%). The value of *fish and crustaceans* exports was 15% lower in 2020,

due to lower prices for most commodities in the sector as well as lower quantities exported of several species, including crab, lobster, salmon, and shrimps and prawns. Finally, the value of *live animals* exported was 8% lower in 2020 compared to 2019, due to lower exports of cattle and hogs (-9% and -16%, respectively).

Table 5: Annual growth (YoY) for selected commodities, live animals and animal products, 2020

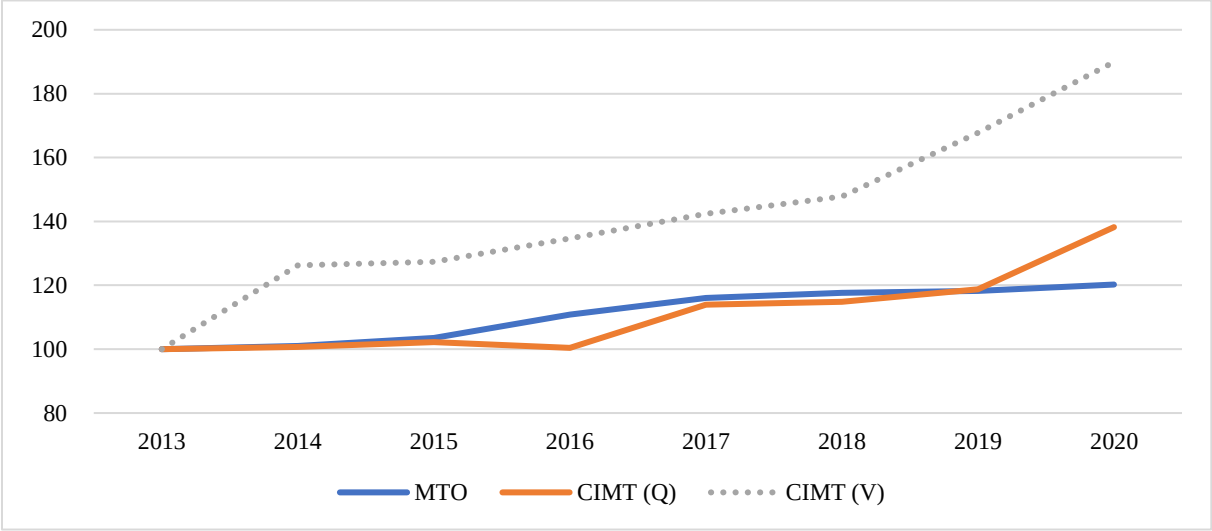
Category	Commodity	2020 Annual growth (year over year)	
		Quantity	Value
Meat and edible offal			**12%**
	Bovine cuts	0%	2%
	Swine	23%	23%
Fish and crustaceans			**-15%**
	Crab	-4%	-10%
	Lobster	-13%	-20%
Live animals			**-8%**
	Cattle	-7%	-9%
	Swine	4%	-16%

Source: Statistics Canada, CIMT database

Meat and edible offal

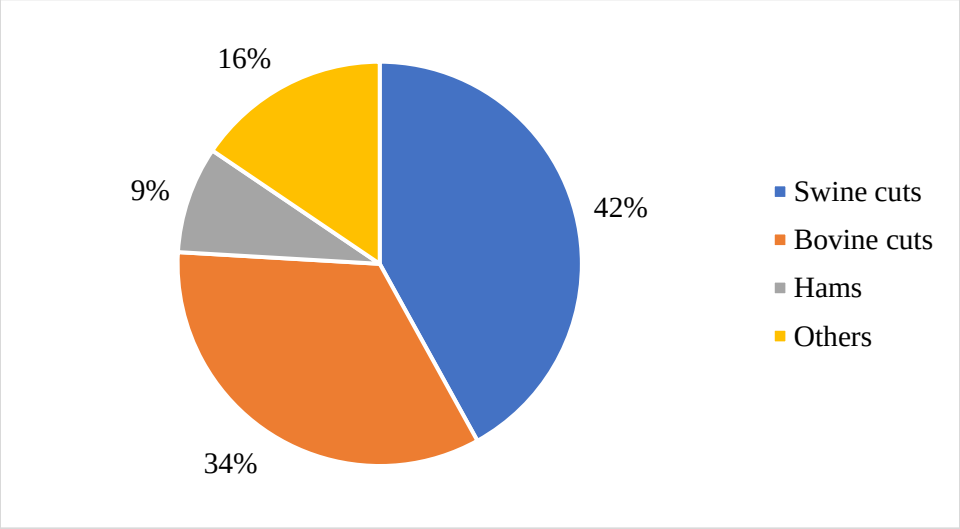
Figure 21 shows that quantities of *meat and edible offal* exported were mostly flat between 2013 and 2016, then increased steadily until 2020. This category mostly consists of beef and pork products, both of which have seen significant growth in quantities exported between 2013 and 2020 (65% and 31%, respectively), and even higher growth in terms of value (160% and 60%, respectively), suggesting an important price effect during this period.

Figure 20: Meat and edible offal exports, 2013-2020 (2013 = 100)



Source: Statistics Canada, CIMT database, and AAFC, 2018

Figure 21: Value share of meat and edible offal, 2020



Source: Statistics Canada, CIMT database

Swine cuts represent the largest meat export market in both quantities and value. In 2020, most fresh/chilled cuts were exported to Japan and the US (48% and 38% of total volume exported, respectively), while the main destinations for frozen cuts were China (69%) and Japan (6%). Exports of pork products to China have been abnormally high in 2020 (an increase of

135% compared to 2019), as Chinese hog production has been severely impaired by the ASF outbreak in recent years, stimulating higher imports of pork meat. Other than China, exports of swine cuts have been increasing in Japan and other smaller export markets, potentially due to the entry into force of the Comprehensive and Progressive Agreement for Trans-Pacific Partnership in late 2018. Therefore, it seems unlikely that the pandemic was the main reason for the increased exports of pork in 2020.

Exported quantities of Canadian bovine cuts have been steadily on the rise between 2013 and 2019, but stagnated in 2020. The main destination for these products is the US, which imported over 73% of the volume of Canadian beef exports in 2020 (76% in value). Smaller export markets include Japan (10% quantity) and China (3% quantity). Variations in the exports to the US may be attributed to the cattle production cycle: lower profitability decreased the American national herd between 2007-2014 which increased beef import demand to the US. Lower feed costs and improved grazing conditions then turned into higher profitability, prompting American producers to expand their herds until 2019, the probable peak of the current cycle (USDA, 2021a). As the national herd expands in the US, reliance on imports diminishes, thus affecting the Canadian beef production sector. Therefore, it is more likely that the recent peak in the current cattle production cycle caused beef exports to stagnate in 2020 rather than being caused by COVID-19.

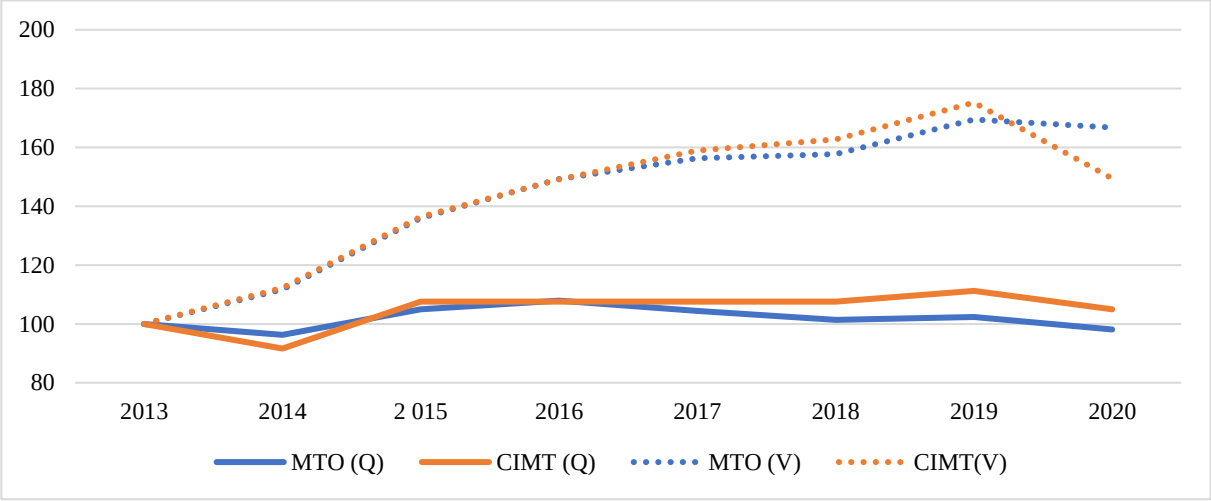
Seafood and crustaceans

In its outlook for the Canadian fish and seafood sector, Fisheries and Ocean Canada (DFO) uses historical data and a dynamic simulation model[9] to project what the industry may look like in the medium term, under some specified assumptions (DFO, 2018). The fish and seafood industry is highly export-oriented with approximately 80% of the Canadian production being exported (DFO, 2018). As *Figure 22* depicts, the value of these exports is typically driven by price variations more than volumes, which tend to be relatively constant. Strong prices supported the increase in value of exported products between 2013 and 2019, but prices decreased in 2020 due to a sharp decline in demand for fish and seafood, as well as an

[9] Similar to the model AAFC uses for its MTO.

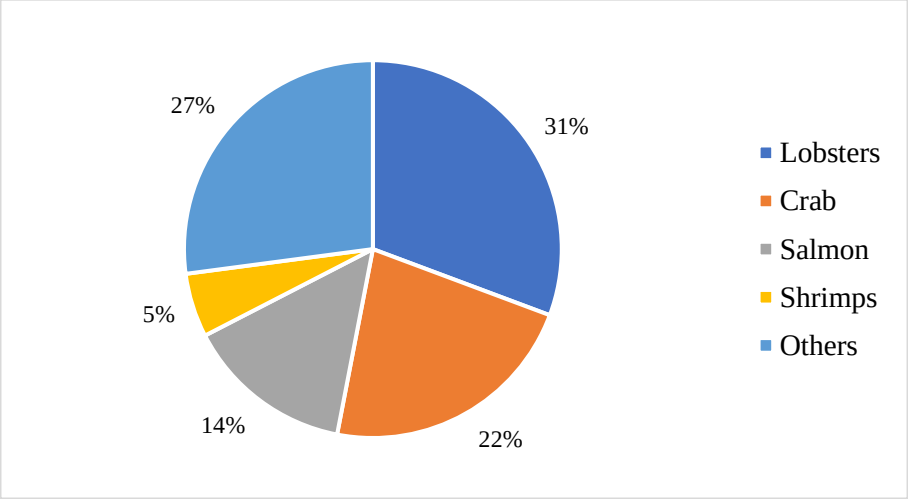
oversupply for most species (FAO, 2020, 2021)[10]. COVID-19 most likely contributed to this decline in prices for three main reasons: 1) consumers' demand shifting away from fresh produce to prepared and packaged products; 2) collapse of the demand from the foodservice industry, which is a major marketing channel of seafood; and 3) weaker demand for luxury products (e.g., lobster, crab) due to economic hardship affecting consumers (FAO, 2020b).

Figure 22: Fish and seafood exports, 2013-2020 (2013 = 100)



Source: Statistics Canada, CIMT database, and AAFC, 2018

Figure 23: Value share of fish and seafood exports, 2020



Source: Statistics Canada, CIMT database

[10] Sectors such as salmon have long production cycles, and were unable to adjust to rapidly changing demand, while other products such as lobster and crab are considered luxury, and are mostly consumed in the foodservice industry, which was severely impacted by COVID-19 (FAO, 2020, 2021)

Lobster is the main commodity exported from Canada by the fish and seafood industry ($1.8 billion in 2020). The quantities of lobster exported increased 62% from 2013 to 2019 while the value of these exports increased by 89%. The US is Canada's main importer, since the American and the Canadian markets are highly integrated, but most of the growth in demand in recent years has come from Asia, with China's imports of lobster in 2019 being more than 10 times their 2013 levels, reaching almost 29 kilotonnes in 2019 ($506 million). South Korea is another market that has seen significant growth in demand (+344%) during this period. However, lobster exports in 2020 were 13% lower in terms of quantity and 20% lower in terms of value. This decrease in lobster demand affected the majority of the export markets, and is most likely due to the pandemic for the reasons mentioned in the previous paragraph. DFO was projecting that the quantity of lobster exported to remain mostly stable between 2019 and 2020 and therefore the drastic decline in 2020 (-13%) will be attributed to COVID-19 in the model.

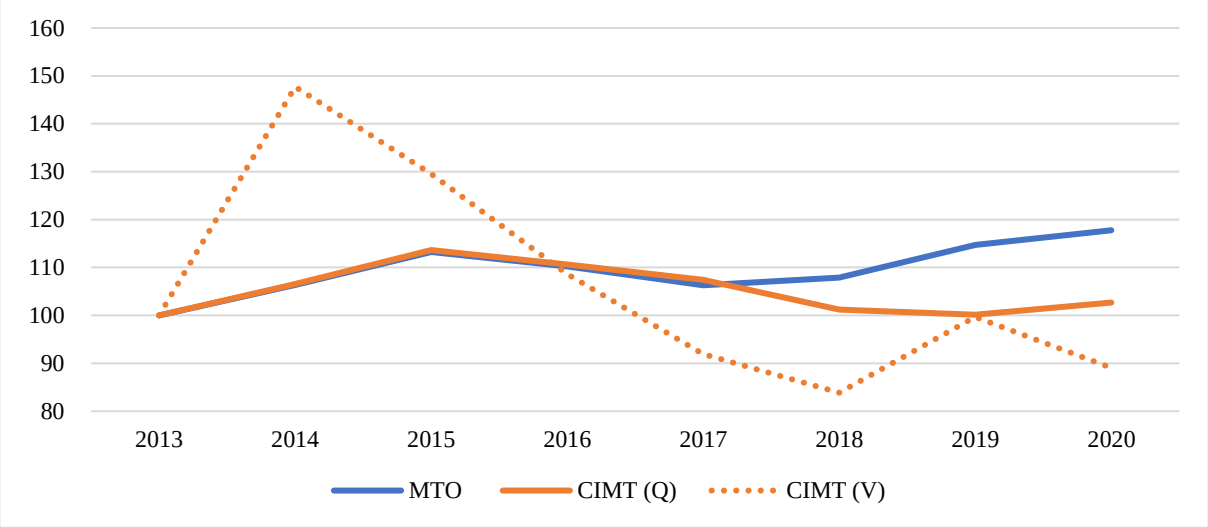
The second most exported fish and seafood commodity is crab ($1.3 billion in 2020). Unlike lobster, quantities of crab exports have been trending down between 2013 and 2019, but strong prices have supported an increase in value over time. Exports peaked in 2017 due to high demand from China, Japan, and other Asian markets, but weaker landings in subsequent years limited quantities available to export (Sackton, 2020). The pandemic caused early concerns regarding spring harvest disruptions but ultimately did not materialize. Furthermore, while a sharp decline in demand from the foodservices industry led to a 20% price decrease in early spring of 2020, retail demand grew significantly, contributing to a price surge in May 2020. Overall, prices for crab in 2020 have been volatile, but the average price remained lower than in 2019. COVID-19 may have contributed to the lower value of Canadian crab exports, mostly because the pandemic prompted demand displacement and price adjustments. The 3% decline in quantities exported is consistent with the trend between 2013 and 2020, and thus it was assumed that the health crisis had a negligible impact on volumes of crab exported.

Live animals

As for live animals, Canada's exports mainly consist of cattle and swine and are almost exclusively traded with the US. *Figure 24* shows the evolution of livestock exports between 2013 and 2020, and *Figure 25* provides a breakdown of the quantities and values of cattle and

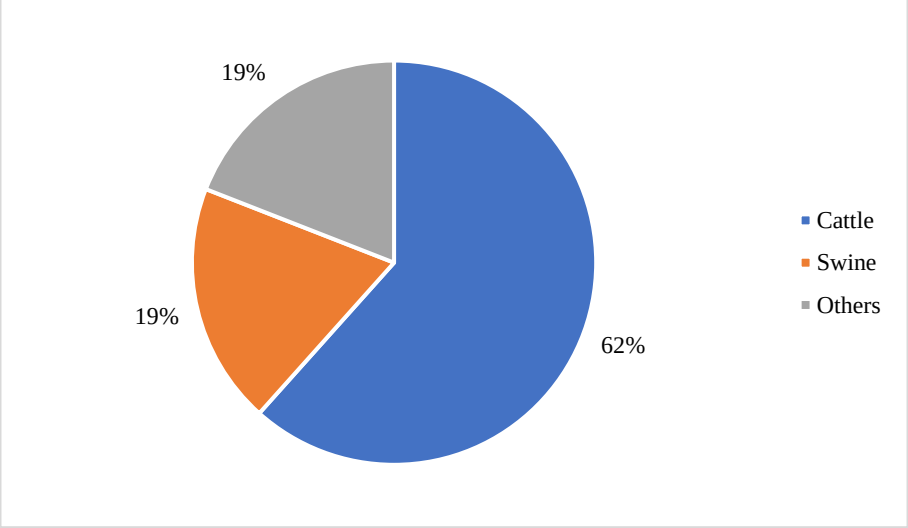
hogs traded during this period. With COVID-19 outbreaks occurring in slaughterhouses and meat packaging plants on both sides of the border in the spring of 2020, processing capacity was reduced This situation created backlogs and effectively lowered cattle and swine demand from the US (Statistics Canada, 2020c). This imbalance in supply and demand contributed to a decrease in the prices of both cattle and swine, as US livestock prices fell in reaction to plant closures.

Figure 24: Cattle and hogs exports, 2013-2020 (2013 = 100)



Source: Statistics Canada, CIMT database, and AAFC, 2018

Figure 25: Value share of livestock exports, 2020



Source: Statistics Canada, CIMT database

In 2020, the number of cattle exported to the US was down 7% compared to 2019 and 35% lower than in 2013. In terms of value, 2020 cattle exports were 9% lower than the previous year and 15% lower than in 2013. Multiple factors may help explain the continuation of the current downtrend including the dynamics of the cattle cycle, the current contraction of both the Canadian and the American national herds, and lower slaughter capacity due to coronavirus outbreaks in meat processing plants on both sides of the border. Because slaughter cattle exports are typically higher than feeder cattle exports, lower slaughter rates in the US due to COVID-19 had a non-trivial impact on Canadian cattle exports during 2020.

Live swine exports to the US have been slowly declining between 2015 and 2019, but rebounded slightly in 2020: the number of hogs exported increased 4% compared to the previous year and was 11% higher than in 2013. However, high volatility in live hogs prices resulted in a 16% decrease in the value of swine exports despite the increase in quantity (McEwan et al., 2021). Higher exports may be driven by lower finishing capacity (a result of backlogged animals due to the reduced processing related with COVID-19), increased production compared to recent years, and higher American demand due to production declines associated with porcine reproductive and respiratory syndrome (USDA, 2021b).

Exports of live animals have likely been influenced by COVID-19 and its effects on supply chains. However, these variations do not represent a change in demand for live animals or meat products, but rather adjustments from the supply side responding to issues in the meat processing sector. Therefore, the variations in exports of livestock are not included in Scenario 3, as the objective is to simulate how the change in food demand affected the Canadian agri-food industry in 2020.

Table 6: Export scenario summary

Category	Commodity	2020				Related to COVID-19?	Variation modeled
		Quantity (millions kg)	Δ Year over year	Value (million $)	Δ Year over year		
Cereals				**10,407**	**17%**		
	Wheat	20,399	14%	6,406	15%	Not likely. Record exports to China mostly due to increased demand for feed as it is rebuilding its pig herd.	N/A
	Durum	5,634	17%	2,012	32%	Probably. Durum is largely used to make pasta and semolina, products affected by an increase in consumption during COVID-19.	3A: 12% 3B: 17%
Oilseeds				**10,108**	**37%**		
	Rape or colza seeds	11,777	43%	6,277	47%	Not likely. High YoY variation due to 2019 trade disruptions with China, mostly resolved in 2020.	N/A
	Soya beans	4,373	11%	2,533	27%	Not likely. YoY variation mostly due to increased Chinese demand for feed as it is rebuilding its pig herd.	N/A

Edible vegetables				**7,095**	**29%**		
	Lentils	3,116	47%	2,214	85%	Partially. Lentils and peas are an affordable protein source with long shelf life, and were high in demand during the pandemic. Other factors contributing to this increase are tariff reductions in India and low production in recent years in Turkey.	3A: 23.5% 3B: 47%
	Peas	3,830	5%	1,449	9%		
Meat and edible offal				**8,339**	**12%**		
	Swine	1,185	23%	4,213	23%	Unlikely. High demand from China most likely due to lower domestic production due to ASF	N/A
	Bovine cuts	363	-2%	2,831	3%	Unlikely. Probably due to the recent peak in cattle cycle, causing the US to be less reliant on imports	N/A
Fish and crustaceans				**5,783**	**-15%**	Most likely. Prices for most species declined in 2020, which may be attributed to COVID-19 for 3 reasons: 1) demand shifting away from fresh to frozen and packaged products; 2) collapse of demand from food industry; 3) economic hardship lowers demand for luxury products such as lobster and crab	
	Lobsters	76	-13%	1,775	-20%	Most likely. See reasons above	3A: -13% 3B: -15%
	Crabs	49	-4%	1,109	-10%	Unlikely to have a significant impact on quantities. The impact was felt on prices and thus revenues, but growth in retail demand mitigated the drop in demand from foodservices	N/A

Live animals				**1,803**	**-8%**		N/A
	Cattle	669,672	-7%	1,111	-9%	Partially. Lower slaughter rates in the US due to COVID-19 outbreaks had a non-trivial impact on cattle exports from Canada. Other reasons include the American herd had been expanding until recently but is now contracting (cattle cycle).	
	Swine	5,288,003	4%	348	-16%	Partially. Backlogged animals due to COVID have reduced finishing capacity in Canada. Other factors include higher Canadian production, and high American demand due to recent production decline caused by PRRS	

Chapter 4: Results

In this chapter, results from the shocks applied to the model are presented, based on the scenarios described in *Chapter 3*. The initial shocks to the model, as described in *Chapter 3*, are the direct effect on the economy. Shocking the model with these direct effects will determine the direct plus indirect effect on the economy. The direct plus indirect effect incorporates the impact of the backward linkages in the economy.

The first scenario simulates higher food retail sales using Nielsen store scanner data; the second scenario investigates the impact of lower foodservice sales; and the third scenario evaluates international trade changes and how they affected the Canadian agri-food sector. All scenarios are then combined to study the overall effect of the pandemic. Results presented include the impacts on Canadian industrial output, GDP, and employment, and the sectorial and regional distribution of these effects.

4.1 Impacts of Scenario 1: Food retail sales

The first scenario simulates the retail food expenditure changes stemming from the COVID-19 pandemic. *Table 7* shows the volume changes applied to the IO model for each province. As expected, most categories show positive variations during the first year of the pandemic compared to the 2019 benchmark, except for *Bread, rolls and flatbreads* and *Cookies, crackers and baked sweet goods,* where the change in volume is negative in most regions. Potential reasons for lower sales of these food categories an increase in home baking of products such as bread and cookies. This is supported by the increase in sales of *Flour and other grain mill products* or a change in eating habits due to people having different routines. For instance, working or studying from home may reduce the demand for lunches and snacks such as sandwiches, crackers, and cookies.

Table 7: Volume change of food categories per region, first year of COVID-19

Household Food Expenditures Categories	ATL	QC	ON	MB-SK	AB	BC	Canada
	Δ Volume %	Δ Volume %	Δ Volume %	Δ Volume %	Δ Volume %	Δ Volume %	Δ Volume %
Bottled water, soft drinks and ice	6.8%	7.0%	3.9%	12.0%	7.8%	8.1%	5.3%
Bread, rolls and flatbreads	-3.0%	-5.9%	3.9%	-3.9%	-7.0%	-2.4%	-1.5%
Breakfast cereal and other cereal products	5.6%	6.0%	5.8%	4.6%	6.6%	4.6%	3.2%
Butter and dry and canned dairy products	19.2%	22.3%	19.0%	16.9%	18.9%	16.9%	12.3%
Cheese and cheese products	11.3%	12.1%	10.8%	10.3%	13.8%	10.1%	7.2%
Chocolate (except confectionery)	29.2%	33.2%	30.1%	25.8%	23.1%	28.7%	26.3%
Coffee and tea	18.8%	21.5%	14.7%	17.4%	21.0%	14.8%	19.4%
Confectionery products	4.5%	4.3%	3.9%	5.1%	6.7%	5.7%	1.6%
Cookies, crackers and baked sweet goods	-9.9%	-11.8%	-0.4%	-16.8%	-16.4%	-11.0%	-2.6%
Eggs in shell	9.0%	10.5%	8.4%	8.9%	9.7%	7.9%	2.7%
Fish, crustaceans, shellfish and other fishery products	18.6%	16.0%	19.2%	16.9%	38.2%	-2.0%	0.4%
Flavouring syrups, seasonings and dressings	17.3%	18.0%	16.7%	17.4%	19.0%	17.1%	13.0%
Flour and other grain mill products	31.3%	36.5%	35.9%	25.4%	28.2%	20.4%	22.6%
Flour mixes, dough and dry pasta	15.6%	19.9%	10.1%	16.1%	18.9%	13.2%	11.2%
Fresh and frozen beef and veal	9.3%	10.9%	12.3%	7.4%	9.3%	4.1%	0.9%
Fresh and frozen pork	12.7%	16.5%	6.6%	15.8%	14.5%	14.9%	8.8%
Fresh and frozen poultry of all types	5.8%	6.4%	7.0%	2.8%	7.6%	6.9%	1.4%
Fresh fruits and nuts	6.1%	6.4%	8.5%	3.3%	5.6%	4.9%	1.6%
Fresh potatoes	15.7%	19.3%	15.9%	12.4%	15.1%	12.0%	7.0%
Fresh vegetables (except potatoes)	10.2%	10.9%	11.0%	8.4%	11.4%	8.0%	4.6%
Fresh, frozen and canned fruit and vegetable juices	4.1%	4.1%	2.8%	5.8%	6.1%	7.5%	2.2%
Grain and oilseed products, n.e.c.	18.7%	21.0%	15.0%	17.4%	20.2%	15.7%	16.2%

Ice cream, sherbet and similar frozen desserts	10.7%	12.0%	12.9%	11.0%	9.0%	8.4%	2.7%
Margarine and cooking oils	16.8%	18.3%	18.9%	15.0%	13.5%	14.3%	14.2%
Other food products, n.e.c.	15.0%	16.2%	14.5%	13.7%	17.0%	13.1%	11.3%
Other miscellaneous crop products	15.8%	22.2%	10.2%	22.8%	16.8%	28.5%	12.8%
Prepared and packaged seafood products	19.5%	20.6%	20.4%	17.8%	23.3%	17.4%	7.8%
Preserved fruit and vegetables and frozen foods	15.7%	17.5%	14.1%	15.0%	18.1%	14.3%	10.4%
Processed fluid milk and milk products	6.6%	7.7%	6.8%	5.2%	6.3%	5.5%	4.7%
Processed meat products, other miscellaneous meats and animal by-products	9.5%	10.9%	10.0%	8.5%	9.1%	7.4%	5.3%
Snack food products	6.2%	6.2%	5.7%	6.4%	8.4%	6.5%	4.0%
Sugar and sugar mill by-products	21.7%	26.3%	20.2%	20.2%	19.8%	15.6%	16.9%
Sub-Total	8.3%	8.8%	8.3%	8.2%	8.8%	7.8%	5.3%

Taking into account the increases and decreases in food retail sales, the net direct effect was an increase in industrial output of $4,027 million, GDP of $1,123 million, and employment of 11,000 jobs (see *Table 8*). The direct plus indirect effects of this shock was an increase in industrial output of $8,614 million, GDP of $2,929 million, and employment of 31,400 jobs.

Table 8: Direct effect and direct plus indirect effect of the change in food retail sales from Scenario 1 in terms of industrial output, GDP, and employment

Canada	**Δ Industrial output ('000 $)**	**Δ GDP ('000 $)**	**Δ Employment (jobs)**
Direct effect	4,026,929	1,123,001	11,034
Direct + indirect effect	8,614,256	2,928,684	31,355

At the national level, the industries contributing the most to this increase in industrial output are mostly processed food industries such as *Dairy product manufacturing* ($1,047 million), *Meat product manufacturing* ($784 million), and *Other food manufacturing* ($551 million). Other important increases occur in *Dairy cattle and milk production* ($452 million), *Poultry processing* ($350 million), and *Frozen food manufacturing* ($315 million). The only

negative variation in industrial output is in *Bread, cookie, cracker, and bakery product manufacturing* (-$168 million). *Table 9* shows the 10 industries most affected by the increase in food retail sales modelled in Scenario 1.

Table 9: The 10 industries most affected from the change in food retail sales from Scenario 1, Canada, in dollars and percentage

Industries	Benchmark ('000 $)	Δ Output ('000 $)	Δ Output (%)
Dairy product manufacturing	15,446,792	1,047,198	7%
Meat product manufacturing (except poultry processing)	21,609,270	783,556	4%
Other food manufacturing (except other snack foods)	8,859,762	550,458	6%
Dairy cattle and milk production	6,869,094	452,063	7%
Poultry processing	7,779,689	350,359	5%
Frozen food manufacturing	4,727,051	314,903	7%
Beef cattle ranching and farming, including feedlots	10,714,033	287,967	3%
Other animal food manufacturing	6,675,925	227,363	3%
Other crop farming	6,674,572	219,569	3%
Oilseed processing	7,431,325	206,569	3%

Regionally, the geographical distribution of the impact is skewed towards the larger provinces of Ontario ($3,027 million), Quebec ($2,205 million), and Alberta ($1,179 million) (see *Table 10*). These three provinces combined account for 74% of the increase in production due to changes in retail sales. The smallest provincial changes in industrial output occur in Prince-Edward-Island and Newfoundland and Labrador. Very small impacts are seen in Yukon, Northwest Territories, and Nunavut.

Table 10: Direct effect and direct plus indirect effect on each region of the change in food retail sales from Scenario 1, in terms of industrial output, GDP, and employment

	Direct effect			Direct + indirect effect		
Region	Δ Output ('000 $)	Δ GDP ('000 $)	Δ Employment (jobs)	Δ Output ('000 $)	Δ GDP ('000 $)	Δ Employment (jobs)
NL	56,965	23,221	118	99,825	42,829	300
PE	48,271	16,710	165	86,058	33,364	386
NS	76,621	28,202	309	153,976	60,887	747
NB	135,514	52,265	370	233,657	91,368	847

QC	1,067,777	293,528	3,383	2,204,536	745,329	9,120
ON	1,504,801	379,414	3,589	3,026,834	999,771	10,553
MB	189,556	49,759	686	457,405	148,067	1,908
SK	103,866	25,482	192	423,064	139,176	1,190
AB	450,371	136,685	845	1,178,897	399,377	3,211
BC	389,833	116,022	1,375	744,028	265,408	3,089
YT	475	256	0	954	530	1
NT	236	126	0	1,454	730	1
NU	2,641	1,332	1	3,567	1,847	2
CE	0	0	0	0	0	0
CANADA	**4,026,929**	**1,123,001**	**11,034**	**8,614,256**	**2,928,684**	**31,355**

The five industrial sectors in each region that were affected the most by the change in food retail sales are given in *Table 11*. The industrial sectors affected depends on the degree of specialization and their spatial location. For instance, the Atlantic provinces are affected by important increases in the fishing and seafood manufacturing industrial sectors. Quebec, Ontario, and British Columbia are affected by significant changes in dairy farming and processing. The Prairie provinces are affected by changes in livestock and oilseed farming and meat processing industries.

Table 11: The five industrial sectors with the largest changes in industrial output in each region from Scenario 1, in dollars and percentage

Region	Industries	Benchmark ('000 $)	Δ Output ('000 $)	Δ Output (%)
NL	Fishing, hunting and trapping	810,261	36,894	5%
	Seafood product preparation and packaging	1,336,278	16,985	1%
	Aquaculture	190,669	8,661	5%
	Dairy product manufacturing	92,383	5,287	6%
	Soft drink and ice manufacturing	74,877	3,144	4%
PE	Frozen food manufacturing	494,915	25,930	5%
	Potato farming	300,391	13,481	4%
	Dairy product manufacturing	181,576	12,479	7%
	Dairy cattle and milk production	91,082	6,182	7%
	Seafood product preparation and packaging	506,649	1,980	0%
NS	Fishing, hunting and trapping	1,304,115	34,765	3%
	Seafood product preparation and packaging	1,348,742	20,339	2%

	Dairy product manufacturing	251,335	15,961	6%
	Dairy cattle and milk production	147,786	9,227	6%
	Other animal food manufacturing	238,536	8,288	3%
NB	Frozen food manufacturing	612,311	42,340	7%
	Seafood product preparation and packaging	1,469,619	19,350	1%
	Fishing, hunting and trapping	433,369	19,199	4%
	Poultry processing	322,254	14,938	5%
	Aquaculture	259,780	11,512	4%
QC	Dairy product manufacturing	5,844,130	390,425	7%
	Meat product manufacturing (except poultry processing)	5,825,196	198,471	3%
	Dairy cattle and milk production	2,537,096	166,243	7%
	Other food manufacturing (except other snack foods)	2,562,333	146,125	6%
	Other animal food manufacturing	2,278,380	83,893	4%
ON	Dairy product manufacturing	6,063,690	428,268	7%
	Other food manufacturing (except other snack foods)	4,567,013	292,334	6%
	Meat product manufacturing (except poultry processing)	6,039,397	284,737	5%
	Poultry processing	3,234,404	157,800	5%
	Dairy cattle and milk production	2,180,948	150,060	7%
MB	Meat product manufacturing (except poultry processing)	1,726,885	62,829	4%
	Oilseed processing	939,277	36,706	4%
	Hog and pig farming	1,119,831	36,487	3%
	Potato farming	305,307	34,041	11%
	Frozen food manufacturing	553,839	28,187	5%
SK	Oilseed processing	2,680,568	62,277	2%
	Canola farming	5,079,022	59,418	1%
	Beef cattle ranching and farming, including feedlots	1,587,668	40,829	3%
	Other crop farming	728,205	22,784	3%
	Dairy product manufacturing	286,022	19,040	7%
AB	Meat product manufacturing (except poultry processing)	6,951,694	191,716	3%
	Beef cattle ranching and farming, including feedlots	5,758,656	140,133	2%
	Dairy product manufacturing	908,323	57,110	6%
	Other crop farming	1,909,865	52,992	3%

	Oilseed processing	2,063,021	51,047	2%
BC	Dairy product manufacturing	1,435,934	94,796	7%
	Other food manufacturing (except other snack foods)	1,237,542	75,287	6%
	Poultry processing	1,366,516	57,499	4%
	Dairy cattle and milk production	636,745	41,312	6%
	Aquaculture	790,714	40,900	5%
YT	Aquaculture	2,284	269	12%
	Other crop farming	1,242	124	10%
	Other food manufacturing (except other snack foods)	964	120	12%
	Telecommunications	135,786	49	0%
	Potato farming	373	47	13%
NT	Truck transportation	98,639	206	0%
	Oil and gas extraction (except oil sands)	224,975	204	0%
	Air transportation	354,690	153	0%
	Poultry and egg production	2,912	138	5%
	Crude oil and other pipeline transportation	68,416	80	0%
NU	Seafood product preparation and packaging	17,086	1,412	8%
	Fishing, hunting and trapping	14,934	1,147	8%
	Other provincial and territorial government services	1,712,168	250	0%
	Food and beverage stores	128,493	134	0%
	Air transportation	89,708	113	0%
CE	Defence services	375,690	0	0%
	Other federal government services (except defence)	1,085,504	0	0%

The results presented so far for Scenario 1 provide the net results of changes in food retail sales during the pandemic. However, it is interesting to investigate the impact of the negative food retail sales to estimate their impact. Looking only at the negative shocks applied to the model, the overall decline in Canadian production is $475 million, of which 50% occurs in the province of Ontario (-$239 million) (see *Table 12*). It is interesting to note that Quebec is the second most affected province (-$83 million), despite being the only province with a positive change in sales of *Bread, rolls and flatbread*, and the smallest negative change in *Cookies, crackers, and baked sweet goods*. This is an example of how provinces are economically linked, as Quebec is mostly affected by the variation in demand from neighboring regions.

Unsurprisingly, the industrial sector most affected by this negative shock is *Bread, cookie, cracker and bakery product manufacturing* (-$250 million), followed by *Grain and oilseed milling* (-$16 million), and *Tortilla and pasta manufacturing* (-$14 million).

Table 12: Direct effect and direct plus indirect effect on each region of the decrease in food retail sales from Scenario 1, in terms of industrial output, GDP, and employment

	Direct effect			Direct + indirect effect		
Region	**Δ Output ('000 $)**	**Δ GDP ('000 $)**	**Δ Employment (jobs)**	**Δ Output ('000 $)**	**Δ GDP ('000 $)**	**Δ Employment (jobs)**
NL	-1,591	-685	-3	-2,378	-1,081	-7
PE	-88	-43	0	-471	-210	-2
NS	-6,736	-2,532	-23	-9,719	-3,828	-43
NB	-2,566	-1,160	-5	-4,939	-2,155	-16
QC	-46,657	-19,104	-143	-82,630	-35,149	-344
ON	-142,509	-50,676	-322	-238,821	-92,423	-752
MB	-6,653	-3,388	-24	-15,194	-6,722	-63
SK	-3,603	-1,495	-6	-11,770	-4,502	-31
AB	-26,834	-12,756	-45	-49,223	-22,770	-121
BC	-41,319	-19,148	-143	-59,738	-27,780	-240
YT	-45	-20	0	-69	-34	0
NT	-5	-2	0	-73	-36	0
NU	-29	-11	0	-50	-22	0
CE	0	0	0	0	0	0
CANADA	-278,635	-111,023	-715	-475,074	-196,711	-1,619

4.2 Impact of Scenario 2: Foodservice sector

The second scenario focuses on the decline in sales from the foodservice industry. *Table 13* shows the decline in the foodservice sector between 2019 and 2020 for each region included in the IO model. Overall, sales declined by $21.7 billion in Canada, a drop of 28% compared to 2019. The provinces of Ontario and Quebec had the largest declines in sales ($9.5 billion and $4.7 billion, respectively), both showing a decline of 31% compared to 2019. Since no data is available for Nunavut in 2019, the decline in sales is assumed to be similar as that of the other northern regions (Yukon and Northwest Territories), approximately 23%.

Note that Scenario 2 applies a reduction proportional to each region's decline in sales for consumers expenditure (final demand), and that a significant share of *Prepared meal*, the foodservice industry output, is used as intermediate input or exported. Neither intermediate input nor exports is shocked in Scenario 2. Therefore, the total negative shock applied in the model is equal to $15.4 billion, which is lower than the total decline in foodservice sales estimated by Statistics Canada.

Table 13: Regional annual variation in restaurant sales (all types), 2020

Region	Δ Sales ('000 $)	Δ Sales (%)
Newfoundland and Labrador	-161,714	-19.1%
Prince Edward Island	-62,430	-19.9%
Nova Scotia	-419,304	-23.8%
New Brunswick	-239,836	-18.8%
Quebec	-4,661,474	-31.3%
Ontario	-9,521,943	-31.1%
Manitoba	-474,357	-21.7%
Saskatchewan	-339,322	-17.5%
Alberta	-2,432,727	-24.6%
British Columbia	-3,319,133	-25.2%
Yukon	-19,305	-23.0%
Northwest Territories	-18,318	-23.5%
Nunavut*	-4,107	-23.5%
CANADA	**-21,673,970**	**-28.1%**

** Nunavut data are estimates as no data is available for the territory in 2019*
Source: Statistics Canada, Table 21-10-0019-01.

Table 14 shows the direct effect and direct plus indirect effect of a decrease in foodservice sales from Scenario 2 for each region in the model. The direct effect on production in Canada is a decrease in industrial output of $13,862 million, a decrease in GDP of $6,331 million, and a loss of 173 thousand jobs. The direct plus indirect effect resulted in a decrease in industrial output of $24,122 million, while GDP and employment fell by $10,843 million, and 221 thousand jobs, respectively.

Table 14: Direct effect and direct plus indirect effect of reduction in sales of foodservice sector from Scenario 2, in terms of industrial output, GDP, and employment

Canada	Δ Industrial output ('000 $)	Δ GDP ('000 $)	Δ Employment (jobs)
Direct effect	-13,862,318	-6,330,952	-173,269
Direct + indirect effect	-24,121,685	-10,842,658	-220,626

Table 15 identifies the 10 sectors most affected with the largest decline in industrial output in Canada. At the national level, the most affected industrial sectors are *Foodservices and drinking places* (-$12,383 million), *Meat product manufacturing* (-$811 million), and *Dairy product manufacturing* (-$519 million). Other industries affected significantly include *Traveller accommodation* (-$484 million), *Lessors of real estate* (-$478 million), and *Food and beverage stores* (-$452 million). Results provide evidence that the foodservices sector's backward linkages are important with high value-added products from industrial sectors such as meat and dairy manufacturing, but also with the short-term lodging industry (e.g., hotels, resorts, motels), lessors of real estate (e.g., owners renting and leasing properties), and even food and beverage stores, which may act as suppliers for some foodservice establishments or provide foodservices themselves.

Table 15: The 10 industries most affected from the decrease in sales of foodservice from Scenario 2, Canada, in dollars and percentage

Industries	Benchmark ('000 $)	Δ Output ('000 $)	Δ Output (%)
Foodservices and drinking places	75,935,178	-12,383,338	-16%
Meat product manufacturing (except poultry processing)	21,609,270	-811,491	-4%
Dairy product manufacturing	15,446,792	-518,555	-3%
Traveller accommodation	18,845,853	-484,436	-3%
Lessors of real estate	106,105,808	-478,181	0%
Food and beverage stores	31,756,465	-452,005	-1%
Beef cattle ranching and farming, including feedlots	10,714,033	-347,857	-3%
Food, beverage and tobacco merchant wholesalers	23,460,889	-316,809	-1%
Banking and other depository credit intermediation	97,417,211	-264,228	0%
Poultry processing	7,779,689	-244,802	-3%

Table 16 provides the regional distribution of the direct effect and direct plus indirect effect. Once again, Ontario is the province showing the largest direct plus indirect effect (-$9,705 million), followed by Quebec (-$5,043 million), Alberta (-$3,610 million) and British Columbia (-$3,117 million). The impact is small in the three northern territories and in Prince-Edward-Island.

Table 16: Direct effect and direct plus indirect effect on each region of the decrease in sales of foodservice in terms of industrial output, GDP, and employment

	Direct effect			Direct + indirect effect		
Region	**Δ Output ('000 $)**	**Δ GDP ('000 $)**	**Δ Employment (jobs)**	**Δ Output ('000 $)**	**Δ GDP ('000 $)**	**Δ Employment (jobs)**
NL	-133,555	-63,239	-1,780	-212,082	-101,455	-2,125
PE	-44,374	-20,722	-683	-86,415	-37,722	-910
NS	-318,597	-145,911	-4,232	-492,668	-225,548	-5,309
NB	-189,997	-87,763	-2,708	-345,031	-153,997	-3,454
QC	-2,861,559	-1,369,167	-44,467	-5,042,960	-2,320,226	-55,913
ON	-5,669,432	-2,465,836	-69,978	-9,705,523	-4,295,468	-88,692
MB	-388,828	-180,002	-5,367	-782,702	-336,754	-7,283
SK	-306,103	-142,874	-4,114	-679,505	-288,113	-5,402
AB	-1,876,112	-918,473	-18,409	-3,609,675	-1,619,026	-24,200
BC	-2,038,633	-919,799	-21,513	-3,116,609	-1,440,030	-27,314
YT	-11,381	-5,791	-6	-14,555	-7,568	-8
NT	-19,931	-9,422	-9	-26,529	-12,854	-13
NU	-3,817	-1,954	-2	-7,430	-3,896	-4
CE	0	0	0	-1	-1	0
CANADA	**-13,862,318**	**-6,330,952**	**-173,269**	**-24,121,685**	**-10,842,658**	**-220,626**

Table 17 identifies the 5 most affected industrial sectors by the decline in foodservices sales in each province. For almost all regions, the *Foodservices and drinking places* industry experiences the largest losses and the backward linkages vary from region to region. Important output declines occur in the meat processing sector across provinces, causing an indirect effect on the agricultural sectors of hogs and beef farming, especially in the Prairies. Dairy products manufacturing is also affected with lower sales to the foodservice sector, significantly impacting Ontario and Quebec where production is concentrated. Finally, the hotelling industry (*Traveller accommodation*) is among the top industries for most regions, providing evidence regarding the importance of the linkages between the foodservice sector and the tourism industry. That being

said, the hotelling industry has suffered greater economic harm from the travel bans that limited their ability to operate.

Table 17: The five industrial sectors with the largest changes in industrial output in each region from Scenario 2, in dollars and percentage

Region	Industries	Benchmark ('000 $)	Δ Output ('000 $)	Δ Output (%)
NL	Foodservices and drinking places	948,787	-118,519	-12%
	Fishing, hunting and trapping	810,261	-9,788	-1%
	Traveller accommodation	233,043	-7,428	-3%
	Seafood product preparation and packaging	1,336,278	-5,511	0%
	Food and beverage stores	551,764	-5,261	-1%
PE	Foodservices and drinking places	284,443	-38,464	-14%
	Dairy product manufacturing	181,576	-5,859	-3%
	Meat product manufacturing (except poultry processing)	61,912	-4,412	-7%
	Frozen food manufacturing	494,915	-3,868	-1%
	Dairy cattle and milk production	91,082	-2,889	-3%
NS	Foodservices and drinking places	1,794,627	-283,913	-16%
	Traveller accommodation	441,819	-11,364	-3%
	Lessors of real estate	2,244,160	-10,545	0%
	Food and beverage stores	884,628	-10,149	-1%
	Dairy product manufacturing	251,335	-9,154	-4%
NB	Foodservices and drinking places	1,263,433	-165,829	-13%
	Poultry processing	322,254	-9,818	-3%
	Petroleum refineries	7,666,160	-9,052	0%
	Frozen food manufacturing	612,311	-6,941	-1%
	Traveller accommodation	302,808	-6,861	-2%
QC	Foodservices and drinking places	14,613,272	-2,554,187	-17%
	Dairy product manufacturing	5,844,130	-183,182	-3%
	Meat product manufacturing (except poultry processing)	5,825,196	-142,628	-2%
	Food and beverage stores	6,872,920	-112,828	-2%
	Lessors of real estate	22,686,705	-81,691	0%
ON	Foodservices and drinking places	29,385,864	-5,078,208	-17%
	Meat product manufacturing (except poultry processing)	6,039,397	-274,074	-5%
	Lessors of real estate	41,463,188	-218,962	-1%
	Dairy product manufacturing	6,063,690	-206,205	-3%
	Food and beverage stores	11,454,949	-180,454	-2%
MB	Foodservices and drinking places	2,100,052	-333,310	-16%
	Meat product manufacturing (except poultry	1,726,885	-55,371	-3%

	processing)			
	Hog and pig farming	1,119,831	-33,421	-3%
	Traveller accommodation	888,452	-27,117	-3%
	Beef cattle ranching and farming, including feedlots	689,826	-17,123	-2%
SK	Foodservices and drinking places	2,013,572	-264,341	-13%
	Beef cattle ranching and farming, including feedlots	1,587,668	-50,720	-3%
	Oilseed processing	2,680,568	-23,123	-1%
	Canola farming	5,079,022	-23,020	0%
	Other crop farming	728,205	-20,000	-3%
AB	Foodservices and drinking places	10,302,973	-1,671,995	-16%
	Meat product manufacturing (except poultry processing)	6,951,694	-292,710	-4%
	Beef cattle ranching and farming, including feedlots	5,758,656	-193,216	-3%
	Traveller accommodation	2,995,120	-86,303	-3%
	Lessors of real estate	13,403,778	-74,375	-1%
BC	Foodservices and drinking places	13,026,544	-1,849,573	-14%
	Traveller accommodation	4,050,671	-93,090	-2%
	Lessors of real estate	18,212,284	-70,218	0%
	Food and beverage stores	5,201,026	-55,736	-1%
	Dairy product manufacturing	1,435,934	-52,865	-4%
YT	Foodservices and drinking places	80,065	-7,583	-9%
	Traveller accommodation	84,690	-2,148	-3%
	Food and beverage stores	60,845	-915	-2%
	Recreational vehicle (RV) parks, recreational camps, and rooming and boarding houses	23,313	-607	-3%
	Telecommunications	135,786	-208	0%
NT	Foodservices and drinking places	103,439	-15,896	-15%
	Traveller accommodation	68,283	-2,015	-3%
	Repair construction	218,614	-999	0%
	Recreational vehicle (RV) parks, recreational camps, and rooming and boarding houses	31,147	-716	-2%
	Food and beverage stores	87,149	-684	-1%
NU	Traveller accommodation	44,903	-1,677	-4%
	Foodservices and drinking places	18,107	-1,521	-8%
	Seafood product preparation and packaging	17,086	-751	-4%
	Fishing, hunting and trapping	14,934	-486	-3%
	Food and beverage stores	128,493	-431	0%
CE	Defence services	375,690	-1	0%
	Other federal government services (except defence)	1,085,504	0	0%

4.3 Impact of Scenario 3: International trade

As discussed in *Chapter 3*, international trade of agri-food products has been affected by disruptions caused by the pandemic, but other factors also contributed to variations in international trade. These include, among others, geopolitical issues (e.g., diplomatic relations between Canada and China), disruptions in global markets due to unpredictable events (e.g., ASF in China, droughts in India), tariffs, exchange rates, and production cycles. To estimate the change in exports due to the COVID-19 pandemic, two scenarios were developed based on the best currently available data and assumptions concerning other factors. Scenario 3A is a conservative estimate while Scenario 3B contains larger estimates. The estimates are based on forecasts and year-over-year changes. For each commodity, the smaller change in absolute value was assigned to Scenario 3A and the largest was assigned to Scenario 3B. While the rankings of the industrial sectors affected is not expected to vary much between Scenarios 3A and 3B, they can be considered as lower and upper bounds for measuring the economic impact from trade.

Table 18 summarizes Scenarios 3A and 3B. The lower bound for *Durum* is set at 12%, which represents the difference between actual exports in 2020 and a simple linear forecast based on the last four years. The upper bound of 17% is the difference between 2020 exports and 2019 exports. For *Lentils*, the upper bound is 47%, which is the year-over-year variation in exports between 2020 and 2019. The lower bound is set to half of the upper bound, or 23.5%[11]. For *Lobster*, the lower bound is set at -13%, representing the difference between 2020 and 2019 exports. The upper bound is set at -15%, based on the difference between a linear forecast for 2020 using data from 2013 to 2019.

The CIMT database, used in this research to estimate variations in exports, reports data with the HS commodity classification which does not align precisely with the IO commodity classification. Therefore, some manipulation is necessary prior to applying the shocks to the IO model. *Table 17* depicts how variations in HS commodities from the CIMT database translate into the IO commodity classification. For instance, in Scenario 3A, *Durum* represents 24% of *Wheat* exports, meaning that a 12% increase in *Durum* exports corresponds to a 3% increase in exports of *Wheat*. For the *Lobster* commodity, two IO commodities are affected, since the CIMT

[11] Forecasts were not used to compare with 2020 data because too much volatility in quantities exported in recent years causes a poor fit for simple linear forecast.

database does not provide the detail whether lobster exports are prepared/packaged or not. These account for 31% of the fish and seafood exports.

Table 18: Shocks applied to Scenarios 3A and 3B

HS Commodity	3A Δ Volume (%)	3B Δ Volume (%)	IO commodity	Share of IO commodity	3A shock (%)	3B shock (%)
Durum	12%	17%	Wheat	24%	3%	4%
Lentils	23.5%	47%	Fresh vegetables (except potatoes)	31%	7%	15%
Lobster	-13%	-15%	Fish, crustaceans, shellfish and other fishery products	31%	-4%	-5%
			Prepared and packaged seafood products			

4.3.1 Impact of Scenario 3A

Overall results for Scenario 3A for Canada are presented in *Table 19*. In terms of the direct effect on the economy, this scenario has a net positive change in industrial output of $299 million, a net positive change in GDP of $242 million, and a net increase in employment of 1,222 jobs. The direct plus indirect effect is a net positive increase in industrial output ($359 million), GDP ($275 million), and employment (1,321 jobs).

Table 19: Direct effect and direct plus indirect effect of the change in international trade from Scenario 3A, in terms of industrial output, GDP, and employment

Canada	Δ Industrial output ('000 $)	Δ GDP ('000 $)	Δ Employment (jobs)
Direct effects	298,716	242,071	1,222
Direct + indirect effects	359,328	274,960	1,321

In the international trade scenarios, there are both positive and negative impacts because some of the export markets expanded while others contracted. The positive increase in export resulted in an increase in industrial output of $665 million while the decrease in exports lead to a decrease in industrial output of $306 million. Taking both impacts into account resulted in a net positive impact of $359 million of industrial output.

Table 20 shows the 10 national industries most affected by the change in exports. The largest impact occurred in the *Oilseed and pulse farming* industry ($231 million), *Seafood*

product preparation and packaging (-$184 million), and *Wheat farming* ($123 million). This is consistent with the shocks being modelled for changes in exports of lentils, lobsters, and durum. However, other industries that were not expected to be affected showed changes in industrial output. For example, it was unexpected that the *Greenhouse, nursery and floriculture production* sector would be impacted to this extent. This issue is discussed further in *Chapter 5*.

Among the other most affected industrial sectors, industries with strong backward linkages are impacted, such as pesticide and fertilizer manufacturers, and downstream industries, such as merchant wholesalers which are involved in exports. Interestingly, food wholesalers seem to be more affected by the decrease in seafood exports than the increase in lentils and durum, as the estimated impact on this industry is negative. Meanwhile, miscellaneous merchant wholesalers benefit from an increase in output, probably because they engage in wholesaling agricultural supplies.

Table 20: The 10 industrial sectors most affected by the change in international trade from Scenario 3A, Canada, in dollars and percentage

Industries	Benchmark ('000 $)	Δ Output ('000 $)	Δ Output (%)
Oilseed (except soybean and canola) and pulse farming	4,397,153	231,348	5%
Seafood product preparation and packaging	6,458,660	-184,007	-3%
Wheat farming	6,800,798	123,440	2%
Greenhouse, nursery and floriculture production (except cannabis)	4,290,015	119,483	3%
Fishing, hunting and trapping	3,579,332	-83,093	-2%
Vegetable (except potato), melon, fruit and tree nut farming	2,639,282	60,898	2%
Aquaculture	1,441,728	-35,340	-2%
Pesticide, fertilizer and other agricultural chemical manufacturing	6,061,499	28,777	0%
Food, beverage and tobacco merchant wholesalers	23,460,889	-9,586	0%
Miscellaneous merchant wholesalers	20,754,224	8,809	0%

The impact of Scenario 3A is unevenly distributed across Canada. Indeed, it appears that the commodities shocked in this scenario have little in common and therefore affect different regions. For instance, lower quantities of lobster exported result in large losses for the Atlantic provinces in the fishing and seafood manufacturing industries, while higher exports of lentils and durum lead to important increases in pulse and wheat farming in the Prairies. The largest

industrial sector impact occurs in Saskatchewan (increase of $293 million), followed by Ontario (increase of $201 million), Alberta (increase of $125 million), while the largest negative impact occurs in Nova Scotia (loss of $92 million).

Table 21: Direct effect and direct plus indirect effect on each region from the change in international trade from Scenario 3A in terms of industrial output, GDP, and employment

	Direct effect			Direct + indirect effect		
Region	**Δ Output ('000 $)**	**Δ GDP ('000 $)**	**Δ Employment (jobs)**	**Δ Output ('000 $)**	**Δ GDP ('000 $)**	**Δ Employment (jobs)**
NL	-39,499	-12,185	-77	-74,592	-28,693	-199
PE	-17,692	-4,258	-67	-30,922	-11,488	-166
NS	-56,867	-20,769	-227	-91,787	-38,119	-431
NB	-55,337	-15,302	-140	-77,263	-25,038	-253
QC	3,843	2,891	36	7,301	4,296	47
ON	137,881	60,418	718	201,400	93,312	1,000
MB	25,540	13,843	101	37,686	20,197	163
SK	246,992	172,404	711	293,353	194,279	879
AB	75,031	50,172	232	125,270	74,023	388
BC	-21,072	-5,085	-64	-30,905	-7,710	-107
YT	0	0	0	-24	-10	0
NT	-6	-3	0	-15	4	0
NU	-99	-55	0	-173	-94	0
CE	0	0	0	0	0	0
CANADA	**298,716**	**242,071**	**1,222**	**359,328**	**274,960**	**1,321**

However, similar to the results obtained at the national level, some anomalies in the regional results need to be analyzed. Industries such as *Aquaculture*, *Vegetable farming*, and *Greenhouse production* should not see large changes in industrial output following a shock to the three exported commodities mentioned earlier. This likely results in an overestimation of the economic impact in Ontario, which mostly stems from the estimated increase in industrial output in the vegetable farming and greenhouse production industries. See *Chapter 5* for further discussion on this topic.

Table 22: The five industrial sectors with the largest changes in industrial output in each region from Scenario 3A, in dollars and percentage

Region	Industries	Benchmark ('000 $)	Δ Output ('000 $)	Δ Output (%)
NL	Seafood product preparation and packaging	1,336,278	-42,563	-3%
	Fishing, hunting and trapping	810,261	-17,242	-2%
	Aquaculture	190,669	-4,032	-2%
	Food and beverage stores	551,764	-823	0%
	Petroleum refineries	2,246,654	-733	0%
PE	Seafood product preparation and packaging	506,649	-17,479	-3%
	Fishing, hunting and trapping	254,004	-8,343	-3%
	Aquaculture	56,526	-1,829	-3%
	Food and beverage stores	159,052	-371	0%
	Banking and other depository credit intermediation	219,905	-237	0%
NS	Seafood product preparation and packaging	1,348,742	-39,735	-3%
	Fishing, hunting and trapping	1,304,115	-34,698	-3%
	Aquaculture	77,391	-1,966	-3%
	Other animal food manufacturing	238,536	-1,549	-1%
	Food, beverage and tobacco merchant wholesalers	477,409	-1,394	0%
NB	Seafood product preparation and packaging	1,469,619	-47,745	-3%
	Fishing, hunting and trapping	433,369	-10,545	-2%
	Aquaculture	259,780	-6,265	-2%
	Petroleum refineries	7,666,160	-1,862	0%
	Truck transportation	2,337,911	-1,547	0%
QC	Vegetable (except potato), melon, fruit and tree nut farming	845,918	11,507	1%
	Seafood product preparation and packaging	575,709	-10,965	-2%
	Greenhouse, nursery and floriculture production (except cannabis)	451,913	3,201	1%
	Food, beverage and tobacco merchant wholesalers	5,115,577	-2,087	0%
	Fishing, hunting and trapping	305,679	-1,805	-1%
ON	Greenhouse, nursery and floriculture production (except cannabis)	2,472,084	93,613	4%
	Vegetable (except potato), melon, fruit and	982,942	41,629	4%

	tree nut farming			
	Oilseed (except soybean and canola) and pulse farming	106,244	6,641	6%
	Electric power generation, transmission and distribution	17,480,243	4,450	0%
	Miscellaneous merchant wholesalers	9,989,289	4,197	0%
MB	Wheat farming	1,010,749	19,758	2%
	Oilseed (except soybean and canola) and pulse farming	187,066	6,178	3%
	Pesticide, fertilizer and other agricultural chemical manufacturing	474,963	2,484	1%
	Seafood product preparation and packaging	88,789	-2,139	-2%
	Vegetable (except potato), melon, fruit and tree nut farming	38,669	1,699	4%
SK	Oilseed (except soybean and canola) and pulse farming	2,944,589	183,906	6%
	Wheat farming	2,941,770	61,141	2%
	Pesticide, fertilizer and other agricultural chemical manufacturing	1,502,637	9,845	1%
	Petroleum refineries	3,797,393	4,189	0%
	Truck transportation	2,405,905	3,095	0%
AB	Wheat farming	2,222,987	39,661	2%
	Oilseed (except soybean and canola) and pulse farming	1,150,862	34,429	3%
	Pesticide, fertilizer and other agricultural chemical manufacturing	2,627,487	10,765	0%
	Oil and gas extraction (except oil sands)	27,875,566	5,358	0%
	Petroleum refineries	13,123,140	3,228	0%
BC	Aquaculture	790,714	-20,560	-3%
	Seafood product preparation and packaging	882,965	-19,903	-2%
	Greenhouse, nursery and floriculture production (except cannabis)	937,504	19,254	2%
	Fishing, hunting and trapping	355,003	-9,330	-3%
	Other animal food manufacturing	752,065	-4,420	-1%
YT	Aquaculture	2,284	-18	-1%
	Air transportation	106,665	-18	0%
	Other chemical product manufacturing	4,967	2	0%
	Telecommunications	135,786	2	0%
	Petroleum and petroleum products merchant wholesalers	17,314	2	0%
NT	Air transportation	354,690	-66	0%
	Oil and gas extraction (except oil sands)	224,975	33	0%

	Crude oil and other pipeline transportation	68,416	13	0%
	Fishing, hunting and trapping	1,336	-11	-1%
	Repair construction	218,614	4	0%
NU	Fishing, hunting and trapping	14,934	-79	-1%
	Seafood product preparation and packaging	17,086	-35	0%
	Air transportation	89,708	-20	0%
	Other provincial and territorial government services	1,712,168	-17	0%
	Waste management and remediation services	12,070	-6	0%
CE	Defence services	375,690	0	0%
	Other federal government services (except defence)	1,085,504	0	0%

4.3.2 Impact of Scenario 3B

Scenario 3B shocks the same commodities as in Scenario 3A, but assumes that the COVID-19 pandemic has had a larger impact than what is modeled in Scenario 3A. Results from Scenario 3B for each region are presented in *Table 23*. The direct effect from this scenario yields a net increase in industrial output ($702 million), GDP ($499 million), and employment (2,766 jobs). The direct plus indirect effect is also a net positive in the three variables: industrial output grows by $930 million; GDP grows by $614 million; and 3,534 jobs are created.

Table 23: Direct effect and direct plus indirect effect of the change in international trade from Scenario 3B, in terms of industrial output, GDP, and employment

Canada	**Δ Industrial output ('000 $)**	**Δ GDP ('000 $)**	**Δ Employment (jobs)**
Direct effects	702,115	498,656	2,766
Direct + indirect effects	930,138	614,308	3,534

Similar to 3A, Scenario 3B results in an increase in industrial output of $1,340 million, mitigated by lower production in other industries of $410 million, for a net increase of $930 million, more than twice the net effect estimated in 3A. *Oilseed and pulse farming* (increase of $462 million in industrial output) is still the industry benefiting the most from the changes in exports, followed by greenhouse production (increase of $239 million in industrial output), while the seafood manufacturing sector suffers the greatest loss in industrial output ($230 million). Other sectors seeing important changes in industrial output include *Wheat farming* ($175

million) and *Fishing, hunting and trapping* (-$104 million). Backward linkages are similar to those that occurred in Scenario 3A, the most important being the pesticide and fertilizer manufacturers, petroleum refineries, wholesalers, truck transportation, and repair construction. As with Scenario 3A, some unexpected industrial sectors had impacts and these are discussed in *Chapter 5*.

Table 24: The 10 industrial sectors most affected by the change in international trade from Scenario 3B, in dollars and percentage

Industries	Benchmark ('000 $)	Δ Output ('000 $)	Δ Output (%)
Oilseed (except soybean and canola) and pulse farming	4,397,153	462,325	11%
Greenhouse, nursery and floriculture production (except cannabis)	4,290,015	238,799	6%
Seafood product preparation and packaging	6,458,660	-229,994	-4%
Wheat farming	6,800,798	175,503	3%
Vegetable (except potato), melon, fruit and tree nut farming	2,639,282	121,758	5%
Fishing, hunting and trapping	3,579,332	-103,861	-3%
Pesticide, fertilizer and other agricultural chemical manufacturing	6,061,499	52,509	1%
Aquaculture	1,441,728	-44,172	-3%
Petroleum refineries	53,421,383	17,219	0%
Miscellaneous merchant wholesalers	20,754,224	16,849	0%

The distribution of impacts on Scenario 3B are similar to these in Scenario 3A, but output changes are amplified. Saskatchewan is still the province with the largest gain in industrial output ($544 million), followed by Ontario ($420 million), and Alberta ($221 million), mostly because of the increased production in the pulse farming industry. Meanwhile, the Atlantic provinces lose the most due to the importance of fishing and seafood manufacturing industries in their respective economies. For instance, Nova Scotia's industrial output decrease by $114 million, New Brunswick's by $96 million, and Newfoundland and Labrador's by $93 million. Note that for the same reasons mentioned in the analysis of Scenario 3A, Ontario's output variation is most likely overestimated by the model.

Table 25: Direct effect and direct plus indirect effect on each region from the change in international trade from Scenario 3B in terms of industrial output, GDP, and employment

	Direct effect			Direct + indirect effect		
Region	**Δ Output ('000 $)**	**Δ GDP ('000 $)**	**Δ Employment (jobs)**	**Δ Output ('000 $)**	**Δ GDP ('000 $)**	**Δ Employment (jobs)**
NL	-49,371	-15,230	-96	-93,006	-35,755	-248
PE	-22,004	-5,282	-84	-38,427	-14,265	-206
NS	-71,035	-25,942	-284	-114,202	-47,408	-535
NB	-69,078	-19,094	-174	-95,688	-30,960	-312
QC	15,914	7,711	98	33,750	15,798	180
ON	277,692	121,131	1,435	420,054	194,281	2,077
MB	41,746	22,820	165	63,406	34,075	276
SK	459,751	323,505	1,324	543,765	362,777	1,629
AB	127,672	86,562	394	220,847	130,602	684
BC	-9,040	2,546	-12	-10,203	5,231	-10
YT	0	0	0	-12	-2	0
NT	-7	-3	0	58	45	0
NU	-124	-68	0	-205	-110	0
CE	0	0	0	0	0	0
CANADA	**702,115**	**498,656**	**2,766**	**930,138**	**614,308**	**3,534**

Table 26: The five industrial sectors with the largest changes in industrial output in each region from Scenario 3B, in dollars and percentage

Region	Industries	Benchmark ('000 $)	Δ Output ('000 $)	Δ Output (%)
NL	Seafood product preparation and packaging	1,336,278	-53,203	-4%
	Fishing, hunting and trapping	810,261	-21,551	-3%
	Aquaculture	190,669	-5,040	-3%
	Food and beverage stores	551,764	-1,028	0%
	Petroleum refineries	2,246,654	-858	0%
PE	Seafood product preparation and packaging	506,649	-21,849	-4%
	Fishing, hunting and trapping	254,004	-10,429	-4%
	Aquaculture	56,526	-2,287	-4%
	Food and beverage stores	159,052	-463	0%
	Banking and other depository credit intermediation	219,905	-293	0%
NS	Seafood product preparation and packaging	1,348,742	-49,667	-4%
	Fishing, hunting and trapping	1,304,115	-43,371	-3%

	Aquaculture	77,391	-2,457	-3%
	Other animal food manufacturing	238,536	-1,934	-1%
	Food, beverage and tobacco merchant wholesalers	477,409	-1,741	0%
NB	Seafood product preparation and packaging	1,469,619	-59,680	-4%
	Fishing, hunting and trapping	433,369	-13,181	-3%
	Aquaculture	259,780	-7,831	-3%
	Petroleum refineries	7,666,160	-2,221	0%
	Truck transportation	2,337,911	-1,879	0%
QC	Vegetable (except potato), melon, fruit and tree nut farming	845,918	23,013	3%
	Seafood product preparation and packaging	575,709	-13,704	-2%
	Greenhouse, nursery and floriculture production (except cannabis)	451,913	6,401	1%
	Pesticide, fertilizer and other agricultural chemical manufacturing	420,064	2,572	1%
	Food, beverage and tobacco merchant wholesalers	5,115,577	-2,548	0%
ON	Greenhouse, nursery and floriculture production (except cannabis)	2,472,084	187,097	8%
	Vegetable (except potato), melon, fruit and tree nut farming	982,942	83,207	8%
	Oilseed (except soybean and canola) and pulse farming	106,244	13,273	12%
	Electric power generation, transmission and distribution	17,480,243	9,027	0%
	Truck transportation	21,947,919	8,460	0%
MB	Wheat farming	1,010,749	28,028	3%
	Oilseed (except soybean and canola) and pulse farming	187,066	12,341	7%
	Pesticide, fertilizer and other agricultural chemical manufacturing	474,963	4,384	1%
	Vegetable (except potato), melon, fruit and tree nut farming	38,669	3,391	9%
	Seafood product preparation and packaging	88,789	-2,673	-3%
SK	Oilseed (except soybean and canola) and pulse farming	2,944,589	367,516	12%
	Wheat farming	2,941,770	86,960	3%
	Pesticide, fertilizer and other agricultural chemical manufacturing	1,502,637	17,749	1%
	Petroleum refineries	3,797,393	7,620	0%
	Truck transportation	2,405,905	5,694	0%

AB	Oilseed (except soybean and canola) and pulse farming	1,150,862	68,809	6%
	Wheat farming	2,222,987	56,289	3%
	Pesticide, fertilizer and other agricultural chemical manufacturing	2,627,487	19,112	1%
	Oil and gas extraction (except oil sands)	27,875,566	10,277	0%
	Petroleum refineries	13,123,140	6,109	0%
BC	Greenhouse, nursery and floriculture production (except cannabis)	937,504	38,490	4%
	Aquaculture	790,714	-25,698	-3%
	Seafood product preparation and packaging	882,965	-24,872	-3%
	Fishing, hunting and trapping	355,003	-11,661	-3%
	Vegetable (except potato), melon, fruit and tree nut farming	528,719	8,546	2%
YT	Aquaculture	2,284	-23	-1%
	Air transportation	106,665	-21	0%
	Telecommunications	135,786	5	0%
	Other chemical product manufacturing	4,967	4	0%
	Petroleum and petroleum products merchant wholesalers	17,314	3	0%
NT	Air transportation	354,690	-77	0%
	Oil and gas extraction (except oil sands)	224,975	69	0%
	Crude oil and other pipeline transportation	68,416	28	0%
	Fishing, hunting and trapping	1,336	-13	-1%
	Repair construction	218,614	10	0%
NU	Fishing, hunting and trapping	14,934	-98	-1%
	Seafood product preparation and packaging	17,086	-44	0%
	Air transportation	89,708	-24	0%
	Other provincial and territorial government services	1,712,168	-21	0%
	Waste management and remediation services	12,070	-7	0%
CE	Defence services	375,690	0	0%
	Other federal government services (except defence)	1,085,504	0	0%

4.4 Combined impact of Scenarios 1, 2, and 3

The three scenarios were designed to simulate the impact of COVID-19 on the Canadian agri-food industry and were run separately to better understand the implications of different

components of final demand change for agricultural and food products. *Table 27* reports the overall results of combining the three scenarios to get a clearer picture of the total impact of COVID-19 on the agri-food industry and related sectors[12]. The direct effect estimated by the model is a net reduction in industrial output of $9,335 millions, GDP of $4,838 million, and employment of 160 thousand jobs. The direct plus indirect effect is a decrease of $14,863 million in industrial output, a GDP loss of $7,469 million, and the net loss of 187 thousand jobs.

Table 27: Direct effect and direct plus indirect effect in Canada from combining all scenarios in terms of industrial output, GDP, and employment

Canada	Δ Industrial output ('000 $)	Δ GDP ('000 $)	Δ Employment (jobs)
Direct effects	-9,334,973	-4,837,587	-160,240
Direct + indirect effects	-14,862,696	-7,469,340	-186,843

Table 28 identifies the 10 industries that were most affected by the simulation of the three scenarios combined. The positive economic impact was an increase in industrial output of $3,589 million, but the negative effect amounted to a decrease of $18,452, for a net effect of a reduction in industrial output of $14,863 million. The most important impact occurs in the foodservice industry, which sees its industrial output reduced by as much as $12,353 million. Other sectors with large negative effects include *Traveller accommodation* (-$478 million), *Lessors of real estate* (-$443 million) and *Food and beverage stores* (-$413 million). Nonetheless, some sectors are also affected positively from the shocks induced by COVID-19: industrial output of *Dairy product manufacturing* increases by $528 million, *Oilseeds and pulse farming* production increases by $369 million, and other food manufacturing sectors also gain from increased retail sales ($350 millions for *Other food manufacturing*, and $260 million for *Frozen food manufacturing*).

[12] Note that because two sub-scenarios were considered in Scenario 3, shocks applied in the global scenario uses the average shocks between 3A and 3B.

Table 28: The 10 industrial sectors most affected from combining all scenarios, in dollars and percentage

Industries	Benchmark (‘000 $)	Δ Output (‘000 $)	Δ Output (%)
Foodservices and drinking places	75,935,178	-12,352,502	-16%
Dairy product manufacturing	15,446,792	527,980	3%
Traveller accommodation	18,845,853	-477,641	-3%
Lessors of real estate	106,105,808	-443,390	0%
Food and beverage stores	31,756,465	-413,303	-1%
Oilseed (except soybean and canola) and pulse farming	4,397,153	369,075	8%
Bread, cookie, cracker and bakery product manufacturing	8,671,929	-355,803	-4%
Other food manufacturing (except other snack foods)	8,859,762	349,694	4%
Frozen food manufacturing	4,727,051	259,708	5%
Food, beverage and tobacco merchant wholesalers	23,460,889	-231,856	-1%

Industrial output declines in almost all provinces, except Saskatchewan where there is a positive effect ($530 million), notably on pulse and wheat farming, which outweighs the negative impact of the pandemic on the foodservice industry and its linkages (-$368 million) for a net industrial output increase of $162 million. Ontario is the province with the largest change in industrial output (-$6,368 million), followed by Quebec (-$2,818 million), British Columbia (-$2,393 million) and Alberta (-$2,258 million).

Table 29: Direct effect and direct plus indirect effect in each region from combining all scenarios in terms of industrial output, GDP, and employment

	Direct effect			Direct + indirect effect		
Region	**Δ Output ('000 $)**	**Δ GDP ('000 $)**	**Δ Employment (jobs)**	**Δ Output ('000 $)**	**Δ GDP ('000 $)**	**Δ Employment (jobs)**
NL	-121,025	-53,726	-1,749	-196,055	-90,851	-2,048
PE	-15,951	-8,782	-594	-35,031	-17,235	-709
NS	-305,927	-141,064	-4,179	-441,687	-207,424	-5,045
NB	-116,690	-52,696	-2,495	-197,849	-90,628	-2,890
QC	-1,783,903	-1,070,339	-41,016	-2,817,898	-1,564,850	-46,679
ON	-3,956,844	-1,995,648	-65,312	-6,367,962	-3,151,900	-76,601
MB	-165,628	-111,911	-4,548	-274,751	-161,551	-5,155
SK	151,134	130,563	-2,905	162,118	129,592	-2,958

AB	-1,324,389	-713,421	-17,251	-2,257,720	-1,117,336	-20,453
BC	-1,663,856	-805,047	-20,176	-2,393,135	-1,175,862	-24,283
YT	-10,906	-5,534	-6	-13,619	-7,043	-7
NT	-19,701	-9,299	-9	-25,053	-12,100	-12
NU	-1,287	-683	-1	-4,052	-2,151	-2
CE	0	0	0	-1	0	0
CANADA	**-9,334,973**	**-4,837,587**	**-160,240**	**-14,862,696**	**-7,469,340**	**-186,843**

Table 26 presents a breakdown of the five industries most affected by the largest change in industrial output in each region. Naturally, the same caveats mentioned in previous sections regarding the model overestimating the effects on some industries apply once again.

Table 30: The five most affected industrial sectors in each region from combining all scenarios, in dollars and percentage

Region	Industries	Benchmark ('000 $)	Δ Output ('000 $)	Δ Output (%)
NL	Foodservices and drinking places	948,787	-118,334	-12%
	Seafood product preparation and packaging	1,336,278	-36,409	-3%
	Fishing, hunting and trapping	810,261	7,709	1%
	Traveller accommodation	233,043	-7,368	-3%
	Food and beverage stores	551,764	-5,570	-1%
PE	Foodservices and drinking places	284,443	-38,314	-13%
	Frozen food manufacturing	494,915	22,060	4%
	Seafood product preparation and packaging	506,649	-18,914	-4%
	Potato farming	300,391	11,538	4%
	Fishing, hunting and trapping	254,004	-8,548	-3%
NS	Foodservices and drinking places	1,794,627	-283,641	-16%
	Seafood product preparation and packaging	1,348,742	-31,692	-2%
	Fishing, hunting and trapping	1,304,115	-12,662	-1%
	Traveller accommodation	441,819	-11,285	-3%
	Lessors of real estate	2,244,160	-10,310	0%
NB	Foodservices and drinking places	1,263,433	-165,112	-13%
	Seafood product preparation and packaging	1,469,619	-40,640	-3%
	Frozen food manufacturing	612,311	35,356	6%

	Potato farming	167,714	8,307	5%
	Traveller accommodation	302,808	-6,705	-2%
QC	Foodservices and drinking places	14,613,272	-2,546,592	-17%
	Dairy product manufacturing	5,844,130	206,994	4%
	Food and beverage stores	6,872,920	-102,001	-1%
	Other food manufacturing (except other snack foods)	2,562,333	92,340	4%
	Dairy cattle and milk production	2,537,096	87,954	3%
ON	Foodservices and drinking places	29,385,864	-5,065,529	-17%
	Dairy product manufacturing	6,063,690	221,891	4%
	Lessors of real estate	41,463,188	-203,642	0%
	Other food manufacturing (except other snack foods)	4,567,013	178,330	4%
	Bread, cookie, cracker and bakery product manufacturing	4,088,863	-174,566	-4%
MB	Foodservices and drinking places	2,100,052	-332,143	-16%
	Potato farming	305,307	30,571	10%
	Traveller accommodation	888,452	-26,467	-3%
	Wheat farming	1,010,749	25,805	3%
	Frozen food manufacturing	553,839	23,821	4%
SK	Oilseed (except soybean and canola) and pulse farming	2,944,589	281,071	10%
	Foodservices and drinking places	2,013,572	-263,420	-13%
	Wheat farming	2,941,770	76,286	3%
	Oilseed processing	2,680,568	38,967	1%
	Canola farming	5,079,022	37,574	1%
AB	Foodservices and drinking places	10,302,973	-1,668,780	-16%
	Meat product manufacturing (except poultry processing)	6,951,694	-101,127	-1%
	Traveller accommodation	2,995,120	-85,132	-3%
	Lessors of real estate	13,403,778	-69,737	-1%
	Oilseed (except soybean and canola) and pulse farming	1,150,862	67,551	6%
BC	Foodservices and drinking places	13,026,544	-1,845,671	-14%
	Traveller accommodation	4,050,671	-92,072	-2%
	Lessors of real estate	18,212,284	-66,190	0%
	Other food manufacturing (except other snack foods)	1,237,542	52,371	4%
	Food and beverage stores	5,201,026	-51,405	-1%
YT	Foodservices and drinking places	80,065	-7,576	-9%

	Traveller accommodation	84,690	-2,142	-3%
	Food and beverage stores	60,845	-910	-1%
	Recreational vehicle (RV) parks, recreational camps, and rooming and boarding houses	23,313	-606	-3%
	Aquaculture	2,284	210	9%
NT	Foodservices and drinking places	103,439	-15,874	-15%
	Traveller accommodation	68,283	-2,007	-3%
	Repair construction	218,614	-934	0%
	Recreational vehicle (RV) parks, recreational camps, and rooming and boarding houses	31,147	-714	-2%
	Food and beverage stores	87,149	-680	-1%
NU	Traveller accommodation	44,903	-1,663	-4%
	Foodservices and drinking places	18,107	-1,516	-8%
	Seafood product preparation and packaging	17,086	622	4%
	Fishing, hunting and trapping	14,934	572	4%
	Food and beverage stores	128,493	-303	0%
CE	Defence services	375,690	-1	0%
	Other federal government services (except defence)	1,085,504	0	0%

Chapter 5: Discussion

Results obtained from the scenarios designed to simulate the impact of COVID-19 are analyzed and discussed in this chapter. Special attention is given to the industrial sectors which are impacted the most, either as losers or gainers, as well as where in the country these effects occur. An assessment of the overall impact is made, including how the pandemic highlighted some deficiencies in the Canadian food system. Policy implications concerning these issues are brought forward, as well as some measures already taken by the government to address these. Finally, limitations of this research are discussed and potential avenues to improve the results are proposed.

5.1 Impact of COVID-19 on the Canadian agri-food industry

The combination of all scenarios provides insights into the overall effect that the pandemic has had on the agriculture and food producing industries and their linkages to other industrial sectors. The overall economic consequences of the pandemic are catastrophic. Even without accounting for supply-side disruptions, industrial output is reduced by almost $15 billion, GDP drops by $7.5 billion, and 187 thousand jobs are lost. These net negative effects from the change in food demand due to the global health crisis are not surprising, as it was already known that the effect on the foodservice industry was larger than the effect on the food retail sector, i.e., sales declined by $21.9 billion in the former and increased by $12.6 billion in the latter. The fact, however, that some industrial sectors are gaining while others are losing merits paying attention to the sectorial and regional distribution of these effects.

5.1.1 Negative impacts

In all provinces, the industrial sector suffering the largest negative effect is the foodservice industry, with industrial output estimated to be reduced by over $12 billion, 16% lower than in 2019. Moreover, this is likely an underestimation of the effect, since the shock applied in Scenario 2 does not take into consideration all foodservice establishments that were shut down during the pandemic such as schools and universities cafeterias or other workplaces foodservice establishments. Statistics Canada (2021b) estimates the sectoral GDP to be

approximately 31% lower in December 2020 compared to 2019, which could represent a loss in industrial output of $26.6 billion, more than doubling the losses estimated by the model used in this research.

The inability of foodservice providers to operate during the pandemic caused disruptions in the supply chain, but the food demand was reallocated to retail stores rather than being lower overall. Owners of foodservice establishments may have been able to reduce variable input costs (mostly food ingredients and wages), but some overhead costs such as rent, utilities, and taxes must be paid despite revenues falling or even completely disappearing for a period. This suggests that the *Lessors of real estate* sector may not have been affected by as much as the model estimates. Rather, foodservice operators have had access to government support to help them weather the storm caused by COVID-19 with federal programs providing interest-free partially forgivable loans, or subsidizing wages, rent and mortgages (Restaurants Canada, 2021). Whether or not this will be sufficient for restaurants and other foodservice providers to keep operating their business remains to be seen and will also depend on the recovery plan and speed. The foodservice industry is mostly composed of small establishments (23% of establishments employ between 1 and 4 employees, and 76% employ between 5 and 99), and employs a larger share of women and visible minorities than most other sectors. This sector is also a popular choice of jobs for students, especially during the summer months. Other than the business-specific programs mentioned above, policies put in place early in the pandemic, such as the CERB and the Canadian Emergency Student Benefit, had eligibility criteria broad enough to include a large majority of the people affected by the impact of COVID-19 on the foodservice industry.

Hotels and other accommodation services are important providers of food services that suffered negative consequences from COVID-19. The model estimates losses from this sector to be around $478 million, 2.5% lower than in 2019. However, the effect of the pandemic and mitigation measures on this industry is far greater than this, as accommodation services were severely affected by travel bans and the lack of tourism due to social distancing and lockdown measures. Estimating these impacts falls out of the scope of this research.

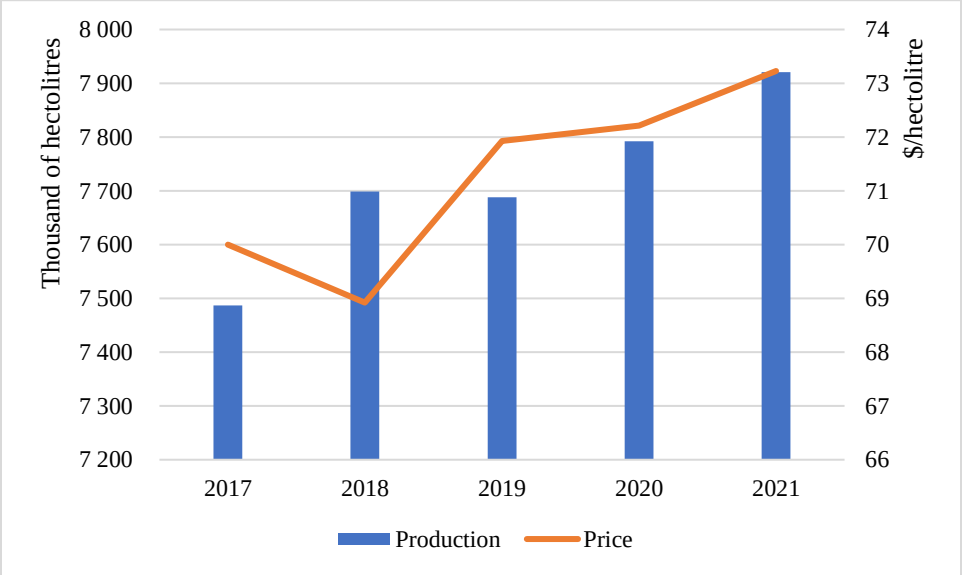
Despite not appearing in the industries most affected at the national level, the fishing and the seafood processing industries are worth investigating, because of the large impact they have in the Atlantic provinces. While Scenario 1 simulates an increase in sales of fish and seafood in retail stores, results from Scenarios 2 and 3 involve important reductions of output in these

industries. After the foodservice sector, the *Seafood product preparation and packaging* industry is the second most affected sector in most Atlantic provinces (third in Prince-Edward-Island). On average, this industrial sector's loss in output represents a decrease of approximately 3% compared to 2019.

5.1.2 Positive impacts

Not all agri-food sectors were negatively affected by the coronavirus epidemic. According to results from the overall scenario, the dairy production and manufacturing sectors are the industrial sectors gaining the most out of this undesirable situation. Despite lower demand from foodservice providers, the net effect is an industrial output increase of about $528 million, 3.4% higher than in 2019, which in turn increases dairy farming production by $226 million (+3.3%) due to the economic relationship between the sectors. These results are confirmed by increases in milk production and milk price through 2020 and 2021, as depicted in *Figure 26*.

Figure 26: Average monthly milk production and farm gate price, Canada, 2017-2021



Source: AAFC (2021), and PLQ (n.d.)

While all regions in Canada produce milk, dairy farms and dairy processing facilities are mostly concentrated in the provinces of Quebec and Ontario, hence why a large share of the industrial sector gains is realized there. The gains estimated by the model, however, do not take

into consideration some of the challenges imposed by the pandemic and the demand switch. For instance, the dumping of milk in the spring of 2020, the stress caused by overall uncertainty and price volatility, processors costs for adjusting production lines and packaging for products that are adapted to retail stores instead of foodservices, or farmers costs and burden for managing human resources and TFWs in the context of the pandemic all represent a cost that is not apparent in the model results. Therefore, the economic gains in the dairy industry may be overestimated and a similar argument can be made for the other food manufacturing sectors in which the overall scenario simulation yields gains, notably *Other food manufacturing* and *Frozen food manufacturing*. Furthermore, the degree to which the increased retail sales will persist in the future remains to be seen and will depend on if and when food expenditures switch back to the foodservice sector during the economic recovery.

Two other industries estimated to gain from the COVID-19 crisis are wheat and pulse farming, with increased international demand for durum and lentils benefiting Canadian exports. This higher than usual international demand for durum and lentils was likely caused by the pandemic as people were looking for long shelf-life products such as pasta and legumes, minimizing the trips to grocery stores and perhaps stockpiling for potential future lockdowns. *Wheat farming* increased its industrial output by $164 million (+2.4%), while *Oilseed and pulse farming* industrial output increased by $369 million (+8.4%). While this situation may have presented profitable opportunities for these industrial sectors, it is unlikely that it represents a "new normal" and that this level of exports will sustain itself in 2021 and further (Barichello, 2021). Moreover, the increase in lentils exported is also related to lower production in India and attributing the entirety or a share (and its value) of the variation to COVID-19 remains arbitrary. From a regional point of view, Saskatchewan is the clear winner from higher exports of lentils as the province is responsible for 95% of Canada's lentils production (Saskatchewan Pulse Growers, n.d.). This is consistent with the results obtained from the overall scenario showing a net gain in industrial output and GDP for the region. However, despite a net positive impact on the province's production, Saskatchewan is still affected by a net loss of jobs, perhaps unsurprisingly, suggesting that the pulse farming industry is less labour intensive than the sectors affected by a net loss such as the foodservice sector. The situation is very similar regarding higher exports of durum, as Saskatchewan also produces most of the Canadian durum wheat (79% in 2020), followed by Alberta (20%).

Other industrial sectors affected by a significant positive variation of output production, in relative terms, include *Potato farming* (+7.2%), *Frozen food manufacturing* (+5.5%), and *Vegetable, melon, fruit, and tree nut farming* (+5.3%), and *Greenhouse, nursery and horticulture production* (+4.6%). Higher retail sales of these products probably drove this increase in output.

It is worth mentioning that the model estimates important gains in the greenhouse production and vegetable farming sectors, especially in Ontario, British Columbia, and Quebec, where these industries are concentrated. Results from the overall scenario overestimate the impact in these sectors because of the way Scenario 3 was designed and simulated in the IO model. Scenario 3 models the variation in exports of lentils, durum, and lobster. Export data for these individual commodities is available from the CIMT database, but the SUTs group them into larger commodity categories. While this has been taken into consideration in the design of Scenario 3 by increasing exports by the share of the individual commodities in their parent group, the shock applied in the model does not discriminate from the other commodities included in the category. In other words, the model simulates an equal shock across all commodities included in the category. Without further disaggregating the SUTs, it is impossible to shock only lentils, durum, or lobster. For instance, increasing the exports of lentils, which are considered a vegetable in the IO tables, is simulated by increasing exports of all vegetables including those grown in greenhouses. This results in overestimating the effects on some sectors (e.g., greenhouse production and vegetable farming) while underestimating the effects on others (e.g., pulse farming). For the same reason, the aquaculture sector (notably in British Columbia) is negatively affected by the simulated decrease of lobster exports, despite lobsters not being farmed in an aquaculture context.

5.2 COVID-19 and the agriculture and food producing sectors: catastrophe or opportunity?

The effects of COVID-19 have been largely uneven, not only among the agri-food sectors but across all industries. The agricultural production industry has faced several issues and challenges, but it is arguably one of the industrial sectors that fared the best compared to others. Meanwhile, a case could be made about the hospitality industry suffering the worst consequences. There are multiple economic interrelations between these two macro-sectors and the question regarding the net impact of COVID-19 on these industries is an interesting one.

On one hand, there is absolutely no doubt that the foodservice industry has been severely hit and that this is having important economic consequences in Canada. Notably, this is a labour-intensive sector and therefore lower industrial output results in a large number of job losses, or at the very least reduced hours worked by employees. While the government put in place policies to address the catastrophic consequences of the epidemic, the question remains how long will the recovery take and will the situation revert to its pre-pandemic levels? If not, how long can foodservice owners continue operating their business, and should they be offered additional financial support? The accommodation and foodservice industry is an important part of the Canadian economy (2.2% of GDP, 6.5% of employment in 2019), but at the same time, the costs incurred by government programs during the coronavirus crisis weigh heavily on the current budget deficit and may not be sustainable for an extended period of time.

On the other hand, the agricultural sector has performed relatively well during the crisis. Some sectors, such as dairy production, pulse, wheat, and potato farming, as well as most food manufacturing industries, have even gained from the food demand changes caused by the pandemic. Naturally, these gains do not represent a desirable situation or opportunity, even for the sectors benefiting from them, and may also be overestimated. However, what they prove is that the food producing sectors have been able to show resilience and to overcome the unexpected challenges imposed by the pandemic. This “Black Swan” event highlighted some deficiencies in the Canadian food system. Some were easily addressed and do not necessarily warrant specific prevention measures (e.g., dumping of milk, empty shelves in grocery stores), but others seem to be deeper, more serious issues that deserve attention, such as the importance of having only a few meat processing facilities in the country, the working conditions in these establishments, and the reliance of the agri-food sector on TFWs.

5.3 Policy implications

5.3.1 Meat processing plants

The consequences of the COVID-19 outbreaks in meat processing plants in the spring of 2020 created a bottleneck in the supply chain affecting industries upstream and downstream. If such disruption was unexpected, and perhaps even unavoidable, improving biosecurity in food producing and processing activities should be one of the top priorities in the sector going forward. Scientists estimate that epidemics, zoonoses, or other diseases, are likely to occur more

frequently as human development is made at the expense of ecological systems (Tollefson, 2020). While this bleak prediction applies to all industries in general, animal producing sectors face additional risks due to workers being in direct contact with animals as well as the density of animals raised on a farm. COVID-19, BSE[13], ASF, avian and swine influenza are all recent examples of how viruses and diseases can spread in the context of food production and processing, and have catastrophic global consequences on the economy and public health.

The meat processing plants outbreaks have raised awareness that the industry is heavily reliant on a few facilities that process a large share of the cattle and pigs in Canada. The idea of smaller, more regionally distributed plants has been suggested as a way to reduce the risk of coronavirus. Rude (2021) argues against this, insisting that larger scale processing and packing plants are inevitable as they are more cost competitive and are better positioned to adopt innovations that would further reduce biosecurity risks such as meat cutting robotics. Nonetheless, legislation that would allow more farmers to use alternatives such as mobile slaughter services and direct sales from the farm may contribute to reducing pressure on large processing plants while also responding to increasing consumer demand for locally produced food.

5.3.2 Temporary foreign workers

Issues related to TFWs are not new. For example, Larue (2020) argues that the TFW program has a long history of being criticized for reasons ranging from contributing to unemployment to questionable work, and/or living conditions for TFWs. Larue (2021) also notes that the pandemic accentuated mistreatment of TFWs, with higher cases of abuse than in previous years concerning housing and transport conditions, and lack of protective equipment, among other issues. In reaction to these serious concerns, the government recently announced a proposition for new regulations to help prevent mistreatment and abuse of TFWs. The objectives of the proposed amendments would be to improve protections for TFWs, prevent bad actors from participating in the program, and strengthen the ability to effectively conduct inspections (Employment and Social Development Canada, 2021). This is certainly a step in the right direction, as it should help improve the working and living conditions of a labour force that is crucial in the agri-food sector.

[13] Bovine Spongiform Encephalopathy, or “Mad cow disease”

5.3.3 Preventive or reactive policies?

Finally, Ker and Biden (2021) recognize that a Black Swan event by definition cannot be predicted and, therefore, designing policies to address the potential consequences of an unpredictable event is costly, inefficient, and misses the mark more often than not. They argue that ex-post targeted policies are more suitable to tackle these kinds of challenges than ex-ante solutions. A case can be made that the government of Canada in cooperation with actors from the agricultural sector were able to quickly address issues arising from the coronavirus pandemic in the agri-food industry.

As Canada begins to recover and with the benefit of hindsight and the increased availability of economic data collected during the crisis period, careful analyses should be made to evaluate if and where support is needed to design efficient targeted policies. This research contributes to this effort by identifying industrial sectors and regions that were most affected by a change in food demand caused by the coronavirus epidemic in the agriculture and food producing industries.

5.4 Research limitations

Some limitations of this research have already been discussed in previous sections, such as how scenarios are designed and the distorting effects resulting in over or underestimating the impact on some industrial sectors and provinces. The difference in the aggregation levels of the various datasets used in this research is such that the degree of precision of the results is affected.

By focusing on the demand side of the pandemic effects, this study assumed that the supply side would be able to respond to the demand shocks applied to the model. This is obviously not the case in the COVID-19 context, where supply-side issues were an important part of the overall impact on the economy, including in the agricultural and food producing sectors. For instance, the effects of the meat processing plants closures in the spring of 2020 are not accounted for in the model but have had serious consequences on the upstream and downstream industrial sectors.

Another limitation is that the impacts modelled in the scenarios are quantity based. One of the assumptions of the IO model is that prices are static. This means that the model assumes no price changes in the 2019 benchmark prices. Naturally, the severe economic distortions that the COVID-19 epidemic caused affected commodity prices during 2020. While this assumption

is necessary to understand the effects on the interrelations between sectors (linkages), it may not be suitable to analyze the costs and revenues impacts on these sectors. For example, the value of crab exports was significantly lower in 2020 (-10%), which is believed to be related to prices dropping because of the pandemic, but the scenarios do not include lower crab exports as the volume was picked up in the retail industry. The crab industry has likely suffered from losses of income during the pandemic, but these effects are not captured by the IO model. A similar argument could be made for other fish and seafood as well as the beef and pork industries, where negative price effects were important in 2020.

The research uses the SUTs for the year 2016 and uses industrial sector GDP data to define a benchmark for the economy in 2019. More recent data to build the IO model would result in a better representation of the economic relationships between the sectors, but it is safe to assume that no major change in technology occurred between 2016 and 2019 that would significantly modify these linkages. However, the pandemic likely introduced major changes in costs of production, as well as in the GDP and employment ratios. The coronavirus epidemic may well have caused lasting disruptions and induced structural changes in several industries.

5.5 Future research

Results from this research contribute to better understand the repercussions of COVID-19 on the Canadian agri-food industry. One of the main conclusions relates to the devastating effects of the pandemic on the foodservice sector. However, foodservice establishments were not all affected equally by the shock. As discussed in *Chapter 3*, the impact on limited-service restaurants (e.g., fast-foods, take-outs) was much lower than the impact on other types of foodservice providers, such as full-service restaurants, bars, etc. Differentiating the effects on the sub-categories in the foodservice industry would provide a better assessment regarding the distribution of the impact in the sector.

Furthermore, different types of foodservice establishments have different input mixes, and lumping all types together in an aggregated category is not ideal, as important details and linkages are lost in the aggregation. As a result, the effects on certain commodities or industrial sectors may be overestimated while they may be underestimated in other cases. For instance, the demand for high-quality ingredients that are typically more used in full-service restaurants (e.g., high-end meat cuts, crab and lobster, specialty vegetables) is likely to have been affected more

severely than the demand for cheaper products such as chicken or lower quality meat cuts used by fast-food restaurants. Disaggregating the foodservice industry could be a promising area for further research, as it could lead to improvements to the AAEA SUTs by providing more details on the linkages between the different foodservice categories and other industrial sectors in the economy.

Prices effects were not taken into account in this analysis. Two potential future research areas are (1) profitability analysis of different industrial sectors and (2) the induced effect of increased or decreased household income. The first analysis would include the change in input costs and revenue for individual agriculture and food processing industrial sectors. The second analysis would close the IO model to household income. This would allow an estimate of the direct, indirect, and induced effect on the economy.

Canada is far from being done with COVID-19. The repercussions are still being felt today, even as recovery seems to be the next step forward. The million-dollar question is whether recovery will pave the way back to pre-COVID life, or if an equilibrium will be achieved in a "new normal" environment. Once enough time has passed and the economy settles in its after-crisis state, future research should consider the longer-term, structural changes that the economy may be undergoing as of today.

Chapter 6: Conclusion

6.1 Context and research problem

The global COVID-19 epidemic is a Black Swan event that has had catastrophic consequences around the globe. The disease itself has caused over 4 million deaths and has put immense pressure on healthcare systems, compromising their capacity to offer much needed essential services. Attempting to limit the spread of the virus, governments put in place measures such as social distancing, non-essential business closures, mandatory curfews, and travel bans. These measures, while justified to contain a highly contagious and potentially deadly virus, have had enormous repercussions on the economy, amplifying the initial shocks caused by COVID-19, such as work absenteeism from having contracted the disease, avoiding the risk of being infected, or for aiding relatives in need of assistance (e.g., children being schooled at home, family member infected by the virus).

In Canada, hospitality is one of the sectors affected the most during the pandemic. The industry does not provide essential services, is reliant on tourism, and implies, to some extent, public gathering. Except for those offering curbside pickup, deliveries, or drive-thru, restaurants were mandated to cease operating. The risk of propagating the virus in these conditions was just too important. As a result, the sector's GDP was 35% lower in December 2020 than it was in 2019 and employment was 27% lower in the same period.

While expenditures on food consumed away from home decreased drastically during 2020, a parallel increase in expenditures on food consumed at home occurred, i.e., food retail stores benefited from an increase of 10% in sales during 2020 compared to 2019 and the online delivery services market increased significantly. In the early spring of 2020, as the first wave of COVID-19 was unfolding in North America, some consumers engaged in hoarding behaviour for certain products including food items, in fear of an eventual food shortage. Images of empty shelves in grocery stores relayed by the media amplified this sentiment of panic, but overall food availability was never a major issue during the pandemic. When panic buying behaviours eventually subsided, changes in consumer habits caused by the pandemic and related lockdown

measures prompted adjustments in food consumption patterns, therefore modifying the basket of food products purchased by Canadian consumers.

Similar effects on food purchases happening in most countries, effectively impacting the global food demand and therefore, international trade. Disruptions on the production side due to lockdown measures or virus outbreaks in processing plants also had an impact on global markets. The early days of the pandemic were marked by uncertainty regarding borders remaining open for trade or not. Governments quickly recognized that food imports and exports were essential to ensure food availability and thus borders remained mostly open for these products. Nevertheless, the change in global food demand and disruptions in food supply chains have impacted quantities of Canadian food products exported, as well as their prices.

Assessing the economic impact of the pandemic on the Canadian food system is crucial to better understand the consequences of COVID-19 on the agriculture and food sectors. Data shows that the pandemic effects were uneven across industrial sectors and regions. This research aimed to identify the most affected agriculture and food sectors impacted by the coronavirus, quantify these economic effects, and analyze their industrial and regional distribution. To do so, it was necessary to determine the impact of COVID-19 on the different components of food demand (retail sales, foodservice sales, and international trade). Finally, another objective of this study was to discuss the policy implications related to the challenges brought forward during the pandemic.

6.2 Method, data, and scenarios

Input-output analysis is well suited to address the research problem of this study because it allows estimating the direct and indirect economic effects on different industrial sectors from an exogenous shock on final demand, such as food demand changes during the pandemic. IO analysis can also be used to assess the industrial distribution of the economic impact of the pandemic. Furthermore, IO models can contain several regions which makes it an appropriate method to analyze the spatial distribution of these effects. For these reasons, IO analysis is an ideal method to address the research problem and the objectives of this study.

The model used in this research is an interregional rectangle input-output model constructed using 2016 data from Statistics Canada. The model includes 14 regions (10 provinces, 3 territories, and Canadian enclaves abroad), 258 industrial sectors, 492 commodities,

and 275 final demand categories. Projections were made to create a benchmark for the economy in 2019 using the industrial GDP estimates published by Statistics Canada (2021b).

To design scenarios that would be used to shock the model, it was necessary to first estimate the impact of COVID-19 on food demand. Three components of food demand affected by the coronavirus crisis have been identified: sales in food retail stores, foodservice sales, and exports of food products. Based on these components, three scenarios were designed to simulate the estimated changes in demand for food commodities. Grocery stores scanner data from Nielsen were used to estimate the variation of different food products in retail stores sales during the first year of the pandemic. Foodservice sales data from Statistics Canada were used to quantify the lower demand affecting this industrial sector. The Canadian International Merchandise Trade database, also from Statistics Canada, allows quantifying variations in quantities of food commodities exported between 2020 recent years.

6.3 Results and discussion

In Scenario 1, the shock applied to the model was the change in food retail sales based on Nielsen scanner data. Almost all food categories were affected by an increase in sales except for bread and other baked goods. Under Scenario 1, the direct effect is an increase in industrial output by $4,027 million, GDP by $1,123 million, and employment by 11,034 jobs. The direct plus indirect effect is an increase of industrial output by $8,614 million, GDP by $2,292, and employment by 31,355 jobs. Results suggest that most industrial sectors realize economic gains under this scenario by increasing their industrial output, notably dairy processing ($1,047 million), meat manufacturing ($784 million), and dairy farming ($452 million). Provinces realizing the largest economic gains are Ontario ($3,027 million), Quebec ($2,205 million), and British Columbia ($1,179 million)

Scenario 2 simulated the decrease in sales in the foodservice industrial sector. The direct effect is that industrial output is reduced by $13,862 million, GDP by $6,331 million, and employment by 173,269 jobs. The direct plus indirect effect is a decrease in industrial output by $24,121 million, GDP by $10,843, and employment by 220,626 jobs. The industrial sectors most affected are the foodservice industry (-$12,383 million), meat manufacturing (-$811 million), and dairy product manufacturing (-$519 million). The provinces most affected under Scenario 2 are Ontario (-$9,706 million), Quebec (-$5,043 million), and Alberta (-$3,610 million).

Scenario 3 modelled the change in international trade attributable to COVID-19, i.e., changes in exports of lentils, durum, and lobster. This scenario was split into two sub-scenarios to account for inherent volatility in exports. Scenario 3A used conservative estimates of changes in exports while Scenario 3B used less conservative estimates. In Scenario 3A, the direct effect was an increase in industrial output by $299 million, GDP by $242 million, and employment by 1,222 jobs. The direct plus indirect effect was an increase in industrial output by $359 million, GDP by $275 million, and employment by 1,321 jobs. Under Scenario 3B, the direct effect was an increase in industrial output by $702 million, GDP by $499 million, and employment by 2,766 jobs. The direct plus indirect effect was an increase in industrial output of $930 million, GDP by $614 million, and employment by 3,534 jobs. In both sub-scenarios, the most affected industrial sectors are pulse and wheat farming, seafood processing, and greenhouse production. The provinces most affected by Scenario 3A and 3B are Saskatchewan, Ontario, and Alberta, in which industrial output increases. Meanwhile, the Atlantic provinces are affected by a decrease in industrial output in both Scenario 3A and 3B.

When combining the three scenarios, the direct effect is a decrease in industrial output by $9,335 million, GDP by $4,838 million, and employment by 160,240 jobs. The direct plus indirect effect is a decrease in industrial output by $14,863 million, GDP by $7,469 million, and employment by 186,843 jobs. The industrial sectors most affected include foodservice (-$12,353 million), dairy manufacturing ($528 million), and traveller accommodation (-$478 million). The most affected provinces are Ontario (-$6,368 million), Quebec (-$2,818), and British Columbia (-$2,393 million).

Results show that the overall consequences of the epidemic are disastrous, especially for the foodservice sector. Of the $14.9 billion reductions in industrial output, $12.4 billion accrues to the foodservice industrial sector. Other than the hospitality sector, most agricultural and food producing sectors have fared fairly well in terms of industrial sector output during the pandemic compared to other industries. Notably, the dairy industry, the pulse and wheat farming sectors, as well as most food manufacturing industries, are all estimated to have increased industrial output during 2020. This can be attributable to multiple factors, such as a low elasticity of demand for food, little disruption caused by the pandemic in industrial sectors that are not labour-intensive such as in agriculture, the collaboration between industry and government to address issues encountered, and a context favourable to some important Canadian agricultural exports.

On the other side, the meat manufacturing industry was severely affected by outbreaks of COVID-19 occurring in meat processing plants and the subsequent impacts have caused significant disruptions in the pork and beef industries, and to a lesser extent, the poultry sector. Among other factors, this has contributed to increased meat products prices, while also increasing farmers' costs of production and reducing farmgate prices.

In terms of regional distribution, the largest variations in industrial sector output occurred in the provinces of Ontario, Quebec, Alberta, and British Columbia. However, Nova Scotia is the province with the largest loss of industrial sector output relative to its pre-pandemic level (-0.6%). This is because of the importance of the fishing and seafood manufacturing industries in the province, which was heavily affected by lower demand from foodservices and exports. Meanwhile, Saskatchewan is the only region in Canada that is estimated to have been able to increase its agriculture and food industrial sector output during the pandemic, due to the preponderance of pulse and wheat farming in the province, commodities for which international demand increased significantly in 2020 because of the pandemic.

In light of these results, it seems like the pandemic has had a positive impact on several agri-food sectors while overall being negative for most industrial sectors in the economy. Yet, it is important to note the assumptions and shortcomings of the model and the scenarios to avoid misinterpreting the results. First, the model assumes that commodities are homogeneous, but the type and packaging of food products purchased in retail stores are different than those purchased by foodservice providers. This was evident in the milk dumping situation, where processors had to adapt production lines to accommodate the demand switch from foodservice to retail, causing an oversupply of milk during this adaptation period. Second, the IO model considers that inputs are used in fixed proportions by the industrial sectors, therefore assuming that the cost of production is fixed and that the same technology is used as in the base year of the model (2016). However, it is likely that the pandemic and measures adopted to limit the spread of the virus (e.g., social and physical distancing, protective equipment, sanitization products) have had an impact on production costs, which is not taken into consideration. Third, the model is adapted to study the direct and indirect effects of economic shocks on the production sector but assumes fixed prices. Depending on the sector analyzed, price effects during the pandemic can be important and should be taken into consideration for a better assessment of the effects on agri-food business profitability. Finally, the model assumes that the industrial sectors can adapt to the

shocks applied, but production capacity plays an important role in a sector's ability to quickly respond to a demand shock and disruptions caused by the virus can hamper that process. The case of the meat processing industry is an example in which production was stalled due to outbreaks of the virus and this has had consequences on other sectors along the supply chain. It is also safe to assume that farmers' production decisions were already made before the onset of the pandemic, limiting their ability to adapt to the crisis.

6.4 Policy recommendations and further research

For these reasons, results from this research may over or underestimate the industrial sector and regional impacts of COVID-19 on the Canadian agri-food industry. Nevertheless, they provide a starting point in assessing the distribution of the economic effects on the agriculture and food industrial sectors and their linkages to other industries. The analysis shows that the impacts of the pandemic were uneven across industrial sectors and regions, and highlights some challenges faced by the agri-food industry such as supply bottlenecks in meat processing and labour issues in general, but also specifically relating to TFWs and their working and living conditions.

While policymakers were quick to adopt measures to help face the challenges imposed by the coronavirus, questions regarding the efficacy and the sustainability of some of these measures remain. Except for the foodservice sector, which is still suffering severe economic repercussions, the agri-food industrial sectors proved to be resilient in a difficult context involving extreme uncertainty. Of course, it may not be wise to try predicting unpredictable Black Swan events just like the coronavirus global epidemic, but building more resilience into the food system is a desirable outcome. Therefore, measures mitigating the additional risks faced by the sector during a crisis, such as labour shortage and working conditions, are following the right path.

This research was able to assess the distributional aspect of the catastrophic economic shocks caused by COVID-19 on the agri-food sector in Canada. Results could be improved upon by considering the ability of industrial sectors to respond to important and sudden shocks, by departing from the Leontief production function used in this research, for instance. The model used also groups together several commodities that would have been interesting to study in a more disaggregated analysis to have a more precise idea of the impact of demand changes on the

production sector. With the pandemic having an important effect on employment and income, endogenizing household expenditures could provide interesting insights into the induced effects that were not analyzed in this study, especially by looking at the effects that a policy such as the CERB may have had on the economy. Finally, this research has highlighted the importance of the negative economic impact on the foodservice industry. Disaggregating the foodservice sector may shed a different light on the importance of these effects depending on the type of establishment, which could further help policymakers designing efficient measures where they are most needed.

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Appendix A: Aggregation concordance, NAICS and IIOC

NAICS		IIOC	
Code	**Industry**	**Code**	**Industry**
11	Agriculture, forestry, fishing and hunting	BS111110	Soybean farming
		BS111121	Canola farming
		BS1111Y0	Oilseed (except soybean and canola) and pulse farming
		BS111140	Wheat farming
		BS1111X0	Grain farming
		BS111211	Potato farming
		BS111900	Other crop farming
		BS111W00	Vegetable (except potato), melon, fruit and tree nut farming
		BS1114A0	Greenhouse, nursery and floriculture production (except cannabis)
		BS111CL0	Cannabis production (licensed)
		BS111CU0	Cannabis production (unlicensed)
		BS112110	Beef cattle ranching and farming, including feedlots
		BS112120	Dairy cattle and milk production
		BS112200	Hog and pig farming
		BS112300	Poultry and egg production
		BS112X00	Other animal production
		BS112500	Aquaculture
		BS113000	Forestry and logging
		BS114000	Fishing, hunting and trapping
		BS115A00	Support activities for crop and animal production
		BS115300	Support activities for forestry
21	Mining, quarrying, and oil and gas extraction	BS211110	Oil and gas extraction (except oil sands)
		BS211140	Oil sands extraction
		BS212100	Coal mining
		BS212210	Iron ore mining
		BS212220	Gold and silver ore mining
		BS212230	Copper, nickel, lead and zinc ore mining
		BS212290	Other metal ore mining
		BS212310	Stone mining and quarrying
		BS212320	Sand, gravel, clay, and ceramic and refractory minerals mining and quarrying
		BS212392	Diamond mining
		BS21239A	Other non-metallic mineral mining and quarrying (except diamond and potash)

		BS212396	Potash mining
		BS21311A	Support activities for oil and gas extraction
		BS21311B	Support activities for mining
22	Utilities	BS221100	Electric power generation, transmission and distribution
		BS221200	Natural gas distribution
		BS221300	Water, sewage and other systems
23	Construction	BS23A000	Residential building construction
		BS23B000	Non-residential building construction
		BS23C100	Transportation engineering construction
		BS23C200	Oil and gas engineering construction
		BS23C300	Electric power engineering construction
		BS23C400	Communication engineering construction
		BS23C500	Other engineering construction
		BS23D000	Repair construction
		BS23E000	Other activities of the construction industry
31-33	Manufacturing	BS311111	Dog and cat food manufacturing
		BS311119	Other animal food manufacturing
		BS3112X0	Grain and oilseed milling (except oilseed processing)
		BS311224	Oilseed processing
		BS311310	Sugar manufacturing
		BS3113X0	Confectionery product manufacturing
		BS311410	Frozen food manufacturing
		BS311420	Fruit and vegetable canning, pickling and drying
		BS311500	Dairy product manufacturing
		BS3116X0	Meat product manufacturing (except poultry processing)
		BS311615	Poultry processing
		BS311700	Seafood product preparation and packaging
		BS3118X0	Tortilla and pasta manufacturing
		BS3118Y0	Bread, cookie, cracker and bakery product manufacturing
		BS311919	Other snack food manufacturing
		BS3119X0	Other food manufacturing (except other snack foods)
		BS312110	Soft drink and ice manufacturing
		BS312120	Breweries
		BS3121A0	Wineries and distilleries
		BS312200	Tobacco manufacturing
		BS31A000	Textile and textile product mills

		BS31B000	Clothing and leather and allied product manufacturing
		BS321100	Sawmills and wood preservation
		BS321200	Veneer, plywood and engineered wood product manufacturing
		BS321900	Other wood product manufacturing
		BS322100	Pulp, paper and paperboard mills
		BS322200	Converted paper product manufacturing
		BS323000	Printing and related support activities
		BS324110	Petroleum refineries
		BS3241A0	Petroleum and coal product manufacturing (except petroleum refineries)
		BS325100	Basic chemical manufacturing
		BS325200	Resin, synthetic rubber, and artificial and synthetic fibres and filaments manufacturing
		BS325300	Pesticide, fertilizer and other agricultural chemical manufacturing
		BS325400	Pharmaceutical and medicine manufacturing
		BS325500	Paint, coating and adhesive manufacturing
		BS325600	Soap, cleaning compound and toilet preparation manufacturing
		BS325900	Other chemical product manufacturing
		BS326100	Plastic product manufacturing
		BS326200	Rubber product manufacturing
		BS327A00	Non-metallic mineral product manufacturing (except cement and concrete products)
		BS327300	Cement and concrete product manufacturing
		BS331100	Iron and steel mills and ferro-alloy manufacturing
		BS331200	Steel product manufacturing from purchased steel
		BS331300	Alumina and aluminum production and processing
		BS331400	Non-ferrous metal (except aluminum) production and processing
		BS331500	Foundries
		BS332100	Forging and stamping
		BS332A00	Cutlery, hand tools and other fabricated metal product manufacturing
		BS332300	Architectural and structural metals manufacturing
		BS332400	Boiler, tank and shipping container manufacturing
		BS332500	Hardware manufacturing
		BS332600	Spring and wire product manufacturing
		BS332700	Machine shops, turned product, and screw, nut and bolt manufacturing

		BS332800	Coating, engraving, cold and heat treating and allied activities
		BS333100	Agricultural, construction and mining machinery manufacturing
		BS333200	Industrial machinery manufacturing
		BS333300	Commercial and service industry machinery manufacturing
		BS333400	Ventilation, heating, air-conditioning and commercial refrigeration equipment manufacturing
		BS333500	Metalworking machinery manufacturing
		BS333600	Engine, turbine and power transmission equipment manufacturing
		BS333900	Other general-purpose machinery manufacturing
		BS334100	Computer and peripheral equipment manufacturing
		BS334200	Communications equipment manufacturing
		BS334A00	Other electronic product manufacturing
		BS334400	Semiconductor and other electronic component manufacturing
		BS335100	Electric lighting equipment manufacturing
		BS335200	Household appliance manufacturing
		BS335300	Electrical equipment manufacturing
		BS335900	Other electrical equipment and component manufacturing
		BS336110	Automobile and light-duty motor vehicle manufacturing
		BS336120	Heavy-duty truck manufacturing
		BS336200	Motor vehicle body and trailer manufacturing
		BS336310	Motor vehicle gasoline engine and engine parts manufacturing
		BS336320	Motor vehicle electrical and electronic equipment manufacturing
		BS336330	Motor vehicle steering and suspension components (except spring) manufacturing
		BS336340	Motor vehicle brake system manufacturing
		BS336350	Motor vehicle transmission and power train parts manufacturing
		BS336360	Motor vehicle seating and interior trim manufacturing
		BS336370	Motor vehicle metal stamping
		BS336390	Other motor vehicle parts manufacturing

		BS336400	Aerospace product and parts manufacturing
		BS336500	Railroad rolling stock manufacturing
		BS336600	Ship and boat building
		BS336900	Other transportation equipment manufacturing
		BS337100	Household and institutional furniture and kitchen cabinet manufacturing
		BS337200	Office furniture (including fixtures) manufacturing
		BS337900	Other furniture-related product manufacturing
		BS339100	Medical equipment and supplies manufacturing
		BS339900	Other miscellaneous manufacturing
41	Wholesale trade	BS411000	Farm product merchant wholesalers
		BS412000	Petroleum and petroleum products merchant wholesalers
		BS413000	Food, beverage and tobacco merchant wholesalers
		BS414000	Personal and household goods merchant wholesalers
		BS415000	Motor vehicle and motor vehicle parts and accessories merchant wholesalers
		BS416000	Building material and supplies merchant wholesalers
		BS417000	Machinery, equipment and supplies merchant wholesalers
		BS418000	Miscellaneous merchant wholesalers
		BS419000	Business-to-business electronic markets, and agents and brokers
44-45	Retail trade	BS441000	Motor vehicle and parts dealers
		BS442000	Furniture and home furnishings stores
		BS443000	Electronics and appliance stores
		BS444000	Building material and garden equipment and supplies dealers
		BS445000	Food and beverage stores
		BS446000	Health and personal care stores
		BS447000	Gasoline stations
		BS448000	Clothing and clothing accessories stores
		BS451000	Sporting goods, hobby, book and music stores
		BS452000	General merchandise stores
		BS453A00	Miscellaneous store retailers (except cannabis)
		BS453BL0	Cannabis stores (licensed)
		BS453BU0	Cannabis stores (unlicensed)
		BS454000	Non-store retailers
48-49	Transportation and warehousing	BS481000	Air transportation
		BS482000	Rail transportation

		BS483000	Water transportation
		BS484000	Truck transportation
		BS485100	Urban transit systems
		BS48A000	Other transit and ground passenger transportation and scenic and sightseeing transportation
		BS485300	Taxi and limousine service
		BS486A00	Crude oil and other pipeline transportation
		BS486200	Pipeline transportation of natural gas
		BS488000	Support activities for transportation
		BS491000	Postal service
		BS492000	Couriers and messengers
		BS493000	Warehousing and storage
51	Information and cultural industries	BS511110	Newspaper publishers
		BS5111A0	Periodical, book and directory publishers
		BS511200	Software publishers
		BS5121A0	Motion picture and video industries (except exhibition)
		BS512130	Motion picture and video exhibition
		BS512200	Sound recording industries
		BS515100	Radio and television broadcasting
		BS515200	Pay and specialty television
		BS517000	Telecommunications
		BS518000	Data processing, hosting, and related services
		BS519000	Other information services
52	Finance and insurance	BS521000	Monetary authorities - central bank
		BS5221A0	Banking and other depository credit intermediation
		BS522130	Local credit unions
		BS522200	Non-depository credit intermediation
		BS522300	Activities related to credit intermediation
		BS52A000	Financial investment services, funds and other financial vehicles
		BS524100	Insurance carriers
		BS524200	Agencies, brokerages and other insurance related activities
53	Real estate and rental and leasing	BS531100	Lessors of real estate
		BS531A00	Offices of real estate agents and brokers and activities related to real estate
		BS5311A0	Owner-occupied dwellings
		BS532100	Automotive equipment rental and leasing
		BS532A00	Rental and leasing services (except automotive equipment)

		BS533000	Lessors of non-financial intangible assets (except copyrighted works)
54	Professional, scientific and technical services	BS541100	Legal services
		BS541200	Accounting, tax preparation, bookkeeping and payroll services
		BS541300	Architectural, engineering and related services
		BS541400	Specialized design services
		BS541500	Computer systems design and related services
		BS541600	Management, scientific and technical consulting services
		BS541700	Scientific research and development services
		BS541800	Advertising, public relations, and related services
		BS541900	Other professional, scientific and technical services
55	Management of companies and enterprises	BS551113	Holding companies
56	Administrative and support, waste management and remediation services	BS561100	Office administrative services
		BS561A00	Facilities and other support services
		BS561300	Employment services
		BS561400	Business support services
		BS561500	Travel arrangement and reservation services
		BS561600	Investigation and security services
		BS561700	Services to buildings and dwellings
		BS562000	Waste management and remediation services
61	Educational services	BS610000	Educational services
		NP610000	Educational services
		GS611100	Elementary and secondary schools
		GS611200	Community colleges and C0E0G0E0P0s
		GS611300	Universities
		GS611A00	Other educational services
62	Health care and social assisance	BS621100	Offices of physicians
		BS621200	Offices of dentists
		BS621A00	Miscellaneous ambulatory health care services
		BS623000	Nursing and residential care facilities
		BS624000	Social assistance
		GS622000	Hospitals
		GS623000	Nursing and residential care facilities
		NP621000	Ambulatory health care services
		NP624000	Social assistance
71	Arts, entertainment and recreation	BS71A000	Performing arts, spectator sports and related industries, and heritage institutions

		BS713A00	Amusement and recreation industries
		BS713200	Gambling industries
		NP710000	Arts, entertainment and recreation
		NP999999	Other non-profit institutions serving households
72	Accomodation and food services	BS721100	Traveller accommodation
		BS721A00	Recreational vehicle (RV) parks, recreational camps, and rooming and boarding houses
		BS722000	Food services and drinking places
81	Other services (except public administration)	BS811100	Automotive repair and maintenance
		BS811A00	Repair and maintenance (except automotive)
		BS812A00	Personal care services and other personal services
		BS812200	Funeral services
		BS812300	Dry cleaning and laundry services
		BS813000	Business, professional and other membership organizations
		BS814000	Private households
		NP813100	Religious organizations
		NP813A00	Grant-making, civic, and professional and similar organizations
	Fictional	FC110000	Repair and maintenance
		FC120000	Operating supplies
		FC130000	Office supplies
		FC210000	Advertising, promotion, meals and entertainment
		FC220000	Travel, meetings and conventions
		FC300000	Transportation margins
91	Public administration	GS911100	Defence services
		GS911A00	Other federal government services (except defence)
		GS912000	Other provincial and territorial government services
		GS913000	Other municipal government services
		GS914000	Other aboriginal government services

Appendix B: Commodity concordance, Nielsen data and IIOC

IIOC	Nielsen categories
Bottled water, soft drinks and ice	Flavoured soft drinks Flat water Carbonated water Rtd iced tea cans Coconut water Iced tea mixes
Bread, rolls and flatbreads	Bread - prepackaged Rolls - prepackaged Rolls - in store Tortilla/wraps - prepackaged Bread - in store Bread - dry Croutons Tortilla/wraps - in store
Breakfast cereal and other cereal products	Rte cereals Infant cereal Bread crumbs & corn flakes Butter & dairy spreads Infant formula Coffee creamers - flavoured Milk - c&b Coffee whiteners Powdered milk Coffee creamers excl flavoured
Cheese and cheese products	Natural cheese - exact weight Natural cheese - exact weight deli Natural cheese - random weight Cream cheese - exact weight Processed cheese slices Cottage cheese Grated cheese products Processed cheese spreads Cream cheese - random weight
Chocolate (except confectionery)	Hot chocolate

	Cocoa powder Baking chocolate solid
Coffee and tea	Coffee - roast & ground Tea Coffee -instant Coffee type drinks Hot instant tea Coffee substitutes
Confectionery products	Chocolate Candy confections Gum
Cookies, crackers and baked sweet goods	Baked desserts and breakfast - prepackaged Cookies Crackers Baked desserts - in store Baked breakfast - in store Infant & toddler snacks Graham wafers & crumbs Ice cream cones Graham crusts Baking mixes -puddings
Eggs in shell	Eggs
Fish, crustaceans, shellfish and other fishery products	Fresh seafood
Flavouring syrups, seasonings and dressings	Salad dressing - pourable Mayonnaise & spoonable salad dressing Spices Seasonings & salad toppings Sauce & gravy mix Oriental sauces Meat & seafood sauces Vinegar Baking & cooking sauce Barbecue sauces Mustard - prepared Mexican seasonings Pepper Salt & substitutes Table syrups Garlic spreads

	Cordials & syrups Heavy syrups Liquid seasonings Gravy makers & enhancers Salad dressing - dry Mustard - dry Cream of tartar Pickling salts
Flour and other grain mill products	Flour Hot cereals Cornmeal Wheat germ
Flour mixes, dough and dry pasta	Pasta - dry Dough - refrigerated Cake mixes Pancake & waffle mixes Baking mixes - remaining Pizza crusts - refrigerated Muffin mixes Brownie mixes Couscous Pizza mixes kits Biscuit mixes Cookie mixes Bread / roll / pizza mixes Batters & batter mixes Yorkshire pudding mixes Pie crust mixes Pizza crust/dough - in store No bake products
Fresh and frozen beef and veal	Beef Meat patties - frozen Veal
Fresh and frozen pork	Pork Ham
Fresh and frozen poultry of all types	Chicken Cooked chicken Turkey
Fresh fruits and nuts	Berries Apple Bananas

	Grapes Snacking fruits nuts & seeds Avocados Melon Tangerines/clementines/mandarins Oranges Cherries Fruit salad/mixed fruit Lemons Pears Pineapple Mango Peaches Baking nuts Nectarines Limes Kiwi Plums Grapefruit Other fruits Pomegranate Papaya Apricots Tangelos Persimmon Figs Dates
Fresh potatoes	Potatoes
Fresh vegetables (except potatoes)	Tomatoes Salad - bagged Peppers Onions Cucumbers Broad leaf vegetables - bagged Carrots Mushrooms Lettuces/greens Broccoli Other veg

	Celery Cauliflower Asparagus Mixed+mixed vegetables Beans Corn Cabbage Squash Zucchini Peas Garlic Brussel sprouts Yams Eggplant Kale Radishes Beets Bok choy Ginger root Leeks Sprouts Spinach Pumpkin Okra Turnips Parsnips Rappini Anise Chard Greens Yu choy Kohlrabi Artichokes
Fresh, frozen and canned fruit and vegetable juices	Juices & drinks - shelf stable Juices & drinks - refrigerated Vegetable juices Fruit beverages - frozen Tomato juice Lemon & lime juice Juices & drinks - unspecified
Grain and oilseed products, n.e.c.	Rice - regular

	Rice - specialty Edible seeds Corn starch
Ice cream, sherbet and similar frozen desserts	Ice cream & related products Confections - frozen Yogurt - frozen Water based freezable confections
Margarine and cooking oils	Cooking oils Margarine Cooking sprays Lard & shortening
Other food products, n.e.c.	Dips - prepared Peanut butter Tofu & meat dairy alternatives Sweet spreads Baking chips Honey Flavoured drink mixes Mexican dinner kits & shells Toppings - whipped Sugar substitutes Baking aids Baking extracts Drink powders & liquids - cold Coating mixes Jelly powders Stuffing mixes Yeast less than 500gm Baking powder Cake decor Baking soda Coconut Sundae toppings Instant breakfasts Fondue products Fruit pectin & preservatives Cocktail mixes Food colourings

	Kosher foods Sandwich spreads Toppings - powdered Dips - mixes Fruit glazes Baking gum
Other miscellaneous crop products	Pure maple syrups Seafood - frozen Tuna - c&b Seafood - c&b Salmon - c&b Imitation seafood Seafood spreads & pastes Fish & chips - frozen
Preserved fruit and vegetables and frozen foods	Dinners & entrees - frozen Refrig / deli entrees Soup Pizza & subs - frozen Prepared / deli salads Vegetables - frozen Side dishes Fruit - frozen Pasta sauce - c&b Potatoes - frozen Mexican salsa dips & garnishes Sushi / specialty japanese food Vegetables - c&b Pickles Jams jellies & marmalades Breakfast - frozen Fruit & apple sauce - single serve Oriental noodles & instant light lunches Tomatoes - c&b Ketchup Baked desserts - frozen Pasta - refrigerated Pizza snacks - frozen

	Baby food Refrig / deli pizza Semi moist fruit Specialty eastern foods Fruit - c&b Olives Dough & pastry - frozen Vegetables - dry Baked beans Soup mixes - dry Bouillon products Dry fruit Pasta - c&b Beans - c&b - remaining Pasta and remaining sauces Gravy - c&b Pie fillings Tomato paste Kidney beans - c&b Tomato sauce Asian noodles Peas & beans - c&b Mushrooms - c&b Pizza sauce Chili sauce Relish Chinese food Potatoes - c&b Pickled vegetables Toaster pastries Oriental fondue & bouillon Apple sauce Cranberry sauces - c&b Frozen foods - remaining Processed loaf Bruschetta toppings Maraschino cherries Salad mixes Glazed fruit Beets - c&b Chutney

	Peas - c&b - remaining Soup base mixes
Processed fluid milk and milk products	Milk Yogurt products - refrigerated Cream Sour cream Whipping cream Milkshakes & eggnogs
Processed meat products, other miscellaneous meats and animal by-products	Luncheon meat - exact weight Luncheon meat - random weight Bacon & substitutes Sausages - exact weight Wieners Meat sticks & beef jerky Sausages - random weight Meat - c&b Rem fresh meat Lamb Meat - frozen - remaining Meat pies refrigerated Chili con carne Stew & meatball entrees - c&b Bacon - random weight Meat spreads - c&b Deli wieners Deli beef jerky
Snack food products	Salty snacks Nutritious portable foods Snack puddings Popping corn Puffed cakes Lunch kits Candied snack foods Marshmallow treats Marshmallows Rte gelatin Lunch packs Puddings

	Pudding - rte family size
Sugar and sugar mill by-products	Sugar Icing products Molasses Dessert powders - remaining

Appendix C: Household food expenditures, value share, value and volume change, per region

Household Food Expenditures Categories	Atlantic			Quebec			Manitoba - Saskatchewan		
	Value share (%)	Δ Value, %	Δ Volume, %	Value share (%)	Δ Value, %	Δ Volume, %	Value share (%)	Δ Value, %	Δ Volume, %
Bottled water, soft drinks and ice	3,77%	7,39%	5,26%	3,05%	8,34%	3,90%	3,52%	13,19%	8,08%
Bread, rolls and flatbreads	4,40%	5,01%	-1,54%	5,09%	8,66%	3,86%	4,02%	7,99%	-2,38%
Breakfast cereal and other cereal products	1,48%	5,18%	3,23%	1,38%	9,38%	5,78%	1,53%	8,22%	4,56%
Butter and dry and canned dairy products	1,69%	17,13%	12,31%	1,38%	19,37%	19,04%	1,96%	19,18%	16,89%
Cheese and cheese products	4,60%	13,08%	7,22%	6,37%	15,26%	10,82%	4,77%	15,92%	10,06%
Chocolate (except confectionery)	0,12%	23,36%	26,31%	0,09%	31,64%	30,10%	0,13%	29,94%	28,67%
Coffee and tea	2,16%	16,29%	19,41%	2,02%	17,21%	14,67%	2,40%	15,63%	14,78%
Confectionery products	3,94%	3,14%	1,55%	2,58%	3,66%	3,93%	3,34%	6,36%	5,71%
Cookies, crackers and baked sweet goods	4,88%	3,92%	-2,58%	4,54%	6,74%	-0,40%	4,06%	3,65%	-10,98%
Eggs in shell	1,47%	14,57%	2,67%	1,20%	17,85%	8,44%	1,40%	17,04%	7,86%
Fish, crustaceans, shellfish and other fishery products	1,09%	5,94%	0,38%	1,73%	14,01%	19,19%	0,45%	14,46%	-2,02%
Flavouring syrups, seasonings and dressings	2,36%	16,95%	13,01%	2,10%	22,41%	16,67%	2,44%	22,86%	17,07%
Flour and other grain mill products	0,55%	19,79%	22,59%	0,40%	29,13%	35,93%	0,56%	23,87%	20,44%
Flour mixes, dough and dry pasta	0,87%	18,64%	11,22%	0,98%	18,53%	10,13%	0,80%	20,37%	13,16%
Fresh and frozen beef and veal	4,97%	10,99%	0,91%	5,10%	18,62%	12,26%	4,24%	15,15%	4,10%
Fresh and frozen pork	1,80%	13,20%	8,80%	1,78%	16,32%	6,59%	1,83%	20,40%	14,92%
Fresh and frozen poultry of all types	4,61%	4,72%	1,44%	3,75%	8,88%	6,96%	3,71%	9,45%	6,90%
Fresh fruits and nuts	7,01%	4,33%	1,61%	8,18%	10,34%	8,49%	9,16%	7,35%	4,85%
Fresh potatoes	1,05%	5,97%	6,99%	0,91%	11,99%	15,85%	0,91%	15,47%	11,98%
Fresh vegetables (except potatoes)	6,65%	8,41%	4,55%	8,27%	17,51%	11,00%	8,62%	11,72%	8,04%
Fresh, frozen and canned fruit and vegetable juices	2,59%	6,44%	2,22%	2,97%	8,47%	2,78%	2,35%	11,63%	7,47%

Grain and oilseed products, n.e.c.	0,46%	16,58%	16,20%	0,50%	17,01%	15,01%	0,67%	16,98%	15,72%
Ice cream, sherbet and similar frozen desserts	1,50%	15,47%	2,65%	1,32%	22,08%	12,89%	1,33%	18,08%	8,41%
Margarine and cooking oils	1,02%	15,28%	14,17%	0,92%	21,24%	18,89%	1,02%	19,26%	14,27%
Other food products, n.e.c.	2,74%	15,99%	11,28%	2,47%	19,70%	14,48%	2,54%	19,30%	13,07%
Other miscellaneous crop products	0,12%	8,86%	12,83%	0,22%	12,34%	10,18%	0,07%	26,74%	28,53%
Prepared and packaged seafood products	1,55%	10,12%	7,82%	1,88%	26,18%	20,38%	1,51%	21,86%	17,35%
Preserved fruit and vegetables and frozen foods	13,13%	12,23%	10,44%	12,40%	18,07%	14,10%	12,51%	16,04%	14,27%
Processed fluid milk and milk products	6,11%	6,79%	4,68%	6,64%	9,42%	6,82%	6,43%	7,54%	5,51%
Processed meat products, other miscellaneous meats and animal by-products	5,43%	10,79%	5,31%	5,83%	17,05%	10,01%	6,39%	13,09%	7,36%
Snack food products	5,53%	6,89%	4,03%	3,68%	10,04%	5,73%	4,95%	10,16%	6,45%
Sugar and sugar mill by-products	0,35%	16,38%	16,89%	0,27%	19,97%	20,24%	0,38%	18,76%	15,58%

Household Food Expenditures Categories	**Ontario**			**Alberta**			**British Columbia**		
	Value share (%)	**Δ Value, %**	**Δ Volume, %**	**Value share (%)**	**Δ Value, %**	**Δ Volume, %**	**Value share (%)**	**Δ Value, %**	**Δ Volume, %**
Bottled water, soft drinks and ice	3,38%	11,07%	6,97%	3,15%	13,14%	12,04%	2,79%	11,77%	7,80%
Bread, rolls and flatbreads	4,52%	9,90%	-5,90%	3,94%	7,48%	-3,89%	4,01%	11,11%	-7,04%
Breakfast cereal and other cereal products	1,46%	10,23%	6,04%	1,41%	7,65%	4,58%	1,46%	9,44%	6,57%
Butter and dry and canned dairy products	1,78%	19,09%	22,33%	2,00%	18,02%	16,93%	1,99%	17,24%	18,87%
Cheese and cheese products	4,81%	18,95%	12,11%	4,70%	14,52%	10,26%	4,83%	18,11%	13,78%
Chocolate (except confectionery)	0,11%	36,15%	33,17%	0,13%	26,49%	25,84%	0,13%	26,89%	23,13%
Coffee and tea	2,17%	21,75%	21,49%	2,35%	15,75%	17,44%	2,58%	19,74%	20,97%
Confectionery products	3,24%	3,95%	4,31%	3,63%	5,53%	5,10%	3,62%	7,69%	6,75%
Cookies, crackers and baked sweet goods	4,79%	1,25%	-11,83%	4,05%	2,30%	-16,80%	4,23%	4,34%	-16,35%
Eggs in shell	1,48%	23,57%	10,46%	1,47%	15,58%	8,91%	1,72%	17,14%	9,69%

Fish, crustaceans, shellfish and other fishery products	0,81%	22,21%	15,99%	0,64%	14,77%	16,92%	1,12%	13,03%	38,16%
Flavouring syrups, seasonings and dressings	2,20%	24,95%	17,96%	2,50%	21,60%	17,39%	2,43%	24,38%	18,98%
Flour and other grain mill products	0,54%	30,41%	36,53%	0,57%	24,76%	25,42%	0,60%	27,76%	28,17%
Flour mixes, dough and dry pasta	0,83%	27,80%	19,94%	0,78%	22,30%	16,12%	0,73%	25,28%	18,88%
Fresh and frozen beef and veal	4,15%	18,93%	10,87%	4,68%	16,50%	7,42%	3,89%	20,30%	9,32%
Fresh and frozen pork	1,40%	20,39%	16,55%	1,68%	18,50%	15,84%	1,47%	20,15%	14,54%
Fresh and frozen poultry of all types	4,46%	10,11%	6,41%	4,06%	6,07%	2,83%	4,25%	10,31%	7,62%
Fresh fruits and nuts	9,45%	9,88%	6,38%	9,21%	5,90%	3,28%	9,06%	8,93%	5,55%
Fresh potatoes	0,99%	15,24%	19,29%	0,92%	14,48%	12,44%	0,92%	20,83%	15,12%
Fresh vegetables (except potatoes)	9,14%	16,16%	10,86%	9,29%	10,89%	8,36%	9,42%	14,25%	11,35%
Fresh, frozen and canned fruit and vegetable juices	2,71%	9,52%	4,08%	2,30%	9,03%	5,77%	2,38%	8,58%	6,08%
Grain and oilseed products, n.e.c.	0,60%	24,94%	20,96%	0,69%	16,92%	17,36%	0,64%	22,58%	20,22%
Ice cream, sherbet and similar frozen desserts	1,48%	23,60%	11,96%	1,29%	20,00%	10,99%	1,47%	19,49%	9,03%
Margarine and cooking oils	0,95%	24,57%	18,34%	0,91%	19,21%	14,98%	0,91%	20,50%	13,54%
Other food products, n.e.c.	2,55%	21,78%	16,18%	2,55%	18,36%	13,67%	2,82%	21,35%	16,99%
Other miscellaneous crop products	0,12%	20,80%	22,17%	0,09%	17,89%	22,83%	0,13%	11,66%	16,81%
Prepared and packaged seafood products	1,72%	25,99%	20,58%	1,61%	21,62%	17,82%	1,55%	28,28%	23,32%
Preserved fruit and vegetables and frozen foods	12,02%	18,67%	17,49%	12,18%	14,94%	14,97%	12,13%	18,62%	18,12%
Processed fluid milk and milk products	5,91%	10,26%	7,65%	6,29%	6,57%	5,20%	6,52%	7,96%	6,26%
Processed meat products, other miscellaneous meats and animal by-products	5,42%	16,53%	10,86%	5,94%	13,74%	8,45%	5,39%	14,48%	9,10%
Snack food products	4,56%	8,50%	6,16%	4,67%	9,14%	6,39%	4,46%	10,79%	8,37%
Sugar and sugar mill by-products	0,26%	25,60%	26,28%	0,33%	21,09%	20,19%	0,34%	22,28%	19,78%

Source: The Nielsen Company, provided by AAFC, 2021